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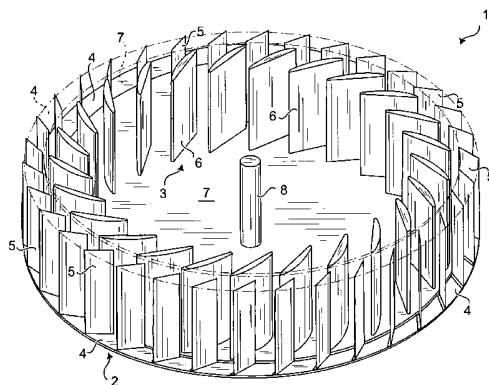
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(54) Title: VERTIKAL AXIS AEOLIAN TURBINE



(57) Abstract: The present invention relates to an improved aeolian turbine (1), comprising a rotor (3), rotatably mounted on an axis coupled with an output shaft (8), and characterised in that said rotor (3) comprises a plurality of blades (6), substantially circularly fixed between two closed elements (7), thus creating an inner cavity, said blades providing a first surface (6'), convex and oriented according to the rotation direction of said rotor, and a second surface (6''), opposed to said first surface (6'); and in that it comprises a conveyor (2), provided with a plurality of air flow deflection means, all along the perimeter of said rotor (3), and in front of said blades (6); said deflection means (5) protecting the blades (6) rotating according a direction opposite to the wind flow entering within the turbine (1) and conveying said wind flow on said second surface (6'') and/or on the profile of said rotating blades (6), thus generating a lift, and inducing the rotor (3) motion; said wind flow converging within said cavity and being deviated at the outlet by said deflection means (5) substantially along the blade (6) profile, thus creating further lift force in the rotor (3) rotation direction. The present invention further relates to an electric generation device.



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## VERTIKAL AXIS AEOLIAN TURBINE

The present invention relates to an improved aeolian turbine.

5 More specifically, the invention relates to a vertical output shaft lift turbine, studied and realised in order to obtain a high efficiency, independently from the force and the direction of the incident wind.

As it is well known, the problem of the energetic supply exists at a global level.

10 Crude reserves are always more depleted and consequently its cost rise. Energetic implants, also in consideration of the always more restrictive safety and anti – pollution rules, are always more expensive.

Remarkable efforts have been made searching alternative sources, in order to obtain allow cost energy source. Aeolian energy is one of the more interesting sources.

15 Problem of exploitation of Aeolian energy is that said energy supply is usually discontinuous both in time and direction.

At present many kind of turbines exist for obtaining energy from the wind force. Among them, it is possible distinguishing the resistance machines and the lift machines. The former exploit the wind energy incident on the blade area, while the latter exploit the lift effect obtained on the surface of suitable screws.

Rotors of said turbines can be:

- vertical axis rotors;
- horizontal axis rotors;
- 25 • hybrids rotors.

In vertical axis rotors, wind direction is perpendicular to the rotor axis. Blades move along a plane parallel to the fluid vein. Typical examples of vertical axis rotors are “Savonius” rotors. They are characterised by a low rotation speed, high momentum and low efficiency. 30 They are suitable for mechanical use such as water pumps. Really, their use is now limited to rustic environments. In any case, they have the remarkable advantage that they do not need being oriented according to the wind direction.

In case of horizontal axis rotors, rotor axis is parallel to the wind direction and rotates along a plane perpendicular to the same direction. 35 Main characteristics of these rotors are:

- high rotation speed;
- total use of the front area;

- high lift coefficient;
- high power.

However, they have disadvantages mainly caused by the fact that they are very cumbersome to realise and manage.

5           Hybrid rotors, that have been realised very recently, have the main object of obtaining advantages both with respect to horizontal axis rotors and with respect to vertical axis rotors.

They provide rotating aerodynamic blades, and a vertical axis. Among the most known, "Darrieus" and "Cycloturbine" can be mentioned.

10           This kind of rotors allows obtaining a high rotation speed, thus preventing manufacturing difficulties for a screw, and not needing a specific orientation with respect to the wind.

Object of the present invention is therefore that of suggesting an aeolian turbine characterised by a high efficiency independently from the wind direction.

15           Another object of the present invention is that of suggesting an aeolian turbine that can be used also for domestic apparatuses.

It is therefore a specific object of the present invention an improved aeolian turbine, comprising a rotor, rotatably mounted on an axis coupled with an output shaft, and characterised in that said rotor comprises a plurality of blades, substantially circularly fixed between two closed elements, thus creating an inner cavity, said blades providing a first surface, convex and oriented according to the rotation direction of said rotor, and a second surface, opposed to said first surface; and in that it comprises a conveyor, provided with a plurality of air flow deflection means, all along the perimeter of said rotor, and in front of said blades; said deflection means protecting the blades rotating according a direction opposite to the wind flow entering within the turbine and conveying said wind flow on said second surface and/or on the profile of said rotating blades, thus generating a lift, and inducing the rotor motion; said wind flow converging within said cavity and being deviated at the outlet by said deflection means substantially along the blade profile, thus creating further lift force in the rotor rotation direction.

Always according to the invention, said axis can be vertical.

35           Still according to the invention, said elements can be comprised of two substantially circular disks or of two circular rings.

Further, according to the invention, said blades can provide a second plane surface, opposed with respect to said first convex surface.

Advantageously, according to the invention, said blades can have both profiles rounded.

5 Always according to the invention, said blades can be fixed to said two elements with an angle between  $42^\circ$  and  $53^\circ$ , preferably  $45^\circ$ , with respect to the line tangent to the perimeter of said two closed elements.

Still according to the invention, said conveyor can be comprised of two circular elements concentrically superimposed with respect to said  
10 closed elements.

Furthermore, according to the invention, said means for deviating the air flow can comprise a plurality of vanes, preferably flat vanes.

Advantageously, according to the invention, said vanes can be  
15 provided at an angle of  $45^\circ$  with respect to the line tangent to the perimeter of said two elements.

Always according to the invention, said turbine can comprise a support structure, providing a plurality of upper arms converging toward a first central joint, and a plurality of lower arms converging toward a second  
20 central joint, said plurality of upper arms and said plurality of lower arms being connected by connection bars and/or supports and/or lateral and radial struts.

It is further object of the present invention an electric generation device, characterised in that it comprises a turbine and a electro-magnetic transducer; the shaft to which said rotor is coupled being mechanically  
25 coupled with said electro-magnetic transducer, so as to generate electric power following the activation of said turbine.

Always according to the invention, said device can comprise an energy storage reservoir, that can be provided with an insulating layer.

Advantageously, according to the invention, said reservoir can  
30 provide a black and matt surface absorbing the solar energy.

The present invention will be now described, for illustrative but not limitative purposes, according to its preferred embodiments, with particular reference to the figures of the enclosed drawings, wherein:

35 figure 1 shows a perspective view of the aeolian turbine according to the present invention open above;

figure 2 shows a top section view of the aeolian turbine according to figure 1;

figure 3 shows a section view of a blade of a rotor of the turbine of figure 1;

5 figure 4 shows a section view of the turbine according to figure 1, wherein incident air flows are shown;

figure 5 shows an embodiment of a support structure of the aeolian turbine of figure 1;

10 figure 6 shows a power vs. wind speed graph; and  
figure 7 shows a power generation device.

Making reference to figures 1 and 2, it is possible observing the aeolian turbine 1 according to the present invention.

15 Said turbine 1 is mainly comprised of two parts: conveyor 2 and rotor 3. Conveyor 2 is fixed. It is comprised of two circular rings 4, 4, faced each other, between which a plurality of plane profile vane 5 are mounted in a normal position.

20 Said vanes 5 suitably convey the air flow impinging on the rotor 3, each one with a different deviation angle with respect to the fluid vein direction, but all with the same and well established incidence angle of each section with respect to the corresponding lines tangent to the rotor 3.

Best keying angle of vanes 5 on said conveyor 2 (incidence angle with respect to the lines tangent to the circle) is  $45^{\circ}$ .

25 Length of said vanes 5 must be such that section of fluid vein entering between two vanes reduces up to the minimum value of 65% at the outlet.

By this solution, a further energetic gain is obtained deriving from a higher wind speed at the outlet (about +25%) with respect to the inlet speed, since it is subjected to a light compression passing through the vanes 5 mounted in a converging position.

30 When impacting with the rotor 3, the wind, also thank to said vane 5, is able exerting a higher pressure on rotor 3 blades 6, thus inducing to the same a bigger thrust, which is proportional to the square of the wind speed.

35 From the above, it is possible understanding that, even with a reduced increase of the wind speed, it is possible obtaining a remarkable energetic gain.

The above phenomenon is important since it allows using the same turbine 1 also in presence of very light wing, this not being possible with known screw turbines.

5 The same solution further promotes the outflow of exhausted air from the opposite side, since diverging vanes 5 create a small depression.

Another function of conveyor 2 vanes 5 is that of repairing the wind from the rotor 3 in correspondence of the quadrant wherein its blades 6 move counter wind, where a braking effect would be obtained, i.e. contrary to the rotatory motion, thus inducing remarkable power losses at the shaft 8.

10 Rotor 3, provided inside the fixed conveyor 2, is comprised of two discs 7, parallel and faced each other, being understood that circular rings can be used as well. Between said discs a crown of suitably shaped blades 6 is mounted, said blades having the same length of said vanes 5, so as said conveyor 2 and said rotor 3 look like a single cylindrical body, thus compacting the assembly.

Conveyor 2 is realised in order to pick up the wind and to transform its kinetic energy into mechanical energy to be transferred to the shaft 8. Wind flow, conveyed by outer vanes 5, enters within the rotor 3, pushing its blades 6, causing their rotation about its axis.

20 It is important the fact that fluid along its path does never move in an axial direction, differently deviating along its horizontal planes when impinging on vanes 5 and blades 6. The above prevents turbulences harmful for functionality and global efficiency of turbine 1.

25 Rotor 3 blades 6 are realised as a body having an asymmetric profile section with two surfaces 6' and 6'', respectively flat and convex, as shown in figure 3.

Possibly, in a different embodiment, surface 6' can be concave.

30 Said conformation is functionally very similar to the wings of an airplane. They are provided along the peripheral part of two discs 7, with an incidence angle ( $45^\circ \pm 3+8^\circ$ ) with respect to the line tangent to the circle including said discs 7. Said position allows obtaining an optimum efficiency, based on the lift aerodynamic laws.

35 In fact, said blades 6 are concerned by the wind flow alternatively according to the two directions, depending on their position during the rotation of the rotor 3, as it can be noted from figure 4. Particularly, first wind flow V impact zone, i.e. inlet, in rotor 3 and second

6

impact zone, i.e. wind flow V outlet from rotor 3, in the side opposite to the first one.

5 It can be clearly understood remembering that a static pressure and a dynamic pressure act on blades 6, according to Bernoulli theorem, stating that sum of static pressure and of dynamic pressure (proportional to the square of the speed) along a streamline remains constant.

10 Therefore, a reduction of static pressure occurs on convex surface 6" of blades 6, due to the increase of the fluid speed V, and thus of the dynamic pressure, the static pressure increasing on the flat part 6'. A depression and an overpressure are thus obtained with respect to the flow of the undisturbed wind.

15 Result is a thrust toward the blade 6 convex surface 6". Thus aerodynamic force does no more acts according to the flow direction, but it is inclined. Said force will have the maximum efficiency for the rotor 3 torque, if it is parallel to the line tangent to the circle described by the application point.

The same force can be broken out by the well-known parallelogram method, into a component named developed lift and into a component named resistance (Magnus effect).

20 Air flow V enters through the conveyor 2, vanes 5 of which tend to canalise it, section by section, according to the same angle with respect to the rotor 3. The latter, stroked by the air canalised flows, due to the reaction on the flat surface 6' of the blades, rotates about its own axis according to the A direction, absorbing part of the kinetic energy and transforming it into mechanic energy available at the shaft 8.

25 Prosecuting their run, air flows, deviated by the same blades 6 according to parallel horizontal planes, meet into the empty central zone 3' of rotor 3, realising a single flow of rather compressed air. Then it strikes blades 6 on the opposite side of the rotor, said blades 6 reacting pushing the rotor 3 according to the same rotation direction, thus increasing the previous thrust and absorbing the residual kinetic energy of air flow V ejected through the blades 6 with a minimum speed.

30 During inlet or outlet of air flow V between rotor 3 blades 6, total resistance exerted, comprising the vector sum of air friction resistance and blade 6 shape resistance, is summed with their lift, thus obtaining a torque.

Maximum efficiency is obtained when resistance is minimum, lift is maximum and the instant vector sum of all the rotor 3 blades 6 gives a twisting force – vector parallel to the line tangent to the circle of discs 7 and an application point on the rotor 3 having the largest ray.

5 Rotor 3 blades 6 obtain a further advantage in that the lift force is the resultant of a force generating pressure on surface 6" and of a force generating by compression on the concave surface 6'.

A solution that can be adopted in this kind of rotor 3 with flat – convex blades 6 is that of rounding also the extreme profile of second  
10 impact of said blades 6, beside that of the first impact profile, as it occurs in the aeronautic structures.

The above is advantageous since blades 6 during their translation motion caused by the rotation of the rotor 3, also have a rotatory motion about their own axis. Therefore, they are in an upright  
15 position when they are stroked by the second impact air flow. However, it is known that a rounded profile has a lower shape resistance with respect to an acute angle profile, resistance that during this phase brakes the translation motion of blades 6. Therefore it is preferred adopting a rounded for both the blade 6 ends.

20 A second solution to be adopted to increase the lift is that of making the surface 6" of said blades 6 rough.

Increasing the diameter of rotor 3, number of revolutions per minute is reduced, while power increases proportional with the ray.

Peripheral speed of this kind of turbine cannot be more than  
25 80% of wind speed thrusting the same.

In figure 5 it is shown the support structure of turbine 1 according to the present invention.

Said structure provides four upper arms 9 converging on a central joint 9', and four lower arms 10, converging on a central joint 10'.

30 Said upper arms 9 and said lower arms 10 are coupled by joint bars 11.

Furthermore, said lower arms 10 are coupled with supports 12 by lateral and radial struts 13.

In figure 6 it is shown the graph of power vs. wind speed for  
35 standard aeolian turbines with respect to the one according to the present invention.

Particularly:

- curve (a) represents available power;
- curve (b) represents power employing a blade free impact turbine;
- 5       • curve (c) represents power employing a blade guided impact turbine; and
- curve (d) represents power employing a turbine 1 according to the present invention.

As it can be noted, employing a turbine 1 according to the present invention, it is possible exploiting substantially all the available power. Curve (d) is almost juxtaposed to curve (a) both for low wind regime and for high wind regime.

10       An embodiment of turbine 1 according to the present invention can be observed from figure 7, employed as domestic power generation device.

15       Said device, indicated by reference number 14, provides aeolian turbine 1, a storage reservoir 15 and an electro-magnetic transducer 16.

Storage reservoir 15 is comprised of a metallic container, covered by a thermal insulating layer and by a protective envelope.

20       A window can be realised in the outer envelope, from which the insulating layer is removed and on which a black and matt surface is applied suitable to absorb the solar energy.

Output shaft of turbine 1 drags a multipolar permanent magnet 16' housed within a hollow cylinder 16", comprised of ferromagnetic material.

25       Thus, due to the rotation of rotor 3, it is possible generating electricity and/or heat, along with the solar energy picked up by the above window. Suitable electrical cables 17 will extract electricity.

On the basis of the above specification, it can be noted that basic feature of the present invention is the fact of obtaining aeolian energy with a high efficiency by a vertical rotor turbine, exploiting both the incident action and the lift on said blades.

30       Another advantage of the present invention is its constructive simplicity, its sturdiness, its low cost and the substantial lack of maintenance.

35       A third advantage of the present invention is that said turbine is really noiseless and that it is not bulky.

The present invention has been described for illustrative but not limitative purposes, according to its preferred embodiments, but it is to be understood that modifications and/or changes can be introduced by those skilled in the art without departing from the relevant scope as defined in

5 the enclosed claims.

## CLAIMS

1. Improved aeolian turbine, comprising a rotor, rotatably mounted on an axis coupled with an output shaft, and characterised in that  
5 said rotor comprises a plurality of blades, substantially circularly fixed between two closed elements, thus creating an inner cavity, said blades providing a first surface, convex and oriented according to the rotation direction of said rotor, and a second surface, opposed to said first surface; and in that it comprises a conveyor, provided with a plurality of air flow  
10 deflection means, all along the perimeter of said rotor, and in front of said blades; said deflection means protecting the blades rotating according a direction opposite to the wind flow entering within the turbine and conveying said wind flow on said second surface and/or on the profile of said rotating blades, thus generating a lift, and inducing the rotor motion;  
15 said wind flow converging within said cavity and being deviated at the outlet by said deflection means substantially along the blade profile, thus creating further lift force in the rotor rotation direction.

2. Turbine according to claim 1, characterised in that said axis is vertical.

20 3. Turbine according to one of the preceding claims, characterised in that said elements are comprised of two substantially circular disks or of two circular rings.

4. Turbine according to one of the preceding claims, characterised in that said blades provide a second plane surface, opposed  
25 with respect to said first convex surface.

5. Turbine according to one of the preceding claims, characterised in that said blades have both profiles rounded.

6. Turbine according to one of the preceding claims, characterised in that said blades are fixed to said two elements with an  
30 angle between  $42^\circ$  and  $53^\circ$ , preferably  $45^\circ$ , with respect to the line tangent to the perimeter of said two closed elements.

7. Turbine according to one of the preceding claims, characterised in that said conveyor is comprised of two circular elements concentrically superimposed with respect to said closed elements.

35 8. Turbine according to one of the preceding claims, characterised in that said means for deviating the air flow comprise a plurality of vanes.

9. Turbine according to claim 8, characterised in that said vanes are flat.

10. Turbine according to one of the preceding claims 8 or 9, characterised in that said vanes are provided at an angle of 45° with respect to the line tangent to the perimeter of said two elements.

11. Turbine according to one of the preceding claims, characterised in that said turbine comprises a support structure.

12. Turbine according to claim 10, characterised in that said support structure provides a plurality of upper arms converging toward a first central joint, and a plurality of lower arms converging toward a second central joint, said plurality of upper arms and said plurality of lower arms being connected by connection bars and/or supports and/or lateral and radial struts.

13. Electric generation device, characterised in that it comprises a turbine as defined in each one of claims 1 – 12, and a electro-magnetic transducer; the shaft to which said rotor is coupled being mechanically coupled with said electro-magnetic transducer, so as to generate electric power following the activation of said turbine.

14. Device according to claim 13, characterised in that said device comprises an energy storage reservoir.

15. Device according to claim 14, characterised in that said reservoir is provided with an insulating layer.

16. Device according to one of the preceding claims 14 or 15, characterised in that said reservoir provides a black and matt surface absorbing the solar energy.

17. Turbine according to each one of the preceding claims, substantially as illustrated and described.

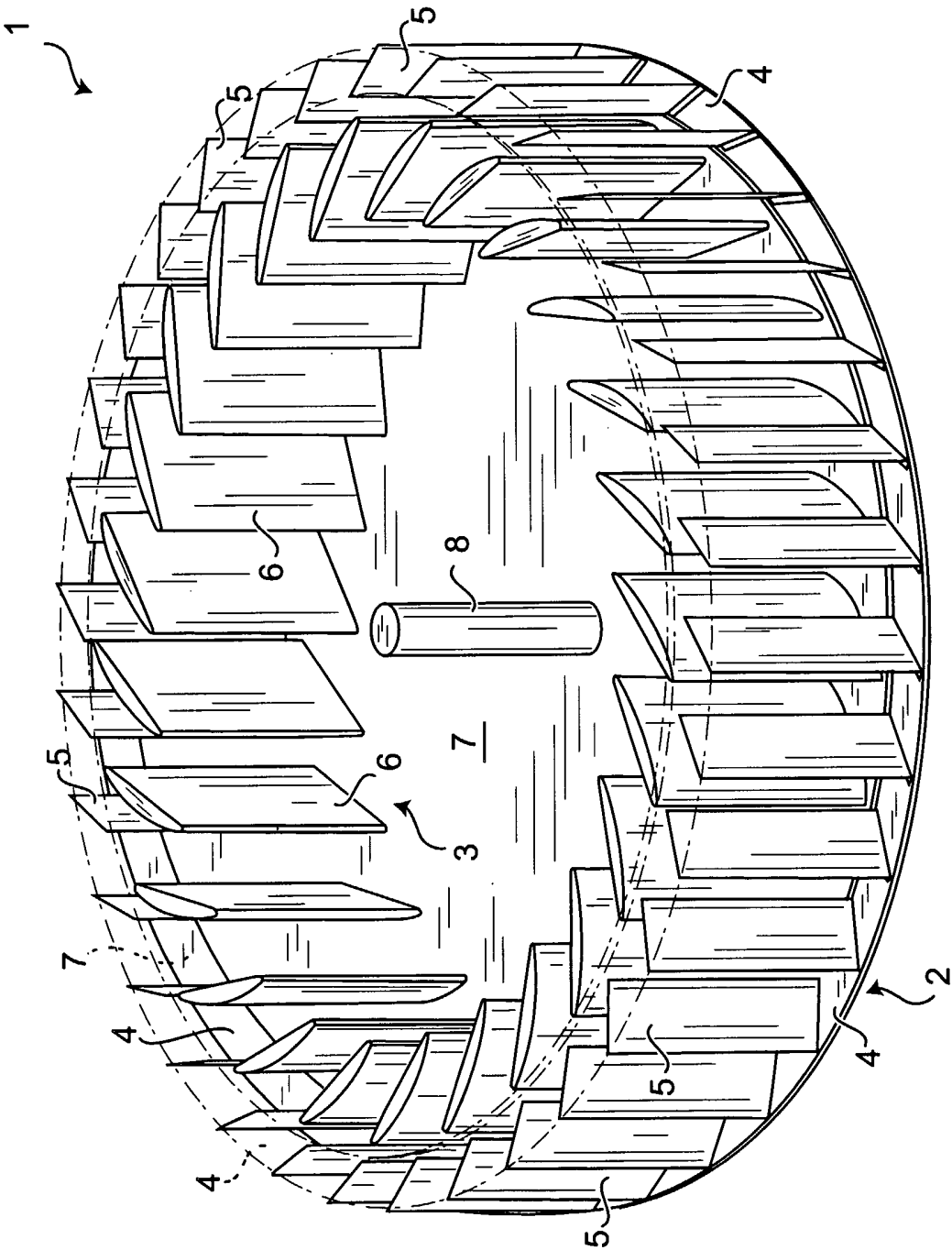
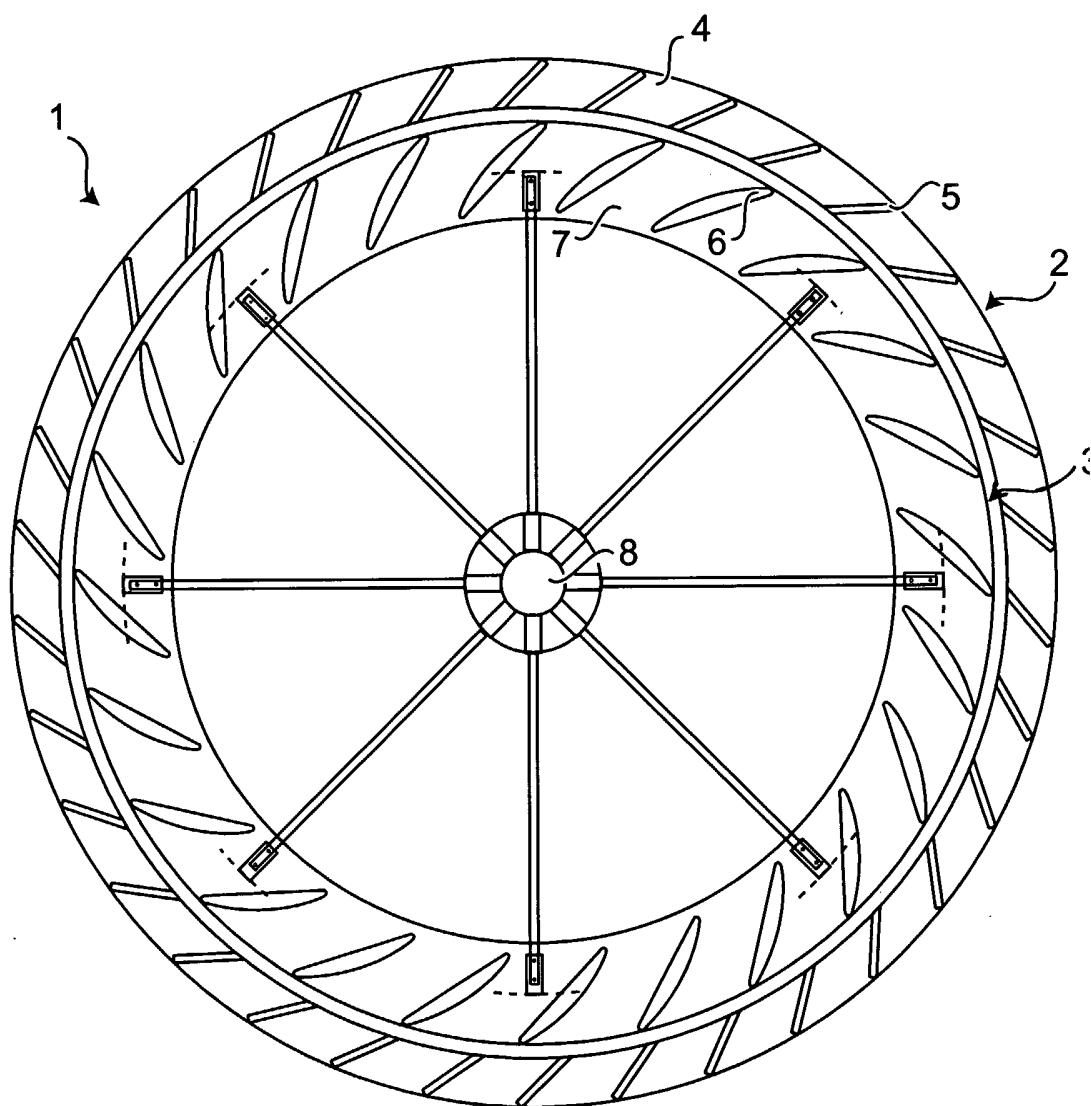
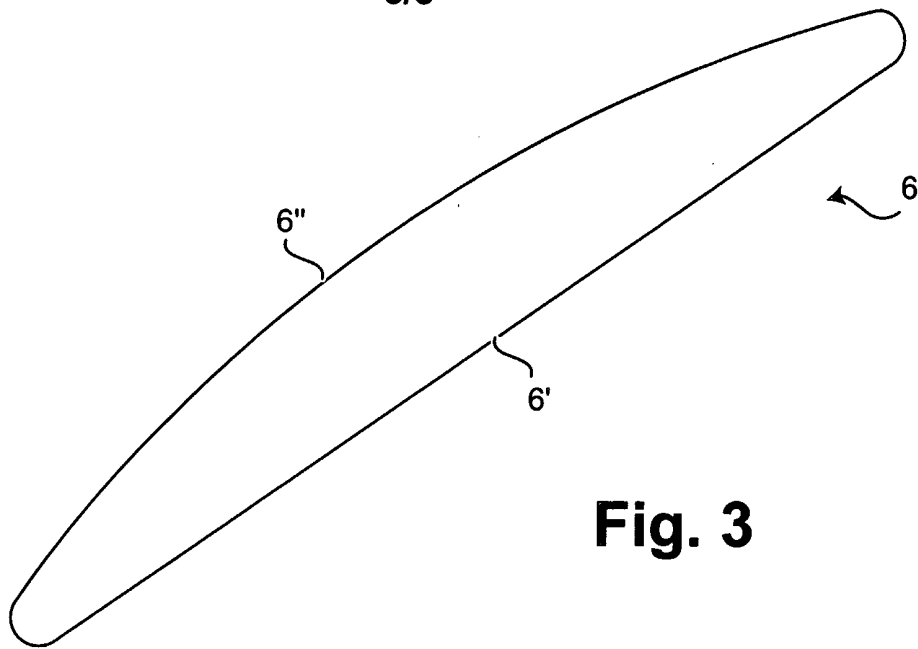


Fig. 1

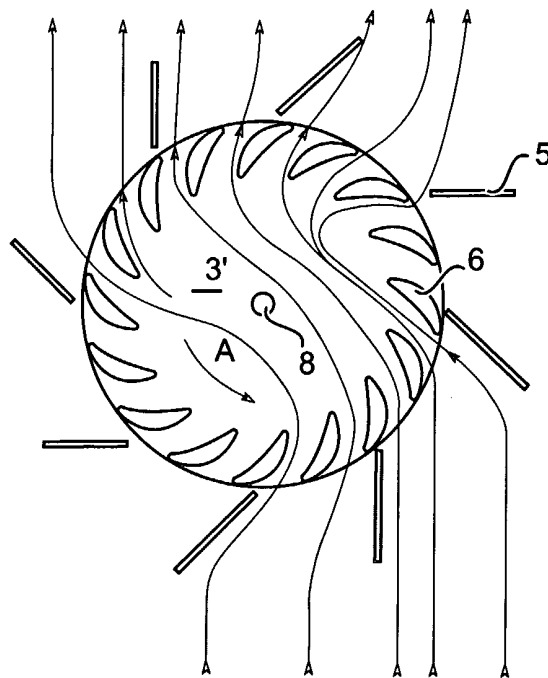
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**Fig. 2**

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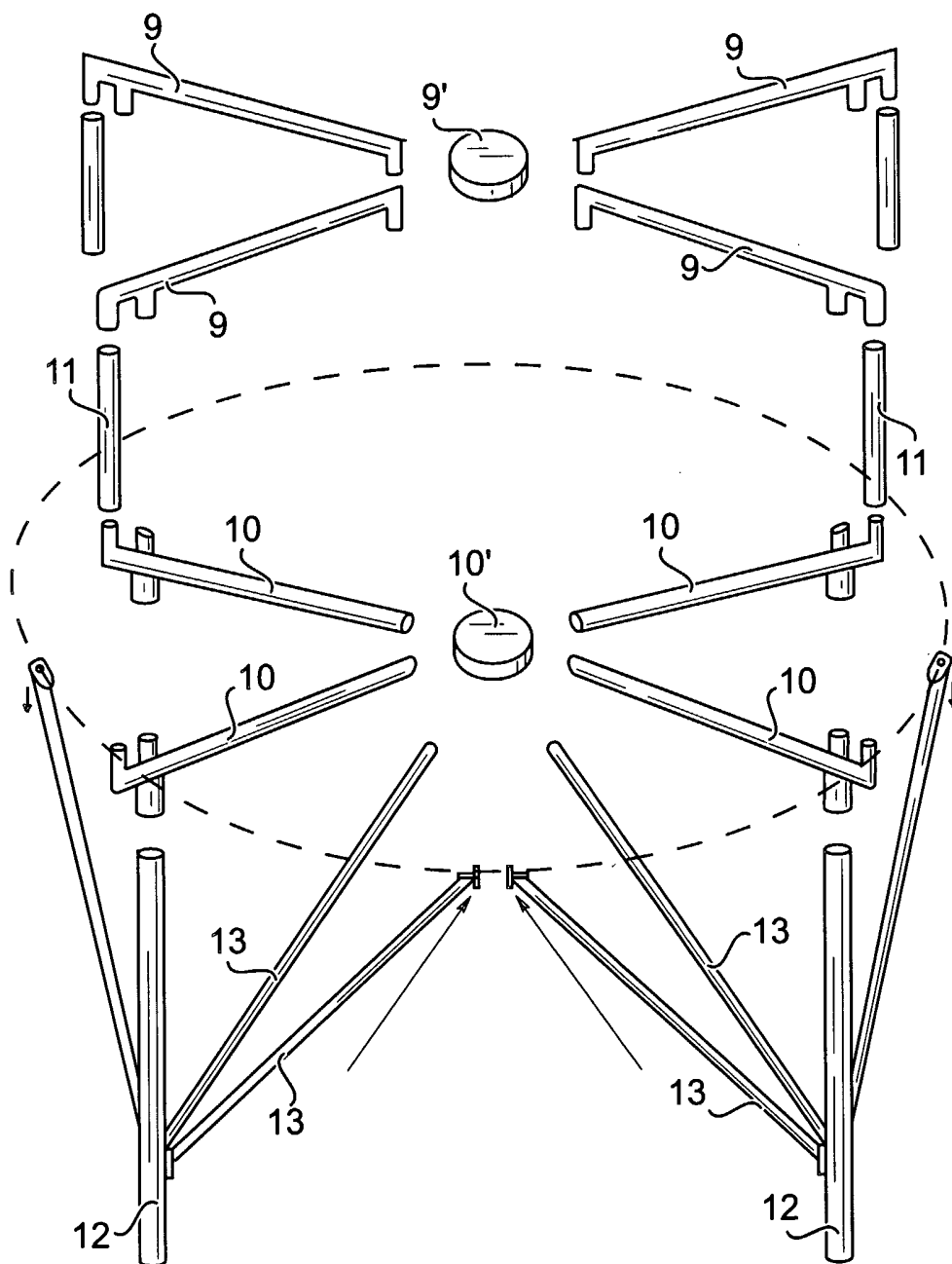


**Fig. 3**



**Fig. 4**

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**Fig. 5**

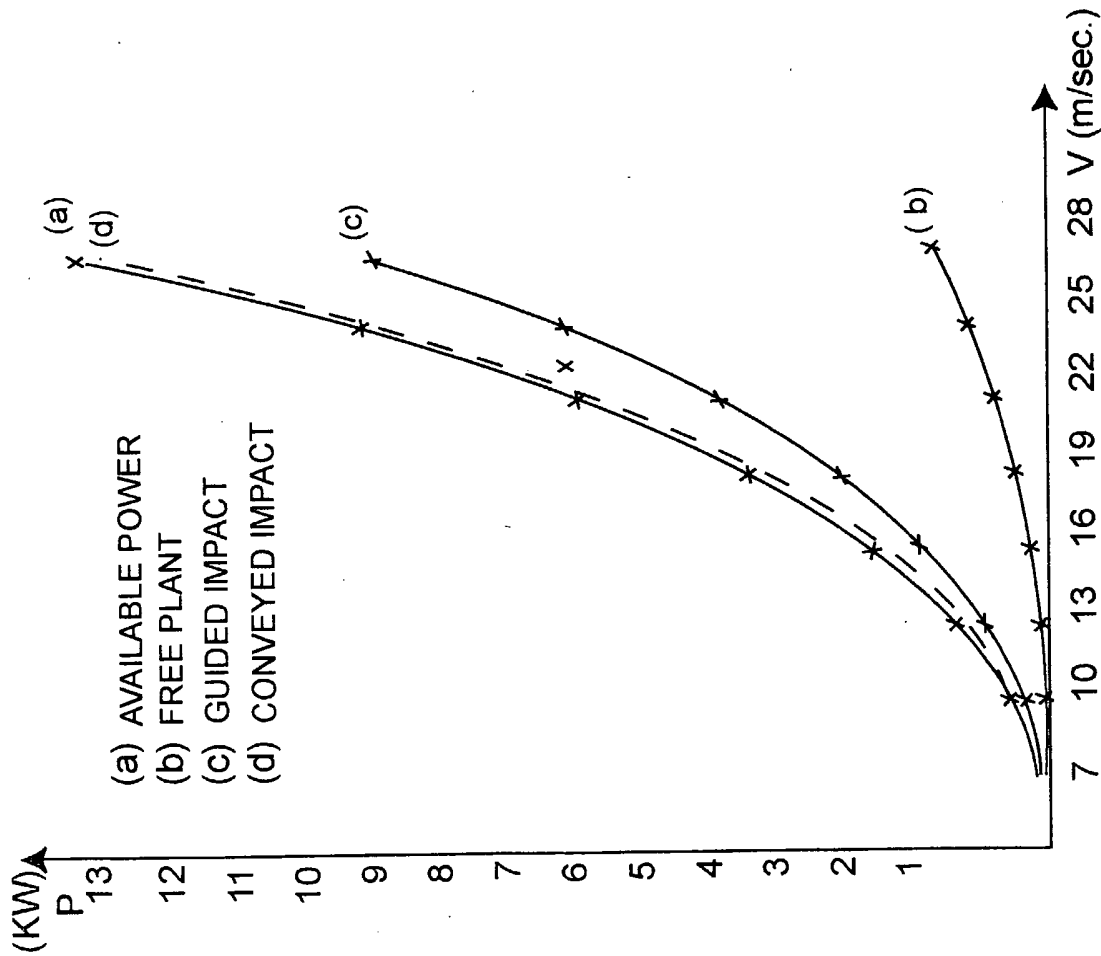


Fig. 6

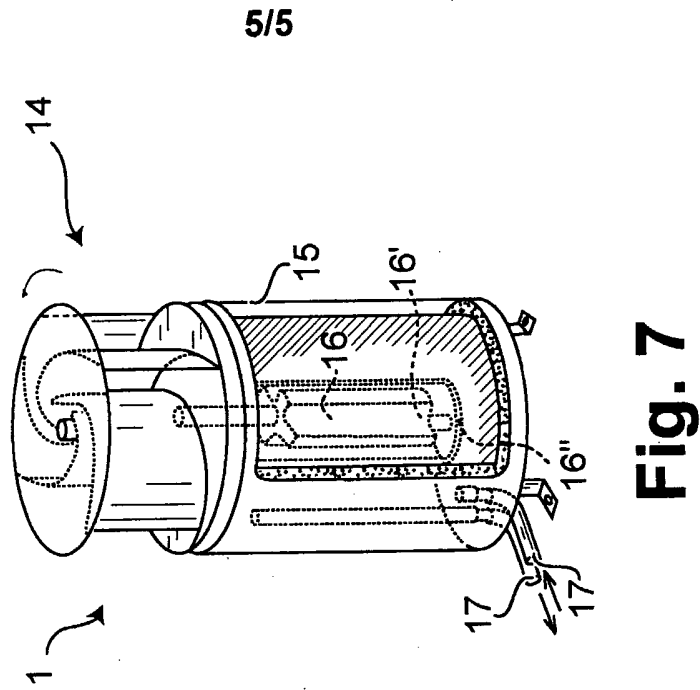


Fig. 7

## INTERNATIONAL SEARCH REPORT

International Application No

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## A. CLASSIFICATION OF SUBJECT MATTER

F03D3/04

F03D9/00

F03D9/02

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 practical, search terms used)

EP0-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category * | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                                                                                                                                                    | Relevant to claim No. |
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| X          | EP 0 522 994 A (VALSAMIDES, MICHAEL)<br>13 January 1993 (1993-01-13)<br>abstract<br>column 4, line 41 - line 51<br>column 5, line 6 - line 22; figure 1<br>column 6, line 30 - line 51<br>column 8, line 17 - line 31<br>column 9, line 24 - column 10, line 2;<br>figure 4<br>column 11, line 27 - line 32; figure 7 | 1-3,<br>5-12,17       |
| Y          |                                                                                                                                                                                                                                                                                                                       | 4                     |
| Y          |                                                                                                                                                                                                                                                                                                                       | 13-16                 |
| Y          | US 2004/130161 A1 (GOMEZ GOMAR JOSEP<br>LLUIS) 8 July 2004 (2004-07-08)<br>paragraph '0030!; figures<br>-----<br>-/--                                                                                                                                                                                                 | 4                     |



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

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01/12/2005

Name and mailing address of the ISA

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| C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                                                                                                                                                                                                                     |                       |
|------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
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Information on patent family members

International Application No

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