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(54) Title: TURBINE ASSEMBLY

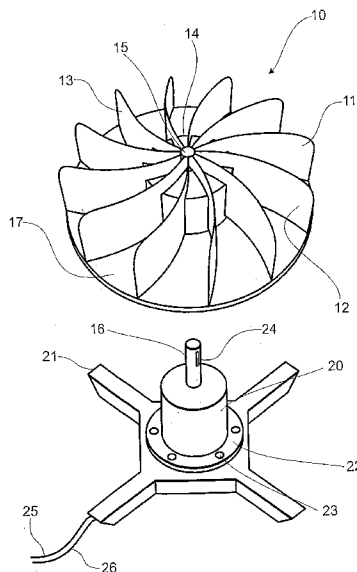


FIG. 2

(57) Abstract: A turbine assembly comprising a blade assembly having a plurality of curved blades with an inner end of each of the curved blades terminating at a cavity. The cavity has an open side with a generator located within the cavity and coupled to the blade assembly. The turbine assembly is suitable for underwater use. Multiple turbine assemblies may be connected to form a power generation station.



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## TURBINE ASSEMBLY

This invention relates to a turbine assembly which may be used for the purpose of generation of electricity. The turbine assembly may be  
5 activated by fluid currents, such as wind or water. More particularly, the turbine assembly may be used in hydro-electric power generation systems utilizing kinetic water energy.

### BACKGROUND TO THE INVENTION

10 Turbines for power generation are known in the art. United States Patent number 5009568 refers to a wave activated generating apparatus comprising a water turbine mounted for rotation within a housing on an upright output shaft. The housing includes a back panel and opposing sides and upper and lower surfaces that form a water nozzle which is adapted to  
15 face oncoming waves and to direct them into the housing. A wave splitter directs a portion of each oncoming wave directly against the facing surfaces of blades of the water turbine while another wave portion is directed against the back panel of the housing and redirected against the facing surfaces of the opposite water turbine blades.

20 The turbine may be mounted on a shaft which is operably connected to a weighted fly wheel of a power generator.

United States Patent number 5664418 refers to a vertical axis wind turbine supported on a frame held in place by an encircling series of crescent shaped tubular deflector vanes. The vanes widen towards the core or hub of  
25 the turbine concentrating the wind. The wind is trapped momentarily on entering a hollow interior of the turbines. A shaft supporting the turbines is coupled to a drive shaft which is then associated with a differential gear box. There are also provided a pair of split axle drive shafts coupled to the differential gear box which carry power through brakes and wheel plate  
30 couplers to electric generators.

United States patent number 5451138 describes an elongate turbine with airfoil-shaped blades mounted transversely to the direction of flow of fluid. The turbine rotates in the same direction irrespective of the direction of fluid flow. Related United States patent number 5451137 describes a similar turbine with the blades arranged in a helical configuration. The helical design has been used for power generation from tides and currents and has been referred to as the Gorlov Helical Turbine after the inventor, Alexander Gorlov.

In regard to the prior art it has been found that the turbine structures are unduly complex making the turbines difficult and costly to manufacture. The connection between the turbine and the generator has also been found to be complicated in structure especially in regard to US Patents 5,009,568 and 5,664,418.

#### OBJECTS OF THE INVENTION

It is an object of the invention to provide a turbine assembly which is simple in structure and efficient in operation.

It is a further object of the invention to provide a blade assembly for a turbine assembly.

It is a still further object of the invention to provide the public with a useful alternative to existing turbines and turbine blade assemblies. Other objects will be evident from the following description.

#### DISCLOSURE OF THE INVENTION

In one form although it need not be the only or indeed the broadest form, the invention resides in a turbine assembly comprising a blade assembly and a generator. The blade assembly has a plurality of curved blades with an inner end of each of the curved blades terminating at an inner cavity or void. The inner cavity or void is open on one side. The generator is located within the inner cavity or void and is coupled or attached to the blade

assembly.

The cavity is suitably sealed and provides an air pocket for the generator. The cavity may be filled with an insulator fluid such as oil or air.

5 The blade assembly suitably has a central hub which may engage in male – female relationship or spigot and socket relationship with a mating shaft of the generator. Preferably the central hub of the blade assembly has a hollow interior and thus forms a socket for engagement with a shaft of the generator which is preferably solid and forms a mating spigot for the socket. However, it is also possible that the generator shaft has a socket for  
10 engaging with a spigot of the central hub of the blade assembly.

The blade assembly may therefore be releasably attached to the generator shaft and thus there may be provided suitable fasteners interconnecting the blade assembly hub and the generator shaft.

15 In any of the above arrangements it will be appreciated that the blade assembly will rotate a central shaft of the generator and thus generate an electric current in conventional manner.

20 Each of the blades of the blade assembly are suitably arcuate forming a concave surface facing the impact of fluid. The opposite surface may be convex or planar. Preferably each of the blades has a uniform width or transverse dimension along their length but this is not essential. Each blade may have a dynamic structure that flexes to expand under fluid pressure and collapses under reverse pressure.

25 Each blade may suitably be pitched at an angle to the axis of rotation. A suitable pitch is 45 degrees. The pitch may vary from one end of the blade to the other.

The generator may be used to produce direct current or alternating current as is known in the art. The generator may also be electric, hydraulic or pneumatic.

### BRIEF DETAILS OF THE DRAWINGS

Reference may be made to a preferred embodiment of the invention as shown in the attached drawings wherein:

FIG 1 is a perspective view of the turbine of the invention;

5 FIG 2 is an exploded perspective view of the turbine of the invention;

FIG 3 is a sectional view of the turbine shown in FIG 1;

FIG 4 is a schematic top plan view of the turbine shown in FIG 1;

FIG 5 is a perspective view of a second embodiment of the turbine of the invention;

10 FIG 6 is a perspective view of a third embodiment of the turbine of the invention; and

FIG 7 is a view showing the mounting of the turbine shown in FIG 1 on a sea or river bed.

### 15 DETAILED DESCRIPTION OF THE DRAWINGS

The turbine assembly 10 shown in FIG 1 has a blade assembly 11 comprising a plurality of blades or vanes. Each blade of the blade assembly 11 has an arcuate shape, as shown most clearly in FIG 4, and terminates at inner cavity 14. Each blade has a concave facing surface 12 that catches the  
20 current and a convex opposite surface 13. The blade assembly 11 sits on a flange 17 that terminates at the inner cavity 14 and extends to an outer end of the blades.

The blade assembly 11 includes a central shaft 15 that rotates with the blade assembly 11. The shaft 15 couples to a rotating central shaft 16 of  
25 a generator 20 that is housed within the inner cavity 14, as seen most clearly in FIG 3. As seen in the exploded view of FIG 2, the generator 20 is fixed to a base 21. This can conveniently be done by a flange 22 held by welds 23. Any other conventional fixing means such as bolts or screws could also be

used.

The shaft 15 is conveniently hollow with a key way (not visible) that mates to a key 24 on the shaft 16 of the generator 20. The key 24 and key way ensures that the shaft 16 rotates with the blade assembly 11 to operate the generator 20. The generator 20 is provided with electrical conductors 25 and 26 as shown in FIG 2 so that an electric current generated by generator 20 may be conducted as desired.

Referring to FIG 3 the detail of the turbine 10 is shown in cross-section. A conventional generator 20 consists of a case 27 that mounts electromagnets 28. A coil 29 on the shaft 16 rotates in the magnetic field formed by the magnets 28 to generate a current that flows through conductors 25, 26. The generator 20 sits in the void formed by the inner cavity 14 of the blade assembly 11. In the case where the turbine 10 is configured for underwater use, the inner cavity 14 is waterproof and may be filled with air, gas or oil so that the generator 20 can operate without needing to provide waterproofing of the generator 20. A positive pressure of fluid (air, gas or oil) can be maintained in the cavity by pumping fluid into the cavity at a slow rate.

As seen clearly in FIG 3, the cavity 14 is open at the bottom and the blade assembly sits over the generator 20 such that the generator 20 is within the cavity. It will be appreciated that the generator 20 may easily be replaced by simply removing the blade assembly 11, detaching the generator 20 from the base 21 and reassembling with a new generator.

In operation the turbine 10 is placed in a fluid flow zone. The fluid flow zone may be a water flow zone such as a river current or an ocean current. The turbine 10 may also be configured for power generation from air flow (wind) but the inventor recognises that river currents and ocean currents are far more reliable than wind. In FIG 4 the direction of fluid flow is shown by arrow B. The fluid flows against concave surfaces 12 and convex surfaces 13 of each blade 11. There is a pressure differential between the force against the concave surface and the convex surface which causes the blade

assembly 11 to rotate in the direction shown by the curved arrow A. Unlike a number of the prior art turbines there is no need to provide a housing to control the flow of fluid over the turbine blades. The turbine 10 is simply placed in a location that has fluid flow and the turbine will rotate. In fact, it will  
5 be appreciated that the turbine will rotate in the same direction irrespective of the direction of fluid flow.

FIG 5 shows a second embodiment of a turbine 50 in which the blade assembly 51 has blades with a pitch with respect to the shaft 15. The inventor has found that a pitch of about 45 degrees is suitable, but the  
10 invention is not limited to this specific angle. In fact, virtually any pitch assists the fluid mechanics of the turbine 10. The best pitch angle will depend on the specific implementation. Furthermore, the pitch may vary from one end of the blade to another. For instance, the pitch may be small near the shaft 15 and increase as the blade extends away from the shaft 15.

15 The blades of the embodiment shown in FIG 5 have a pitch with the lower part of the blade leading the upper part of the blade. This configuration provides a degree of upwards lift, which may be beneficial. The pitch could be flipped so that the upper part of the blade leads the lower part, which generates a degree of downwards lift.

20 A further embodiment of a turbine assembly 60 is shown in FIG 6 in which the blade assembly 61 is formed from dynamic blades that adjust in shape depending on the applied force. This may be achieved by a sectioned blade, such as 62, that expands under an applied force like a sail. The blades having the concave side facing the fluid flow will expand as shown in  
25 FIG 6 to better catch the fluid flow. The other blades will collapse to a non-expanded shape. Other structures could include a resiliently deformable blade fitted against a rigid skeleton on the concave side. The fluid pressure would expand the blade as shown but once rotated it would contract back to the undeformed shape. On the opposite side of the rotation the skeleton  
30 would prevent deformation.

Suitable material for the blades of the blade assembly include plastic

or metal such as aluminium. The turbine assembly could be produced by extrusion moulding, blow moulding or casting.

FIG 7 shows how a pair of turbine assemblies 70, which may be of the form of the embodiment of FIG 1, the embodiment of FIG 5, or the embodiment of FIG 6. A number of turbine assemblies together form a power generation station. The base 71 is mounted near a sea bed 72 or river bed wherein each base 71 is supported by piles 73 and chains 74. If desired, base 71 could be hollow or made from buoyant material to facilitate floating of the turbines 70. If the base 71 is hollow it can be filled with water to sink the turbine assembly or filled with air to raise the turbine assembly. Filling the base with water or air is particularly useful for maintenance purposes as it will aid crane recovery or placement of the turbine assembly.

Filling the base 71 with water or air may also be useful for regulating the depth of the turbine assembly to be positioned in maximum current flow. Adding water to the base would cause it to sink to a lower level. Pumping air into the base to displace water would cause the base to float to a higher level. By pumping in air or allowing in water the level of the base can be changed so that the turbine assembly is positioned in a maximum current zone.

The inventor envisages that this process could be automated by positioning flow sensors at various depths and automatically repositioning the turbine assemblies to the depth having the strongest current.

It will be appreciated that the void or cavity 14 may be filled with air and thus there is the possibility of gases or ions which could be formed as a by-product of electricity being generated by generator 20 within cavity 14. Should the cavity 14 require additional air to keep the cavity dry, air can be delivered by a simple air hose which would be connected to an air compressor shore side. The hose supplying air may accompany the conductors 25 and 26 from shore side. The generator 20 would have reasonable resistance to the elements of corrosion (e.g. seawater) within cavity 14.

It is considered that the turbine of the invention could be used very beneficially as a subsea hydroelectric power station which will not cause pollution. It is also believed that the tides or currents of an ocean are predictable and this will ensure successful operation of the turbine of the invention.

Persons skilled in the art will realise that various issues arise when connecting power generation units to a grid. The issues have been addressed for various other forms of power generation, such as wind generators. It is envisaged that appropriate transformers and phase matching equipment would be located near the power generation station, but not underwater. For example, in an undersea application that transformers would be located on the coastline.

It will also be understood by persons skilled in the art that various safety devices such as fail-safe brakes, and over-current protection will be incorporated in the turbine assembly for practical application. These devices are well known and are omitted for the sake of brevity.

The generator 20 may also have associated therewith a support so as to resist vibration due to the rotation of the blade assembly 11. The control of vibration is well known to turbine engineers and will be implemented as required for efficient operation of the invention.

Although the description has described the primary embodiment of an electrical generator it should be appreciated that the invention is not limited to this particular implementation. The generator 20 may be any suitable device that converts kinetic energy to other useful energy. Thus the generator could be hydraulic or pneumatic.

In summary it will be appreciated that the blade assembly of the invention is simple in structure and has a direct coupling to a generator located within an open void or cavity of the blade assembly.

CLAIMS

1. A turbine assembly comprising:  
a blade assembly having a plurality of curved blades with an inner end of each of the curved blades terminating at a cavity having an open side;  
5 and a generator located within the cavity and coupled to the blade assembly.
2. The turbine assembly of claim 1 wherein the cavity is sealed and filled with an insulator fluid.
3. The turbine assembly of claim 2 wherein the insulator fluid is air, gas or oil.
- 10 4. The turbine assembly of claim 1 further comprising a central hub in the blade assembly that couples with a shaft of the generator.
5. The turbine assembly of claim 4 wherein the central hub releasably couples with the shaft of the generator.
6. The turbine assembly of claim 4 wherein the central hub is a socket  
15 that fits over and engages the shaft of the generator.
7. The turbine assembly of claim 4 further wherein the central hub is a spigot that fits into and engages a socket in the shaft of the generator
8. The turbine assembly of claim 6 or 7 further comprising a key on the shaft that engages a keyway on the socket or a key on the socket that  
20 engages a keyway on the shaft.
9. The turbine assembly of claim 1 wherein the blade assembly further comprises a flange extending from the cavity to an outer end of the blades.
10. The turbine assembly of claim 1 wherein the curved blade have a concave surface and an opposing convex surface.
- 25 11. The turbine assembly of claim 1 wherein each curved blade has a uniform width along its length.
12. The turbine assembly of claim 1 wherein each curved blade has a dynamic structure that flexes to expand under fluid pressure and collapses

under reverse pressure.

13. The turbine assembly of claim 1 wherein each curved blade is pitched at an angle to the axis of rotation.

14. The turbine assembly of claim 13 wherein the pitch is 45 degrees.

5 15. The turbine assembly of claim 13 wherein the pitch varies along the length of the blade.

16. A power generation station comprising two or more turbine assemblies, each turbine assembly comprising: a blade assembly having a plurality of curved blades with an inner end of each of the curved blades  
10 terminating at a cavity having an open side; and a generator located within the cavity and coupled to the blade assembly.

17. The power generation station of claim 16 further comprising a hollow base on each turbine assembly.

18. The power generation station of claim 17 wherein the hollow base is  
15 filled with buoyant material.

19. The power generation station of claim 17 wherein the hollow base is fillable with air or water to adjust a depth of the power generation station when underwater.

20. The power generation station of claim 16 further comprising means  
20 for securing the power generation station to a sea or river bed when underwater.

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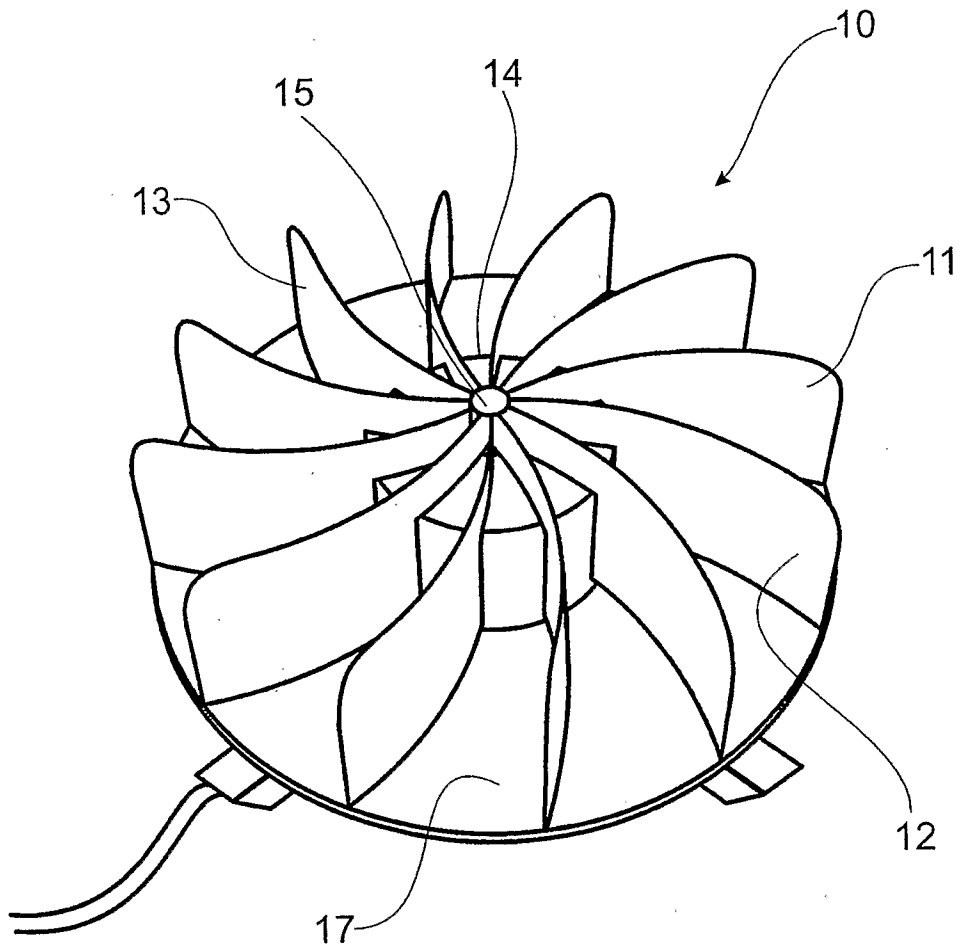


FIG. 1

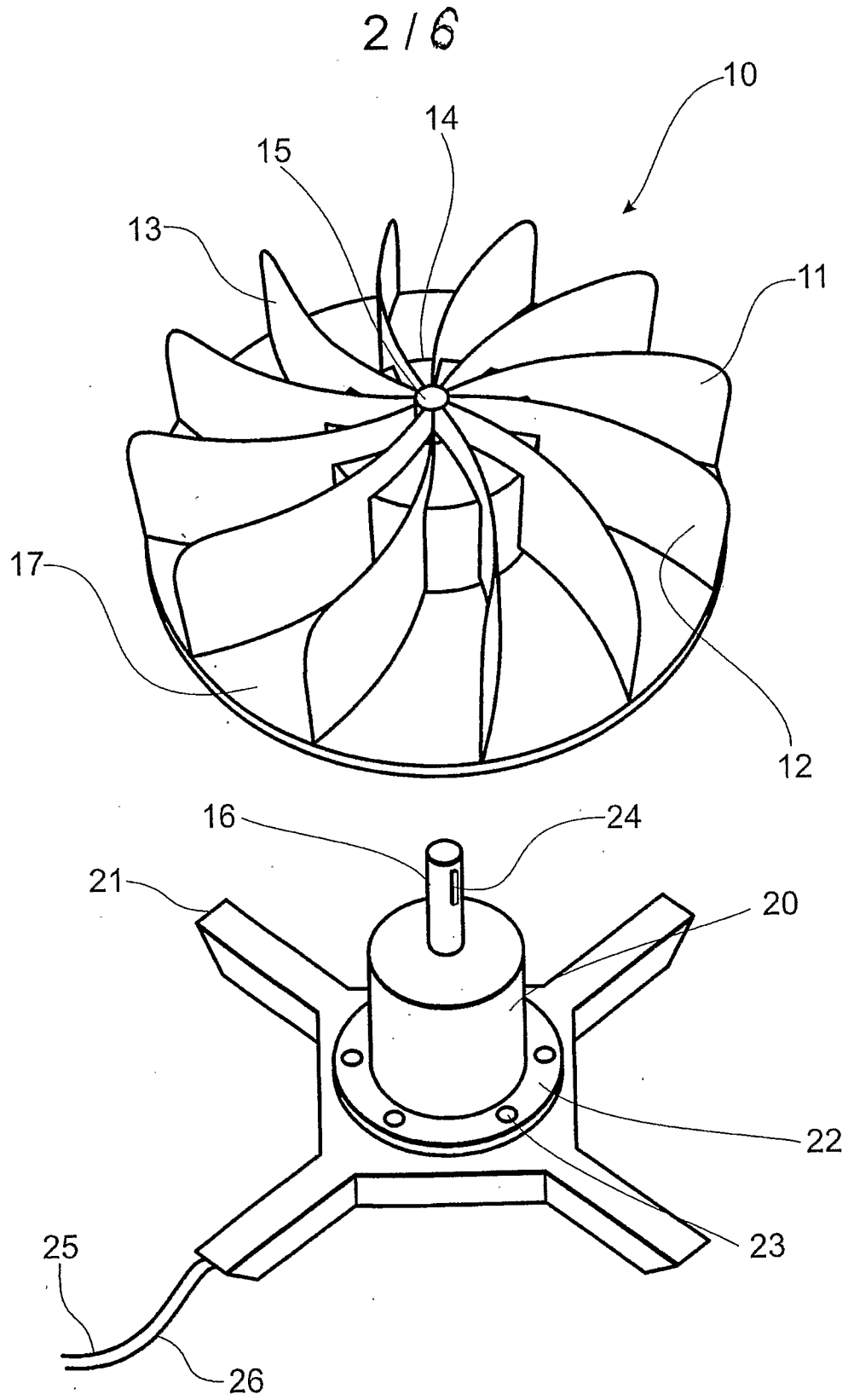


FIG. 2

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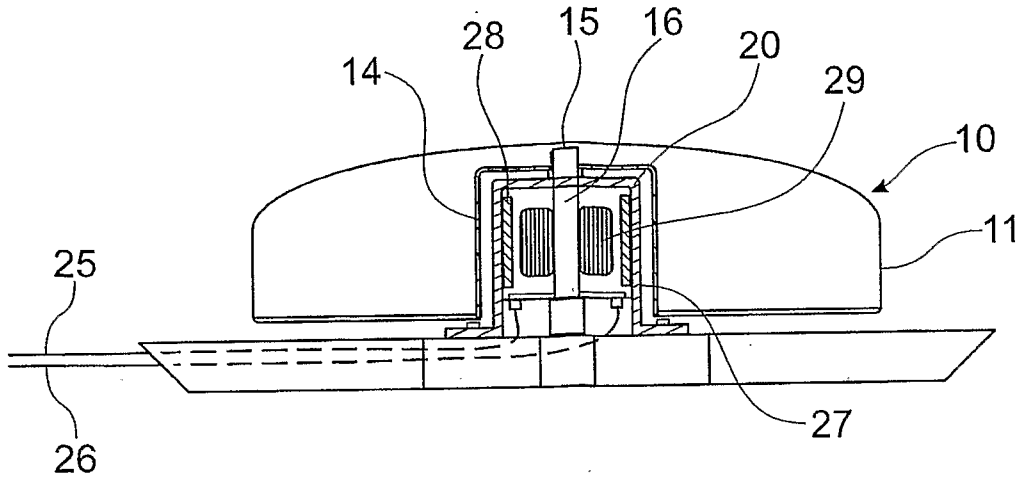


FIG. 3

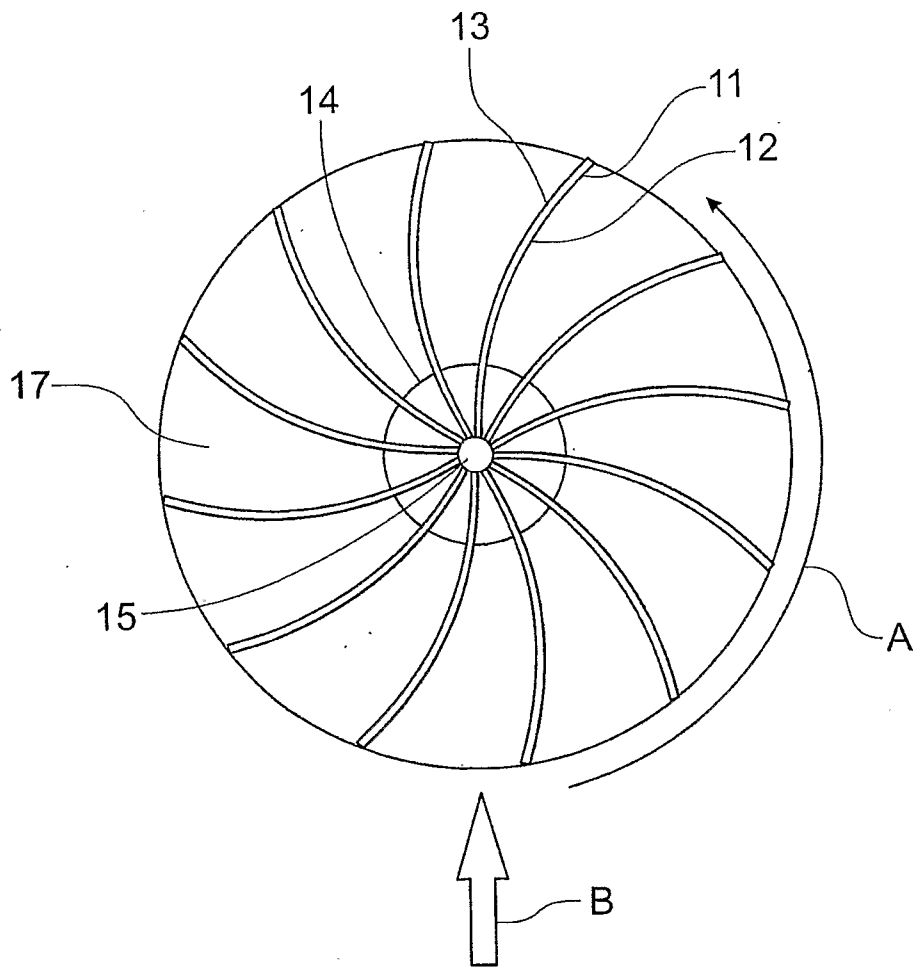


FIG. 4

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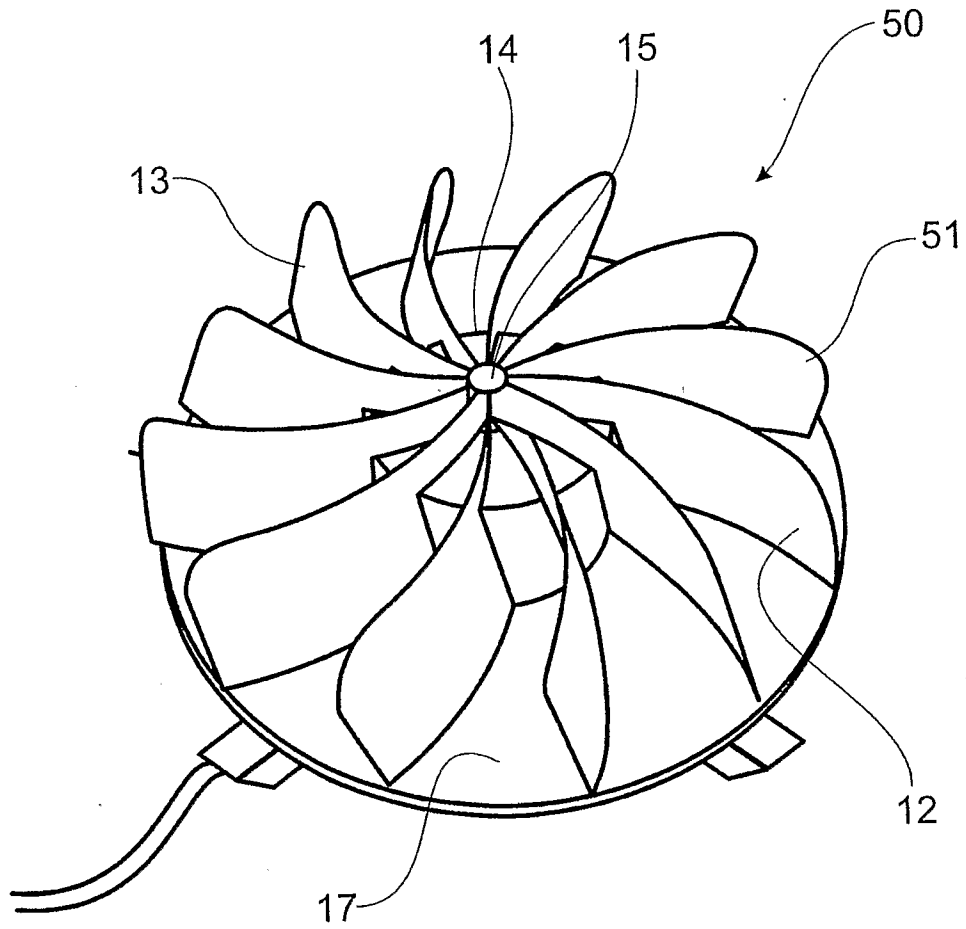


FIG. 5

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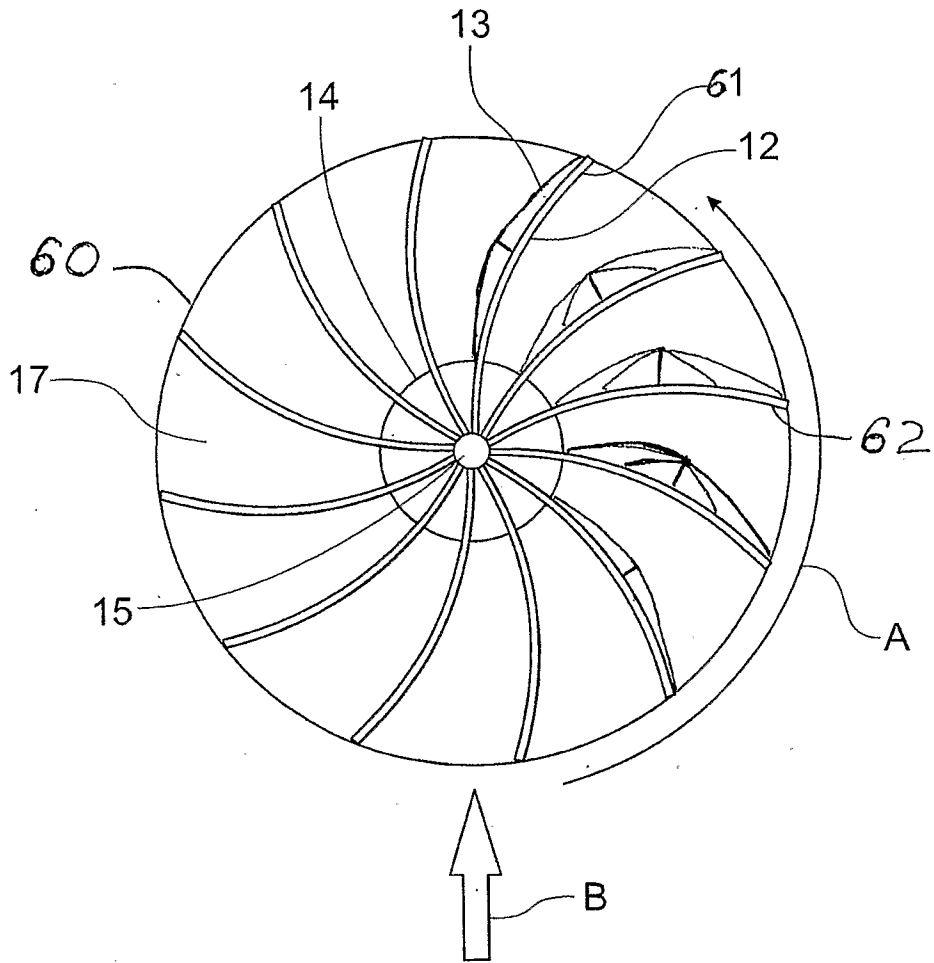


FIG. 6

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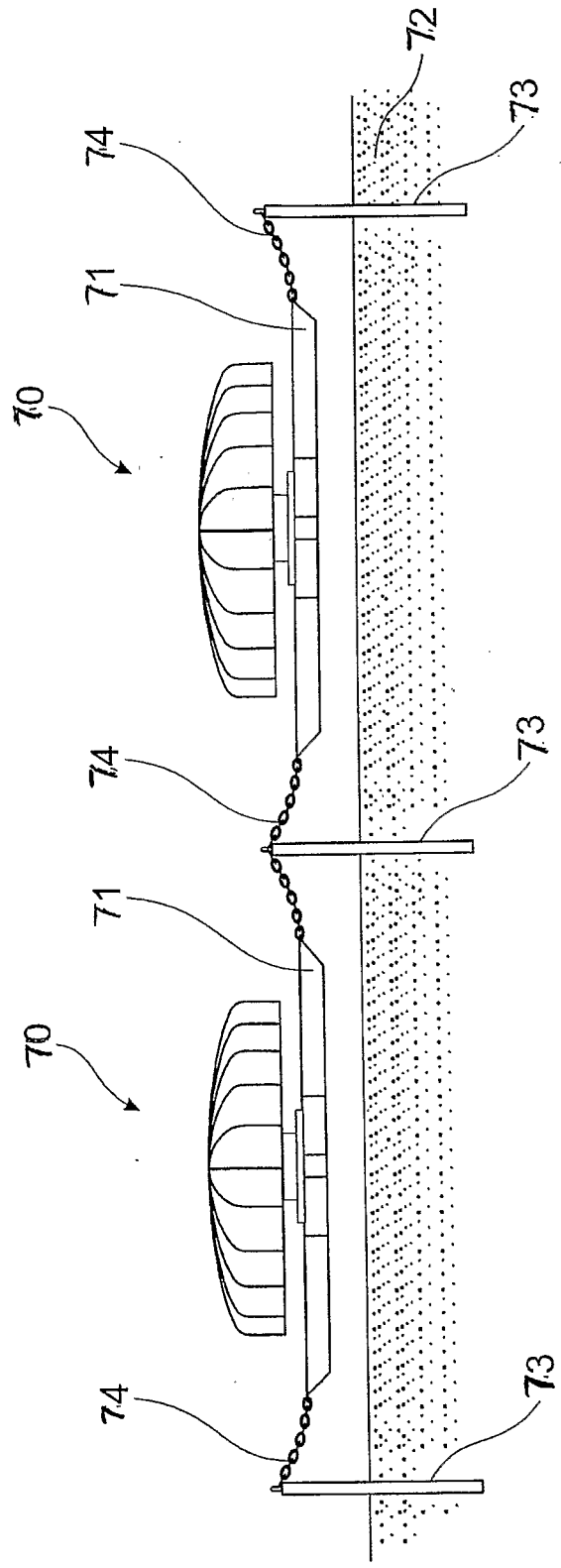


FIG. 7

## INTERNATIONAL SEARCH REPORT

International application No.

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## A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

F03B 13/10 (2006.01)

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F01D 5/14 (2006.01)

ACTION DATE: 24 February 2009

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)

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)

DWPI & EPODOC IPC and ECLA F01D, F03B, F03D and KEYWORDS turbine, impeller, rotor, generator, dynamo, navel, casing, shell, shroud, cavity, hub, central, internal, inner, centre, axis, axle, central, internal, inner, water, hydro, ocean, sea, blade, vane, sail, resilient, bend, open, flex, expand, inflate, balloon, stretch, deform, expand, hollow, or buoyant, tether, secure, depth, and similar terms.

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/102727 A1 (BETANCOURT MORALES) 13 September 2007 English language abstract available from ESPACE, and figure 2 and 4	1 - 11, 13 - 16, 20
A	English language abstract available from ESPACE and Figure 2	12
X	DE 10310227 A1 (PRIKOT) 16 September 2004 English language abstract available from ESPACE, and figure 1	1, 4 - 9, 13 - 16
A	English language abstract available from ESPACE, and figure 1	12

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

\* Special categories of cited documents:

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"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

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

"&amp;" document member of the same patent family

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

Date of the actual completion of the international search

24 February 2009

Date of mailing of the international search report

- 6 APR 2009

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## INTERNATIONAL SEARCH REPORT

International application No.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	AU 2005203573 A1 (ETTRIDGE, Sr.) 2 February 2006 Whole document, in particular page 4 line 19 – 22, page 7 line 17 and figure 1, 7, 8	1, 4 – 11, 13 – 16
X	WO 2007/100639 A2 (KUEHNLE) 7 September 2007 Whole document, in particular page 8 line 10 – page 9 line 13, page 12 line 11 – page 14 line 4, page 14 line 12 – 14, page 14 line 15 – 17, and figure 2, and 11 – 13.	1 – 4, 6 – 8, 13, 15 – 20
A	WO 2004/015266 A1 (NOBLE) 19 February 2004 Abstract and figure 2	12
A	US 5823749 A (GREEN) 20 October 1998 Abstract and figure	12

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2009/000010

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	2007/102727	MX	GT06000004				
DE	10310227	DE	102004001573				
AU	2005203573	NONE					
WO	2007/100639	US	2007/0241566				
WO	2004/015266	AU	2003258233	BR	0313389	CA	2491069
		CN	1675466	EP	1546552	MX	PA05001739
		NZ	538111	US	6682302	US	6929450
		US	2004/0001752	US	2004/0265127	ZA	200500136
US	5823749	NONE					

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX