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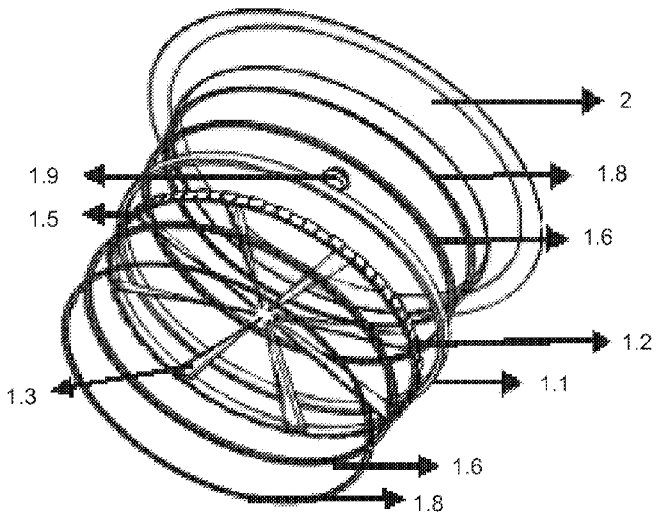

FIGURE 1

(57) Abstract: The invention relates to a shaftless shrouded multi-blade wind turbine which has turbine blades located at the outer diameter instead of the center. The new wind turbine design simultaneously converts kinetic energy of wind into mechanical and electrical energy with its special designed generator rotor together with the larger blades chord which has its chord increases with distance from the center. The rotors, which haven't axis shafts, belonging to special designed generator, rotates with the fan blades integrated with the rotor in the magnetic shell supporting with bearings. The system makes use of all the advantages of both direct drive and brushless motor technologies. This design has a new concept that allows easy installation on buildings and bridges as it does not need supportive towers and support equipments for the central component of the wind turbine.

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[Continued on next page]

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SHAFTLESS MULTI BLADE WIND TURBINE

TECHNICAL FIELD

The invention relates to a shaftless shrouded multi-blade wind turbine which has turbine blades located at the outer diameter instead of the center

PRIOR ART

There is a growing interest to use clean renewable energy resources due to recent energy demand and the high energy cost. Moreover, tendency towards the use of clean renewable energy resources such as wind, solar and water has augmeted because of environment pollution concerns. Investment, thus, has been grown on wind energy in the last decade. In addition, nowadays smart structures that can produce their own energy became popular. Studies on new structures that contain wind turbines take place among priority areas in United States and Europe under “Green Building” concept. A wind turbine typically consists of a tower, a generator, a gearbox, electrical-electronic components and a propeller. The kinetic energy of the wind is converted into mechanical energy by the rotor blades. The rotary motion of the rotor shaft is accelerated and transferred to the generator. Electric energy produced by the generator can either be grid-connected or off-grid using battery for energy storage. A gearbox is used in wind turbines to transmit mechanical power to the generator at different speeds. In recent years, direct drive technology has started to be used in wind turbines as well as in many applications, and wind turbines without gearboxes have been produced. This technology reduces the turbine and maintenance costs.

Small wind turbines that operate in low-wind environments suffer from performance degradation as they often fail to accelerate to a steady, power-generating condition. At low Reynolds number and high attack angle, flow separation occurs at the leading-edge resulting in a sudden stall and consequently power loss. Previous studies showed that the design of airfoil is important to achieve better startability and recommended the use of mixedairfoils. The improved starting capability effectively reduces the time that the turbine takes to reach its power-extraction period and, hence, an increase in overall energy production which can be as much as 40% of the generated energy. This is actually due to the fact that it is commonly known as the "Betz limit". Moreover, small turbines have low start-up torque because of their short rotor diameter (<30cm*)*, blade length and smaller chord towards the blade tip. The power coefficient of small wind turbines can be about 0.25 which is much lower than their large counterparts with a power coefficient reaching 0.45. Due to the limited area problems of urban areas, where lower high tower towers are used instead of large wind turbine small wind turbines.

The aerodynamics characteristic of the rotor airfoil is a key factor which mostly affects the performance. Conventional wind turbine generally has airfoil profiles that has a larger chord size towards the center and becomes narrow towards the tip. The rotor of the generator is driven by a shaft which has smaller diameter than the rotor.

BRIEF SUMMARY OF THE INVENTION

The invention is providing a new concept of wind turbine that allows easy installation on buildings as it does not need supportive neither a tower especially in urban area nor support equipments for the centrally located components of the wind turbine because there is no generator in the centre.

In the new design, the generator is located radially around the turbine blades. The wind turbine does not have a gearbox as it make use of all the advantages of both direct drive and brussless motor technologies.

The rotor has been especially designed to have a larger chord size at the blade tip and decreases with distance from the rotor center. This new design makes able more blades to be installed in the shroud in many various ways to achieve the best performance. In the case of known wind turbines, on the contrary, the high wing width is used in the near-center area and the width of the wing is reduced as the distance from the center increases. Because known turbines are tied to their towers from their center, and in order to provide rigidity, the weight physically reduces the most at the end points of the wings.

Thanks to the special aerodynamic design of the stator and the fixed parts with which the invention is associated, the efficiency is increased as the pressure difference is generated by suddenly changing the direction of flow passing around the turbine. This stator and the fixed part to which it is connected are assembled and carried around the structure, not the center.

The stator in front of / behind / surrounding the rotor of the invention can be a generator, motor or magnetic bearing stator, and these stators, which are wider, can include more complex generator and / or motor and / or magnetic bearing coils.

THE MEANING OF THE FIGURES

Description of the Reference Numerals.

1. Wind turbine
   - 1.1. Stator (radial)
   - 1.2. Rotor
   - 1.3. Turbine Blades
   - 1.4. Magnetic Shell
   - 1.5. Permanent Magnet Bars
   - 1.6. Stator (axial)
   - 1.7. Protection Cover of generator
   - 1.8. Side Cover of generator
   - 1.9. Central rigidity part
2. Wind Turbine shroud and Flansh
   - 2.1. Bearing and safety bearing
3. Control Units
   - 3.1. Microprocessor

3.2. Software
3.3. Magnetic bearing sensors, Distance Sensors
3.4. Speed sensors, Encoder Sensor
3.5. Gyroscope Balance Sensor

DETAILED DESCRIPTION OF THE INVENTION

The invention is a shaftless multi-blade wind turbine which uses a generator impeded into the shroud that holds the rotor blades. The invention is constituted by the parts which are the Wind Turbine with rotor-integrated turbine blades (1), Wind Turbine Shroud *and Flansh* (2), control units (3) and power unit.

The wind turbine (1) is formed by the parts which are at least a stator (1.1), at least a rotor (1.2), at least two blades for turbine (1.3), magnetic shell (1.4) , at least a permanent magnet bar (1.5), Stator (axial) (1.6), generator protection cover and flange (1.7), Side Cover of generator (1.8), Central rigidity part (1.9).

The Wind Turbine (1), which is energized by the power unit at the beginning, produces electricity with its generator. The wind turbine (1) has the all advantages and features of the highly efficient direct-drive technology. The wind turbine maintains the rotation speed of the turbine winds (1.3) and rotor (1.2) by the excitation motor and using different stators or the different coils in the stators. Stator (radial) (1.1) and Stator (axial) (1.6) parts contain more than one coils. These coils are used to obtain the energy with highest possible efficiency from the rotor (1.2), which rotates with different speeds regarding the different speeds of the wind. Some coils are used as generator coils and some are used to hold the speed of the rotor (1.2) in the speed which yields highest possible efficiency. Some other coils are used as magnetic bed coils. Magnetic bed coils are used to assure that the rotor does not contact the stator during rotation (a contactless rotor is obtained). For this purpose, the data coming from gyroscopic balance sensors (3.5) and magnetic bed distance sensor (3.3) are processed via the microprocessor (3.1) and the required power is provided to the corresponding coils of the stator for keeping the rotor contactless. Stator (radial) (1.1) and the Stator (axial) (1.6) are energized by the power unit.

The novel design of the Wind Turbine (1) is gearless and ensures that the rotation speed is maintained constant by using more than one stator (radial) (1.1) and stator (axial) (1.6) or using the different combinations of coils embedded in the stator (as discussed in the previous paragraph) so that electricity is produced with a higher efficiency. The conventional generators work efficiently in one speed and that speed is maintained by a gear box. On the other hand, our design contains different stators and coils which ensures highest possible efficiency in different rotation speeds: For different speeds of the rotor regarding the different wind speeds, the stator which gives the maximum possible efficiency is chosen by the software and control system. Conventional generators are designed and optimized to give maximum efficiency for a pre-determined speed. For example, the rotor is assumed to rotate at the speed of 50 rpm and the generator is designed accordingly. If the efficiency of this generator is 75% at this speed, the efficiency will be lower at different speeds. In our design, which does not contain gear box, this efficiency loss is prevented by using more than one stators which contain different number of coils inside. These coils can be organized by the efficiency maximizing software (3.2) in the microprocessor (3.1) in such a way that the coils can become active, passive, rotor driver or magnetic shell driver according to the different speeds of the wind. Wind speed and rotor (1.2) speed, which are acquired by encoder and speed sensors, are inputs to the efficiency maximizing software (3.2). It is defined in the software (3.2) that which coils will be active and passive with respect to different wind speeds. This definition is the coil placement of the generator which gives the maximum efficiency at that speed. If the rotation speed information from sensors equal to that speed then the corresponding coils are activated according to the definition. If the rotation speed is not one of the defined ones in the software, then the some of the coils are activated as a rotor driver by the microprocessor (3.1) and the speed is increased to the nearest defined speed. The software (3.2) also uses some of the coils in the stator to maintain contactless rotation of the rotors.

Wind Turbine Shroud and Flansh (2) make the turbine to be mounted on any desired building without the need of tower or central point. The design of Wind Turbine Shroud and Flansh (2) is such that wind changes direction abruptly at the exit of the turbine which generates low-pressure field which, in turn, increases the efficiency. Wind Turbine Shroud and Flansh (2) generates low-pressure field by limiting the air flow which also increase air flow into the turbine.

Turbine winds (1.3) are fixed to the rotor (1.2) ring at internal surface of the rotor (1.2) without a shaft. Turbine winds (1.3) has the profile which is narrow at the centre and which enlarges towards the outer wall and has no shaft. The rotor (1.2) moves circularly in the magnetic bed generated by the permanent magnet bars (1.5) and the stator (axial) (1.6). The rotor (1.2) contains at least two turbine blades fixed at the internal surface without a shaft. As the number of blades is increased the efficiency is increased and the lower rotation speeds are possible.

The Wind Turbine Shroud and Flansh (2) contains the parts which are bearing and safety bearing (2.1) and connecting flansh and components (2.2). Bearing and safety bearing (2.1) is used to maintain contactless rotation of the rotor (2.1) in the case of sudden wind speed and weather condition changes. In such a case the rotor contacts first to bearing and safety bearing (2.1). Bearing and safety bearing (2.1) are located conically. The locating angles are chosen such that the rotor is sent back to the central position. These angles are specified by the shape of the rotor (1.2) and the number magnets it contains. By this way, at the point where the rotor touches to bearing and safety bearing (2.1) a natural action-reaction force occurs which sends the rotor to back to its position.

The control unit (3) is constituted by the parts which are microprocessor (3.1), software (3.2), Magnetic bearing sensors, Distance Sensors (3.3), Speed sensors, encoder sensor (3.4) Gyroscope Balance Sensor (3.5) and connection components for connecting power unit (3.6). The microprocessor (3.1) processes the data real-tinme coming from gyroscopic balance sensors (3.5), encoder and speed sensor (3.4) and magnetic bed distance sensor (3.3) and controls the magnetic bed coils and the wind turbine to generate electricity with a higher efficiency. Gyroscopic Balance Sensor (3.5) collects the balance data from the wind turbine which can change due to extreme weather conditions and storm. Encoder and speed sensors (3.4) collects the speed and direction data from rotor and sends data real-time to microprocessor (3.1). The rotor (1.2) speed must be constant to produce electricity with higher efficiency. The speed is maintained constant by some of the coils in the Stator (radial) (1.1).

Magnetic distant sensors (3.3) measures the distance between rotor and stator real-time and sends this information to microprocessor (3.1).

The power unit (4) is formed by the power transmission components (4.1) the power management system (4.2) and batteries (4.3). This unit provides the necessary energy to the wind turbine (1) motor in the initial run. The power management system (4.2) is used to make aerodynamic and magnetic bearings work together and it works synchronously with microprocessor (3.1) to maximize the efficiency. The power unit (4) contains a speed management system which can adjust the rotation speed.

The control unit (3) has the function of a gearbox in systems without gearbox. Mechanical rotation energy and turbine efficiency is maximized with respect to the instant wind speed by the software and hardware within the control unit (3).

The control unit (3) contains the speed adjustment system. Other than the generator, the control unit (3) contains the coils which ignites the rotor with the power coming from the power unit (ignition stator), microprocessor and several sensors which optimizes the efficiency. The control unit (3) and the power unit collects the data such as wind speed, wind receive angle, and air density and processes these data by artificial intelligence such that the desired power output from the generator is obtained at the maximum efficiency by optimizing the rotation speed with respect to the collected data (the power input to the system is minimized while power output of the system is maximized).

Wind Turbine (1) can be manufactured with horizontal or vertical axis in the case of different wind speeds and the wind receive angle.

CLAIMS

1. A shaftless multi blade wind turbine, that is characterized by comprising a wind turbine with rotor-integrated turbine blades (1), a wind turbine shroud (2), a control unit (3) and a power unit which produces electricity in the first run
2. The wind turbine of Claim 1 and it is characterized by comprising at least a stator (1.1), at least a rotor (1.2), at least two blades for turbine (1.3), a magnetic shell (1.4), at least a permanent magnet bar (1.5), a stator (axial) (1.6), a generator protection cover and flange (1.7), a side cover of generator (1.8) and a central rigidity part (1.9).
3. The turbine blades (1.3) of claim 2 and it is characterized by being fixed to the rotor ring (1.2) without any shaft.
4. The turbine blades (1.3) of claim 3 and it is characterized by containing blade profiles (1.3) which has its chord becomes larger towards the shroud and smaller towards the center.
5. The wind turbine shroud and flansh flange (2) of claim 1 and it is characterized by comprising a bearing and safety bearing (2.1) and a connecting flansh and its components
6. The bearing and safety bearing (2.1) of claim 5 and it is characterized by being located conical.
7. The control unit (3) of claim 1 and it is characterized by comprising a microprocessor (3.1), a software (3.2), a multiple of magnetic bearing sensors, a multiple of distance Sensors (3.3), a multiple of speed sensors, an encoder sensor (3.4), a gyroscope balance sensor (3.5) and a multiple of connection components for connecting power unit.
8. The microprocessor (3.1) of claim 7 and it is characterized by determining how much power will be given to the related coil of stators for a contactless running of the rotor (1.2) at a constant speed according the distance and balance data coming from the jirescobic balance sensors (3.5) and the magnetic bearing (distance) (3.3).

9. The software (3.2) of claim 7 and it is characterized by using algorithms which defined for different rotational speeds, to decide which coils of stators are active and which coils are inactive, according collected data about speed of the rotor (1.2) and velocity of wind by the speed sensors, encoder sensors (3.4)
10. The magnetic bearing (distance) sensor (3.3) of claim 7 and it is characterized by transmitting data about the distance of the rotor (1.2) to the stator, in real-time process to the microprocessor (3.1) for contactless rotor (1.2) running in the magnetic field

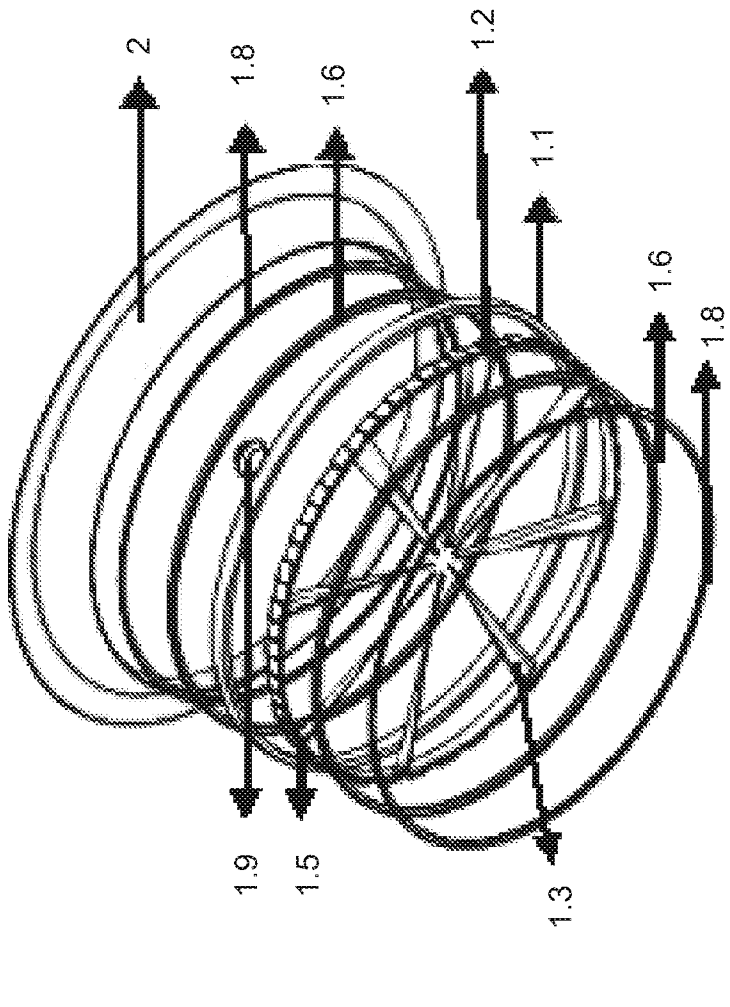

FIGURE 1

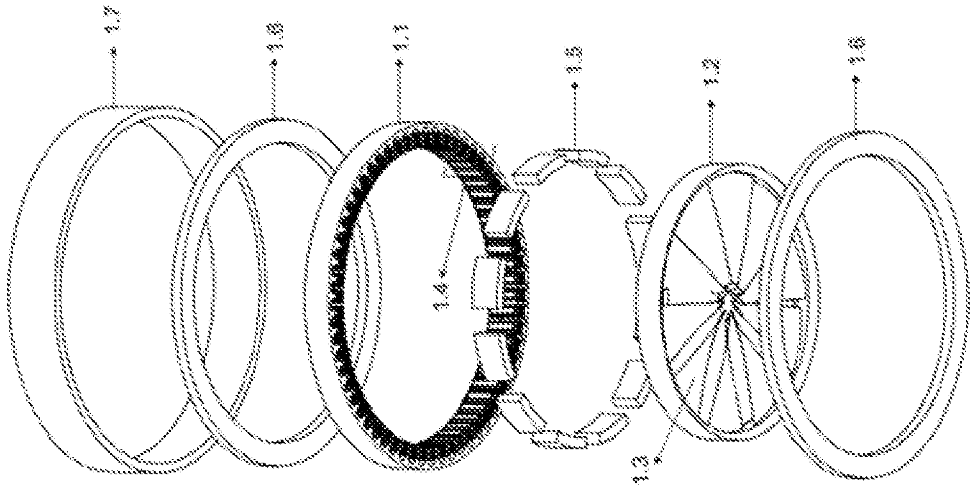

FIGURE 2

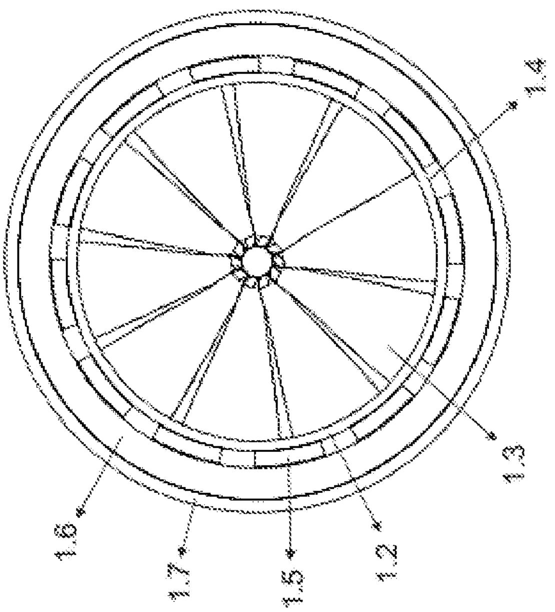

FIGURE 3

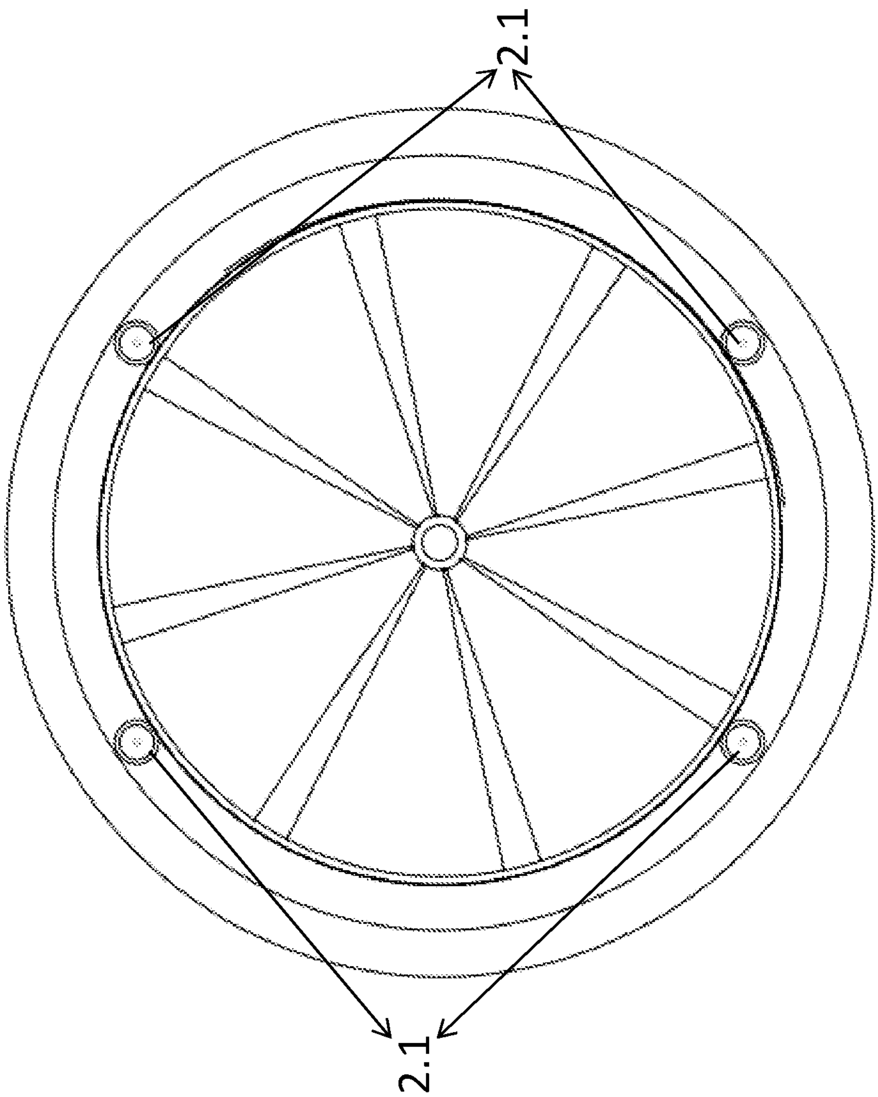

FIGURE 4

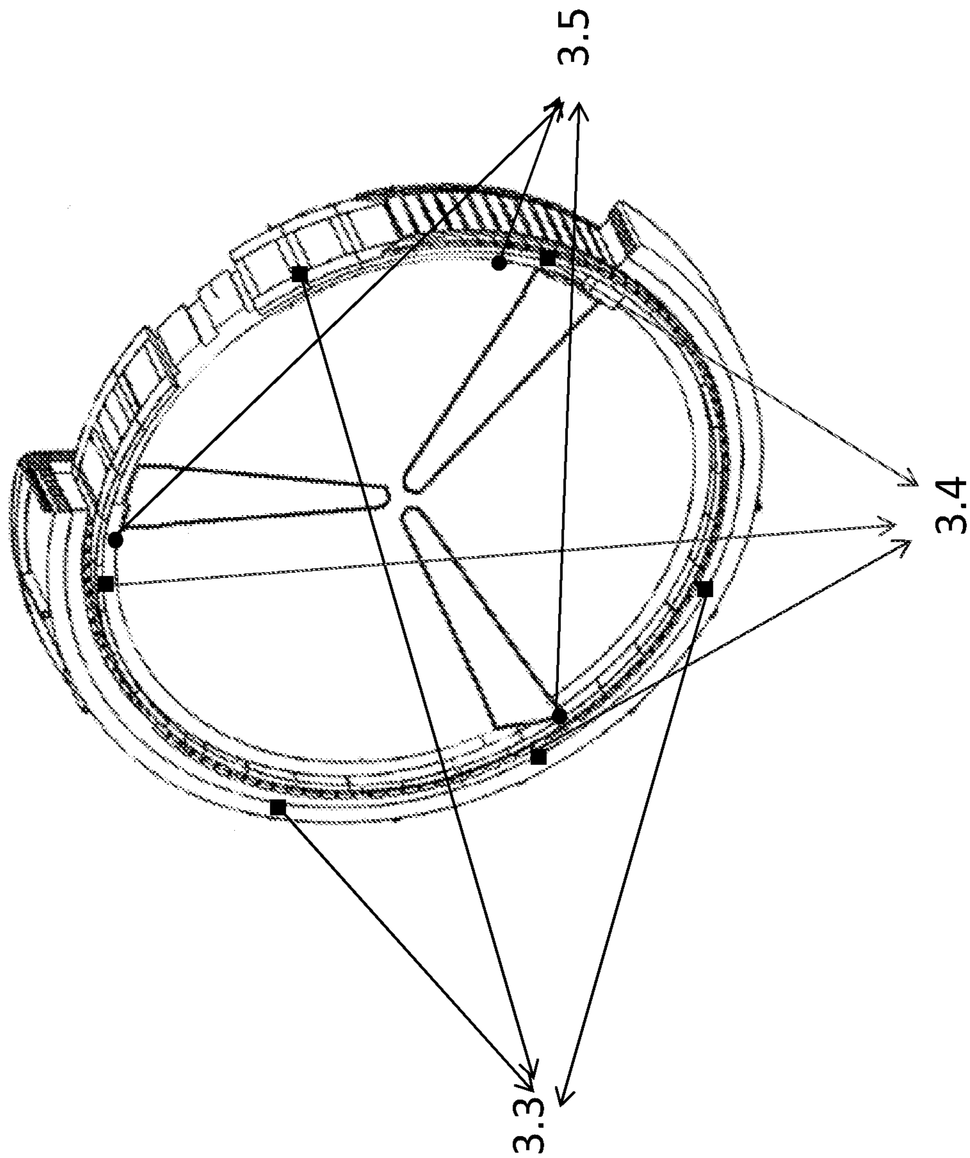

FIGURE 5

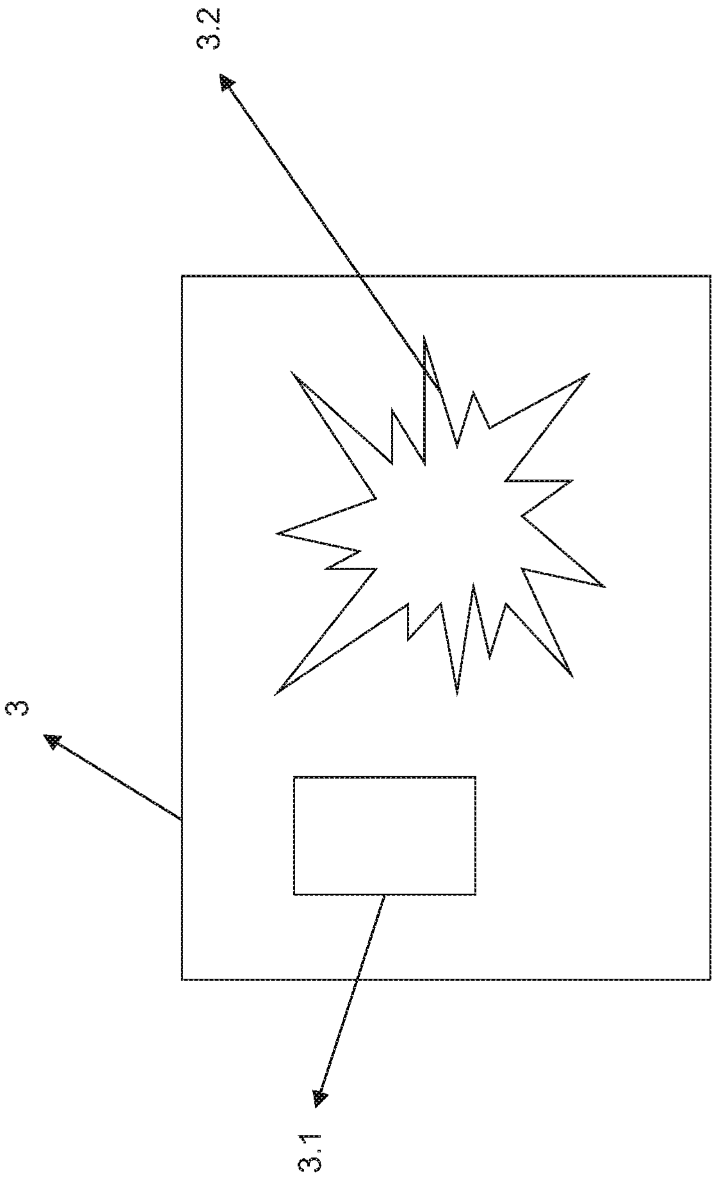

FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/TR2017/050196

A. CLASSIFICATION OF SUBJECT MATTER
INV. F03D1/04 F03D1/06
ADD. F03D7/00

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)
F03D

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 885 047 A1 (FIAT RICERCHE [IT]) 6 February 2008 (2008-02-06) paragraphs [0018] - [0046]; figures 1-16	1-10
X	WO 99/37912 A1 (KAMPEN WILLEM ANTOON VAN [NL]) 29 July 1999 (1999-07-29) the whole document	1-3,5, 7-10
X	DE 36 38 129 A1 (LICENTIA GMBH [DE]) 11 May 1988 (1988-05-11) column 3, line 47 - column 5, line 12; figures 1-3	1-6
X	US 2011/031760 A1 (LUGG RICHARD H [US]) 10 February 2011 (2011-02-10) paragraphs [0031] - [0050]; figures 1-7	1-5,7-10

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
18 October 2017	26/10/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Libeaut, Laurent

INTERNATIONAL SEARCH REPORT

International application No
PCT/TR2017/050196

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2013/266429 A1 (ANDREWS STEVEN JAMES [GT]) 10 October 2013 (2013-10-10) the whole document -----	1-5
A	WO 2014/021798 A2 (BULENT ORAN [TR]) 6 February 2014 (2014-02-06) the whole document -----	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/TR2017/050196

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 1885047	A1	06-02-2008	AT	419671	T	15-01-2009
			CN	101119049	A	06-02-2008
			EP	1885047	A1	06-02-2008
			US	2009001731	A1	01-01-2009
WO 9937912	A1	29-07-1999	AT	251274	T	15-10-2003
			AU	2301599	A	09-08-1999
			BR	9908203	A	28-11-2000
			CA	2318282	A1	29-07-1999
			CN	1289391	A	28-03-2001
			DE	69911740	D1	06-11-2003
			DE	69911740	T2	05-08-2004
			EA	200000793	A1	23-04-2001
			EP	1051569	A1	15-11-2000
			HU	0100373	A2	30-07-2001
			ID	28339	A	10-05-2001
			JP	2002501150	A	15-01-2002
			NO	20003537	A	10-07-2000
			PL	341958	A1	07-05-2001
			TR	200002185	T2	21-12-2000
			WO	9937912	A1	29-07-1999
DE 3638129	A1	11-05-1988	NONE			
US 2011031760	A1	10-02-2011	US	2011031760	A1	10-02-2011
			WO	2009129309	A2	22-10-2009
US 2013266429	A1	10-10-2013	NONE			
WO 2014021798	A2	06-02-2014	TR	201208854	A2	21-12-2012
			WO	2014021798	A2	06-02-2014