(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 June 2008 (12.06.2008)

PCT

(10) International Publication Number
WO 2008/067593 A1

(51) International Patent Classification:
F03D 3/02 (2006.01) *F03D 3/06* (2006.01)

(21) International Application Number:
PCT/AU2007/001865

(22) International Filing Date:
4 December 2007 (04.12.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2006906751 4 December 2006 (04.12.2006) AU
2007904481 21 August 2007 (21.08.2007) AU

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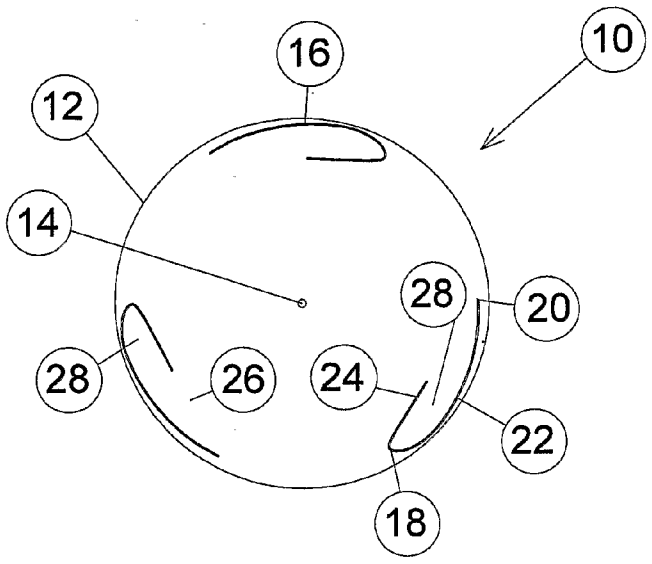
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(54) Title: A WIND TURBINE APPARATUS



(57) Abstract: There is provided a wind turbine apparatus which comprises blades having an aerofoil profile. The apparatus is arranged to start up even in light wind conditions and to act as a lift type device at higher rotational speeds. The apparatus may comprise wind deflectors to concentrate wind through the apparatus. Further, the blades may be orientated at less than 90° to a radius line which leads to improved performance. Still further, the apparatus may be arranged to heat water by means of solar energy.

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TITLE

"A WIND TURBINE APPARATUS"

FIELD OF THE INVENTION

The present invention relates to a wind turbine apparatus.

BACKGROUND OF THE INVENTION

Existing wind turbine apparatuses have a number of problems including fluctuating strength and variable angles of attack of winds found in urban environments. Further, there are problems with noise, vibration and reliability issues in relation to existing wind turbine apparatuses. Still further, a substantial cost is incurred in mounting the wind turbine apparatus at elevated points to reach consistent wind conditions.

The present invention provides a wind turbine apparatus in which at least some of the abovementioned problems are alleviated.

SUMMARY OF THE PRESENT INVENTION

In accordance with one aspect of the present invention there is provided a wind turbine apparatus characterized by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface and a cupped or cut-away portion on an inner foil surface.

In accordance with a further aspect of the present invention there is provided a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile

with a continuously curved outer foil surface, wherein the turbine blades are disposed at an angle of less than 90° to a radius line extending from the axis.

In accordance with a yet further embodiment of the present invention there is provided a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface, wherein wind deflection members are located adjacent the apparatus so as to direct wind air into the apparatus.

In accordance with a still yet further embodiment of the present invention there is provided a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface, wherein the apparatus is also arranged to heat water by means of solar energy.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic end elevation of a wind turbine apparatus in accordance with one embodiment of the present invention;

Figure 2 shows a perspective view of the apparatus of Figure 1;

Figure 3 is a view similar to Figure 1 showing a further embodiment of a wind turbine apparatus and illustrating how wind impacts on the apparatus;

Figure 4 is a view similar to Figure 1 showing the presence of deflection members adjacent to the wind turbine apparatus;

Figure 5 is a view similar to Figure 1 showing a turbine blade apparatus of the present

invention mounted on a ridge line of a roof;

Figure 6 shows three examples of the wind turbine apparatus of the present invention mounted on a ridge line of a roof in single , double or triple turbine modules;

Figure 7 is a schematic end elevation of a conventional vertical axis wind turbine;

Figure 8 is a schematic end elevation of a wind turbine apparatus in accordance with the present invention showing blades which are orientated at an angle less than 90° to a radius line;

Figure 9 is a schematic end elevation similar to Figure 8 showing turbine blades similar to those in Figure 1;

Figure 10 is a perspective view of a double section wind turbine module apparatus of the present invention;

Figure 11 is a schematic end elevation of a wind turbine apparatus in accordance with the present invention showing flexible turbine blades;

Figure 12 is a schematic side elevation showing the wind turbine apparatus of the present invention in conjunction with heating of water by solar energy; and

Figure 13 shows examples of turbine blades useful to the present invention which have cut away profiles.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description of the embodiments shown in the accompanying drawings like reference numerals denote like parts.

In Figures 1 and 2 of the accompanying drawings, there is shown a wind turbine apparatus 10 comprising a pair of end plate discs 12 (only one of which can be seen in Figure 1). The end plate discs 12 are mounted on a central axis 14 and are arranged for

rotation about the central axis 14.

The apparatus 10 further comprises a plurality, in this case three, of asymmetrical aero foil turbine blades 16. The blades 16 are equispaced about the periphery of the discs 12 and are located between the discs 12.

Each blade 16 comprises a leading edge 18, a trailing edge 20, an outer low pressure lift producing curved surface 22 and an inner relatively high (ambient) pressure surface 24. The surface 24 extends rearwardly from the leading edge 18 for a portion of the distance to the trailing edge 20, in this case about 50% of that distance. Thus, there is a gap 26 between a trailing end of each surface 24 and the corresponding trailing edge 20.

Further, each blade 16 is cupped by virtue of a hollow 28 between an inner face of the surface 22 thereof and an adjacent face of the corresponding surface 24. Alternatively, the blades 16 may be provided with cut away portions adjacent the trailing edges 20.

In Figure 3 of the accompanying drawings, there is shown a view similar to Figure 1 except that there is shown a twin blade apparatus 30. In Figure 3, there is shown a plurality of arrows 31 which indicate wind direction. A turbine spinning direction is indicated by arrows 32. As shown, ambient wind indicated by the arrows 31 pushes into a hollow 28 of a cupped blade 16 facing down wind. This action facilitates start up movement of the turbine apparatus 30.

Once rotational movement has commenced there is also a lift effect caused by wind flowing over the surface 22 of the lower blade 16 (as shown in Figure 3 of the accompanying drawings) which induces lift because of the foil shape of the blade 16.

In relation to the embodiments of the present invention shown in Figures 1 to 3 of the accompanying drawings it is noted that the turbine blades 16 are conveniently held

between the two outer end discs 12 as described hereinabove. However, they can also be curved back into the central axis 14 without end plates. Preferably, the number of blades used in a wind turbine apparatus 10 of the present invention is two or three but more can be utilised if desired.

The provision of the cupped configuration of each blade 16 provides the wind turbine apparatus 10 with a dual drag and lift operational effect. In this configuration, the curved outer surface 22 preferably largely follows an outer curve of the end plate discs 12.

Further, the inner high pressure surface 24 can extend rearwardly from the leading edge 18 for a distance from 10 – 90% of the distance between the leading edge 18 and the trailing edge 20. However, this distance is preferably about 50 – 60% of the distance from the leading edge 18 to the trailing edge 20 as this has been found to offer a preferred compromise between early start up performance and Tip Speed Ratio (TSR) performance.

This configuration provides sufficient inside surface for the wind path to be induced to flow smoothly back across the inside of each blade 16 with only a minimal performance change from a full foil.

However, when looking from behind, the foil cupped shape enables the wind air to be caught even in very light winds so that the wind turbine apparatus 10 can be readily started even in light wind conditions. Once the wind turbine apparatus 10 gains sufficient rotational speed and/or the wind gains sufficient strength, it begins to act as a lift type device and the apparatus 10 is therefore able to spin faster than wind speed. It has been

found that the TSR exceeds 1 and may typically operate in the 1.5 – 3 range.

In Figure 4 of the accompanying drawings there is shown a turbine blade apparatus 40 similar to that shown in Figure 1. This embodiment also comprises a pair of opposed wind deflection members 42 and 44. The deflection member 42 has a first plate A and a second plate B. The deflection member 44 has a first plate D and a second plate C. Wind direction is shown by arrows 46 whilst the turbine apparatus 40 spinning direction is shown by an arrow 48.

In Figure 5 of the accompanying drawings, there is shown a turbine blade apparatus 50, mounted on a ridge line 52 of a roof 54. Wind direction is shown by arrows 56 and the turbine apparatus 50 spinning direction is shown by an arrow 58. The turbine blade apparatus is mounted by means of a support frame 59.

Addition of the deflection members 42 and 44 about the periphery of the wind turbine apparatus can increase turbine performance.

In relation to the embodiment of Figure 4 it is found that the plates A and D clearly provide an extra degree of wind concentration through the turbine apparatus 40. Thus, the presence of these plates leads to an increase in performance. However, it has been found that the largest individual improvement from a single plate comes from the plate B which does not compress wind into the turbine. Similarly plate C does not compress wind but also provides significant improvements. Thus, it follows that the deflection members 42 and 44 alter the wind flow patterns through the turbine to advantageous performance effect. Preferably, the apex edges of the deflector members 42 and 44 are disposed at a

distance of less than 20% of the diameter of the wind turbine from the wind turbine to produce significant improvements in performance.

When all four plates A, B, C and D are used, a maximum effect is achieved. However, improvements can be obtained by using only some of the plates A, B, C and D.

In relation to the embodiment of Figure 5 the roof 54 provides one element of a wind deflector. This provides some of the benefits of the embodiments shown in Figure 4.

Further, it has been found that best results are obtained when the deflector members 42 and 44 or the ridge line 52 have a clear V-shaped apex rather than a rounded apex.

Further, it has been found that these techniques can be applied to commercial buildings and office blocks which do not have a roof top ridge line. It has been found that in this case the wind turbine apparatus can be mounted at building edges such as 90° building corners. It has been found that such corners provide an opportunity for mounting of the apparatus of the present invention as the building corners provide an area of wind concentration and offer natural deflector plate type geometry.

Further, roof top ridge lines and building corners structurally are the most strong positions at which to mount wind turbine apparatuses according to the present invention.

In Figure 6 there are shown three examples of wind turbine apparatuses mounted on roof ridge lines. At (a) there is shown a single module, at (b) there is shown a double module

and at (c) there is shown a triple module.

In Figure 7 of the accompanying drawings, there is shown an end view of a conventional wind turbine apparatus 70.

In Figure 7, there is shown a wind turbine apparatus 70 having a central rotational axis 72 and a plurality of peripheral solid turbine foil blades 74. The blades 74 are symmetrical when viewed in end elevation as seen in Figure 7.

The blades 74 have a leading end 76 and a trailing edge 78. The turbine spinning direction is shown by an arrow 77. The blades 74 are disposed at an angle of 90° relative to a radius 75 extending from the axis 72 and intersecting with a line 79 extending from the trailing edge 78 to a mid point where the blade 74 is thickest.

As can be seen each trailing edge 78 extends outwardly beyond the confines of the discs 12. It has been found that this 90° angle is detrimental to efficiency of the apparatus 70.

In Figure 8, there is shown a wind turbine apparatus 80 in accordance with the present invention in which solid turbine foil blades 74 are disposed at an angle of less than 90° to a radius 81 extending from the axis 72 intersecting with a line 83 extending from the trailing edge 78 to a mid point where the blade 74 is thickest. It has been discovered that this angle leads to a substantial improvement in efficiency of the turbine apparatus 80.

In Figure 9 of the accompanying drawings, there is shown a turbine blade turbine apparatus 90 of the present invention which is similar to that shown in Figure 8. However, the apparatus 90 comprises a pair of cupped turbine blades 16 similar to those shown in Figure 1. In this case a line from the trailing edge 20 of each blade 16 to the mid point of the thickest part of the blade 16 intersects a radius line 92 at an angle of about 76°.

As indicated herein above it has been found that improved performance can be obtained by orientation of the blades of figures 8 and 9 at an angle of less than 90°. This angle is determined by intersection of a line drawn from the axis of rotation to the centre of the thickest point of the blade and a line drawn from the centre of the thickest point of the blade to the trailing edge. It is found that orienting the blades at an angle of less than 90° improves the lift to drag ratio and therefore provides an improved performance over traditional blades which are disposed at 90°.

In Figure 10 of the accompanying drawings, there is shown a single module wind turbine apparatus 100 of the present invention. In this embodiment two wind turbine sections 10 are placed together to form one complete module. As shown these turbine sections 10 comprise the plate discs 12 and the turbine blades 16 together with the axis 14. However, as shown the two blades 16 of one section are rotated at 90° from the two turbine blades 16 of the other section. This arrangement provides a smoother torque curve and generally smoother and better balanced performance than single sections of two blades only.

In Figure 11 of the accompanying drawings there is shown an apparatus 110 similar to that shown in Figure 1. However, in this case the apparatus 110 comprises turbine foil blades 112 which have flexible trailing edges 114.

In this embodiment it is found that the trailing edges 114 tend to flex outwardly at increased rotational speeds. Thus, as shown, each trailing edge 114 is arranged to move from its relaxed stationary position outwardly as the spin rate increases. In this way, if rotational speeds become excessive the trailing edges 114 flex outwardly and apply a lower lift and higher drag effect to inhibit increased rotational speeds of the apparatus

110. The blades 112 could be made flexible other than at the trailing edge to achieve a similar result to that achieved by the use of the flexible trailing edges 114.

This effectively increases the blade angle which in turn reduces performance thereby reducing the TSR in relation to increasing wind speeds. This is a simple way of reducing high wind speed spin rates and reducing the chance of runaway and also reducing noise, vibration and turbine damage.

It is envisaged that the wind turbine apparatus of the present invention would be made in a modular style so that a number of units could be connected together in a modular arrangement on a building. Further, it is envisaged that the individual turbines would be relatively easy to manufacture cheaply by low cost mass production techniques such as injection moulding and extrusion. Further, the units could be made from plastics materials. Further, although the embodiments described herein utilise units with a horizontal axis of rotation it is envisaged that units with vertical axis of rotation or any angle in between horizontal and vertical could be utilised.

Further, the wind turbine apparatus of the present invention is particularly envisaged for use in generation of electricity. In that connection it is envisaged that the units of the present invention could utilise regularly available electrical connectors and that the plurality of units in a modular system could be connected together in known manner similar to that employed for photo voltaic solar panels.

As the apparatus of the present invention is designed for mounting onto buildings at external locations of wind concentration, in most instances these locations are also

usually sunny. It therefore stands to reason that there could be significant cost savings if the apparatus also incorporated the ability to heat water.

As it currently stands, wind turbines and solar hot water systems are completely separate items. Both are stand alone and require their own separate mounting frames. These mounting frames in combination with the installation cost of conventional solar hot water systems can typically represent one third of the overall system cost. No synergy currently exists between wind turbines and solar hot water in the form of conventional known technology.

Incorporated into the apparatus of the present invention is the ability to also heat water by solar means without affecting the electrical generation performance of the turbine. This has the advantage of being able to create hot water for a small cost addition, above the base cost of the turbines themselves. Instead of a consumer having to pay the traditional large cost of a conventional solar hot water system, they can now obtain hot water for smaller cost by incorporating it into their purchase of apparatus of the present invention. This way the consumer can save on their solar hot water system costs in addition to now being able to generate electricity.

There are a variety of ways of incorporating solar hot water into the apparatus of the present invention.

One example shown in Figure 12(a) is by running water through an axis 14 in the form of a tube and incorporating parabolic micro-strip reflection into the insides of blades. The sun's rays 130 can be refracted off the inside of the blades and concentrated onto the axis tube to heat the water. Although some sunlight is blocked by the blades as they spin, this method has the advantage of suiting a wider range of sun angles.

Another example is by running water through the mounting frame base 59 and heating via conventional solar thermal means as shown in Figure 12(b) at 122.

Another example is by running water through the mounting frame top and heating via conventional solar thermal means as shown in Figure 12(b) at 124.

In Figure 13(a) and 13(b) there are shown examples of turbine blades 131 and 132 which have cut away profiles. These blades may be used in place of the blades 16 shown in Figures 1 and 2. As can be seen these blade embodiments do not have a hollow 28 but they still have the surface 24 which extends partially from the leading edge 18 towards the trailing edge 20.

Thus, in each case there is a rearwardly facing surface 134 arranged to catch wind at start up in similar manner to the hollow 28.

Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.

CLAIMS

1. A wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface and a cupped or cut-away portion on an inner foil surface.

2. A wind turbine apparatus according to claim 1, characterized in that the apparatus comprises at least two spaced end plates with the axis extending therebetween, the turbine blades being mounted to the end plate discs and extending therebetween.

3. A wind turbine according to claim 2, characterized in that the turbine blades are disposed in spaced manner adjacent peripheries of the end plates and are arranged to orbit about the axis.

4. A wind turbine according to any one of the preceding claims, characterized in that each turbine blade has a leading edge, a trailing edge, an outer low pressure lift providing inner surface and an inner relatively high pressure surface, the inner relatively high pressure surface extending rearwardly from the leading edge for a portion of the distance to the trailing edge so that there is a gap between a trailing end of the inner relatively high pressure surface and the trailing edge.

5. A wind turbine apparatus according to claim 4, characterized in that the inner relatively high pressure surface extends rearwardly for from 10 to 90% of the distance between the leading edge and the trailing edge.

6. A wind turbine apparatus according to claim 5, characterized in that the inner high pressure surface extends rearwardly for from 50 to 60% of the distance between the leading edge and the trailing edge.

7. A wind turbine apparatus according to any one of the preceding claims, characterized in that wind deflection members are located adjacent the apparatus so as to direct wind air into the apparatus.

8. A wind turbine apparatus according to claim 7, characterised in that the wind deflection member comprises one or more plates.

9. A wind turbine apparatus according to claim 7 characterised in that the apparatus is mounted on a ridge line of a roof or a roof edge of a multi storey building so that the ridge line or roof edge acts as a wind deflector.

10. A wind turbine apparatus according to any one of the preceding claims, characterized in that the turbine blades are disposed at an angle of less than 90° to a radius line extending from the axis.

11. A wind turbine apparatus according to any one of the preceding claims, characterized in that the turbine blades are flexible so that they tend to flex outwardly at increased rotational speeds.

12. A wind turbine apparatus according to a wind turbine apparatus characterized by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface, wherein the turbine blades are disposed at an angle of less than 90° to a radius line extending from the axis.

13. A wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface, wherein wind deflection members are located adjacent the apparatus so as to direct wind flow pattern through the apparatus.

14. A wind turbine apparatus characterised by a plurality of elongated turbine blades

rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface, wherein the apparatus is arranged to both generate electricity by means of wind energy and heat water by means of solar energy.

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FIGURE 1

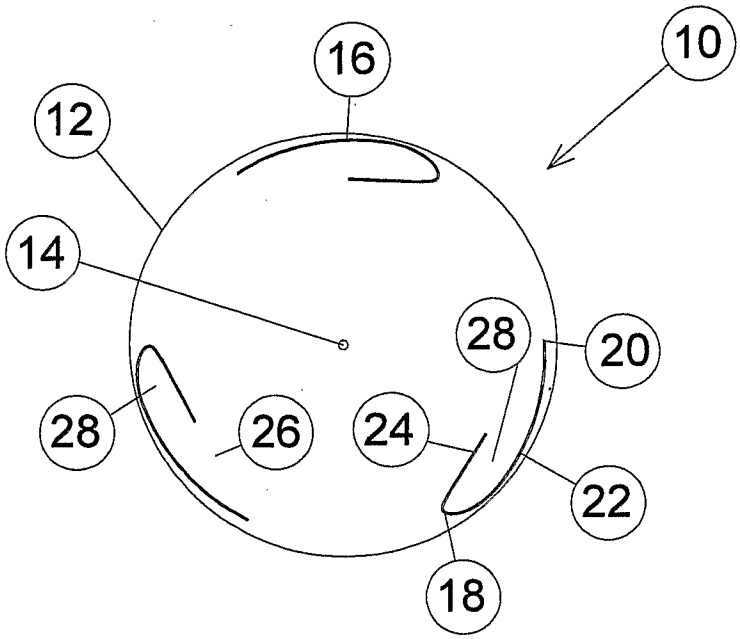


FIGURE 2

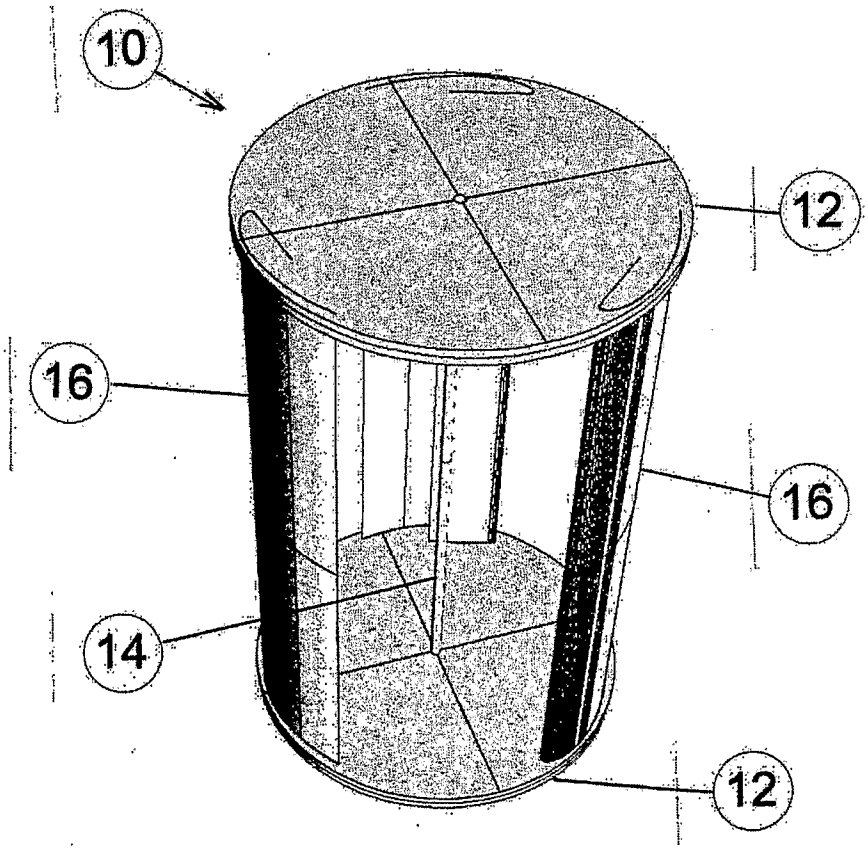


FIGURE 3

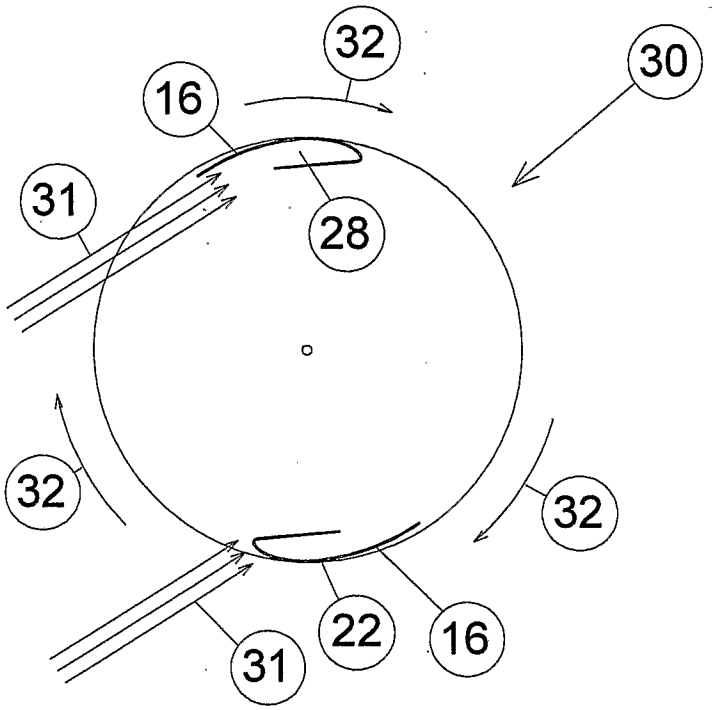


FIGURE 4

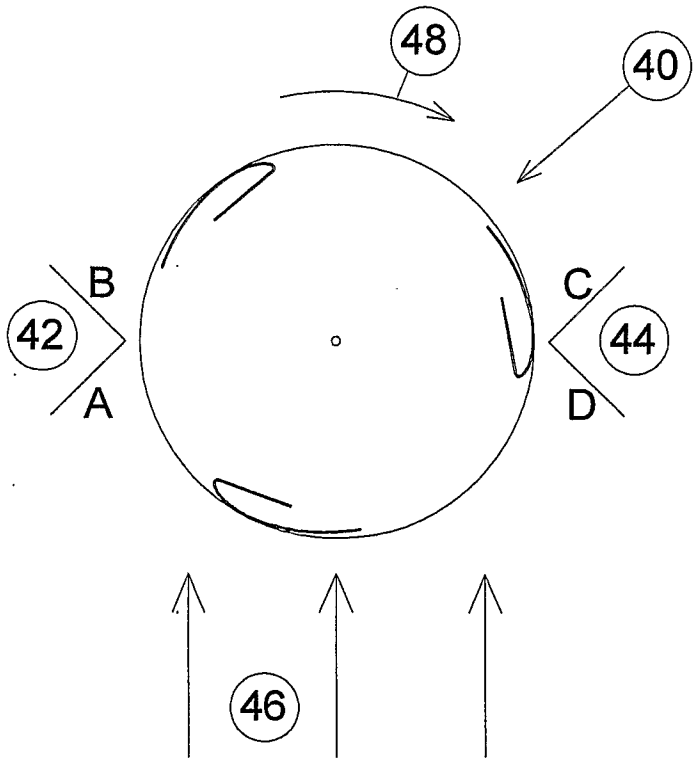


FIGURE 5

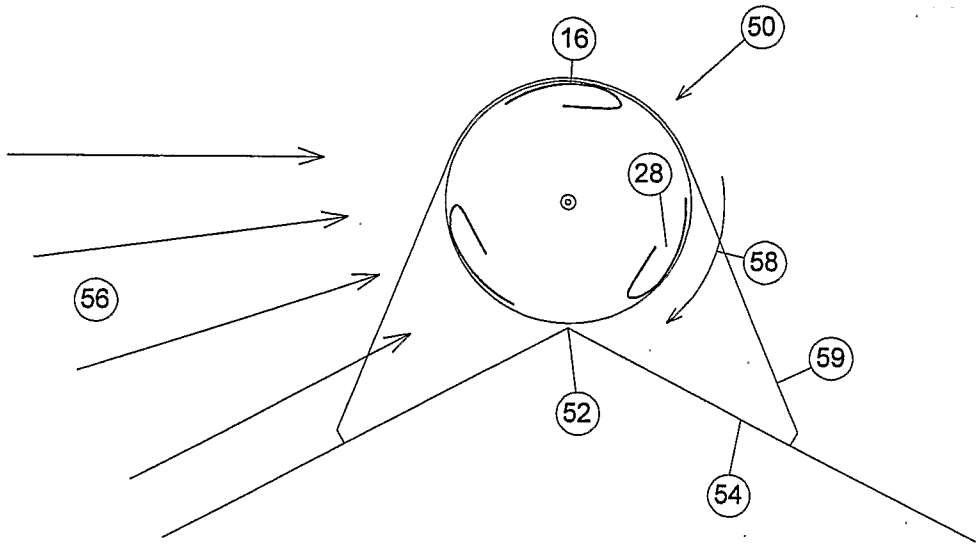


FIGURE 6

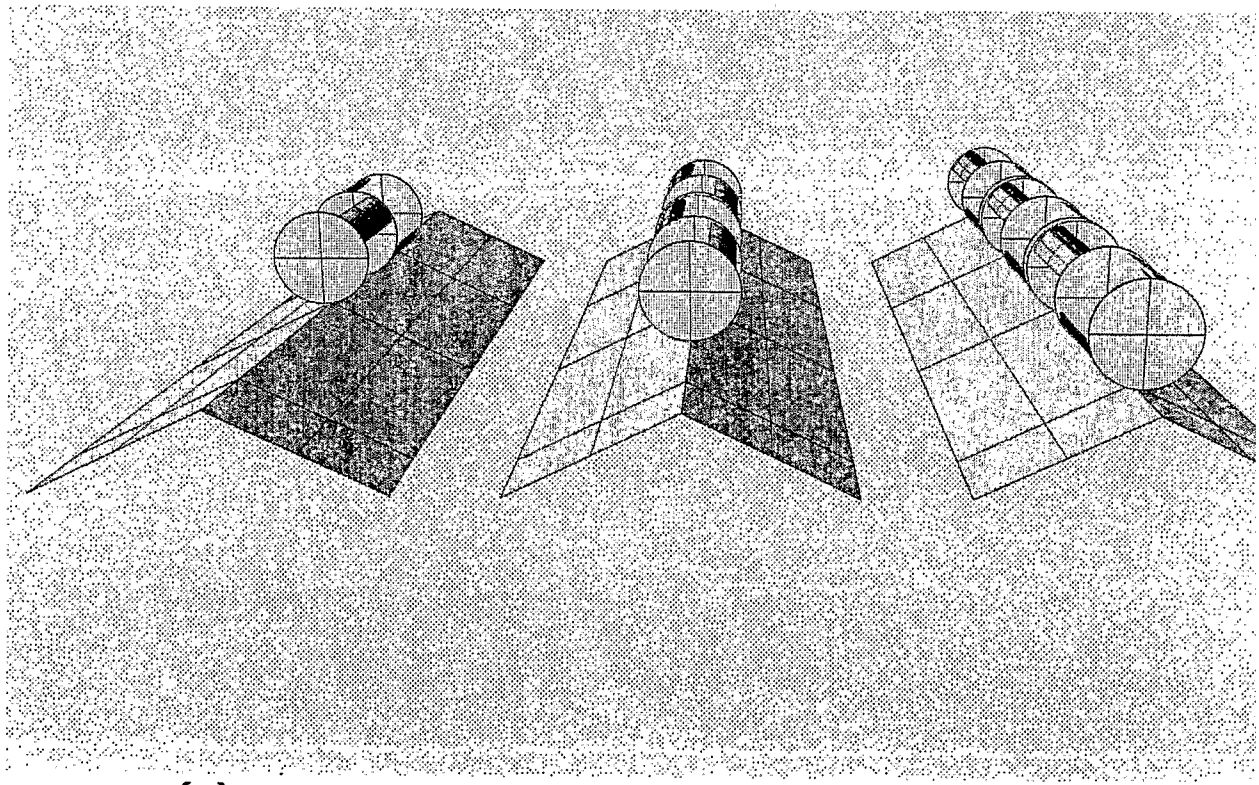


FIGURE 7

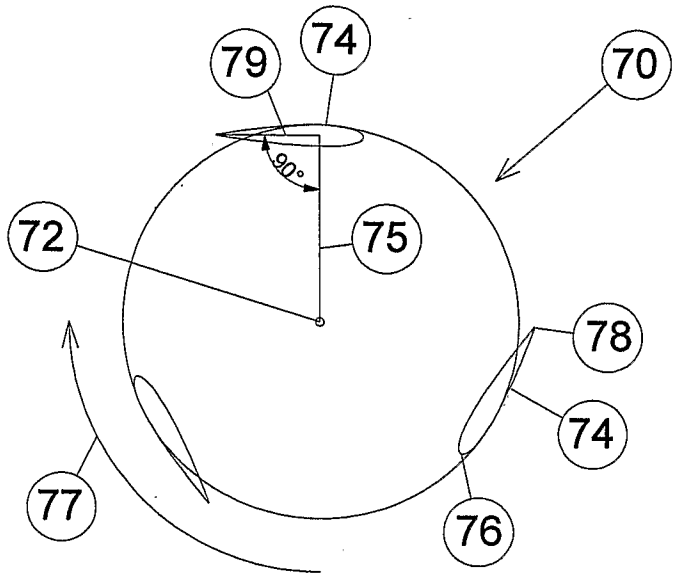


FIGURE 8

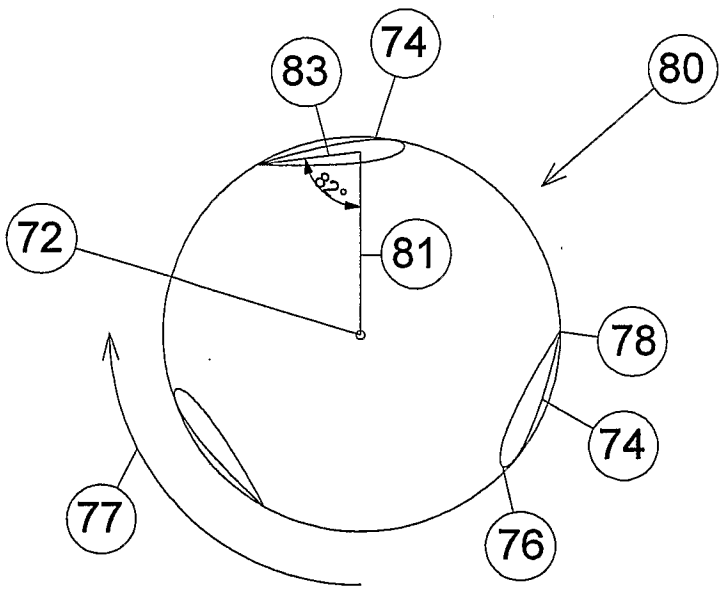


FIGURE 9

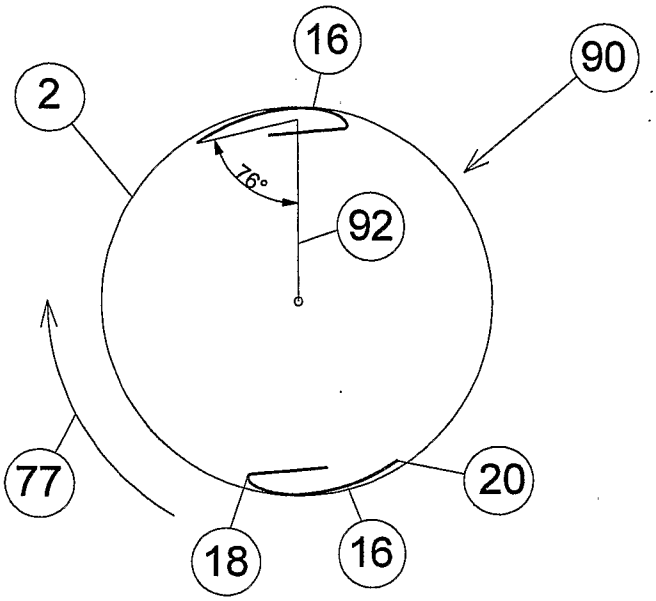


FIGURE 10

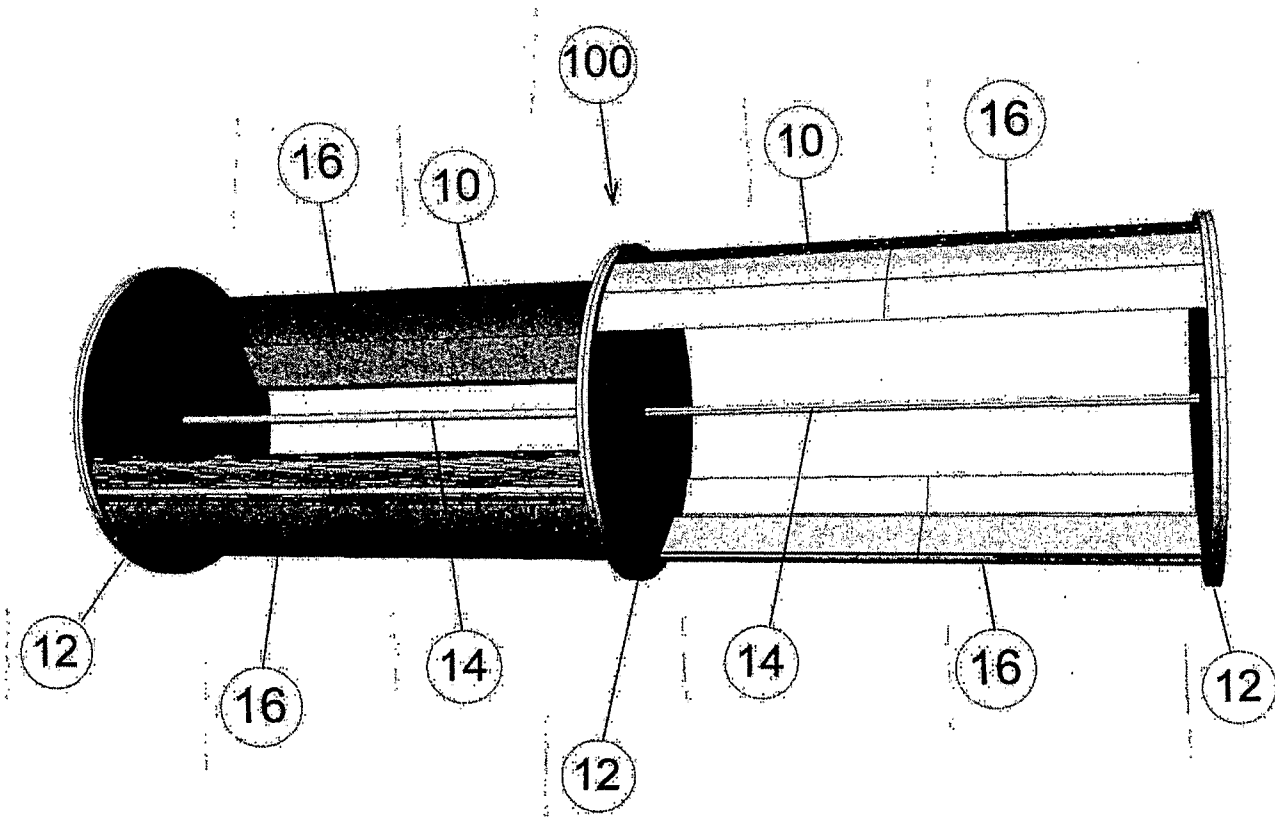


FIGURE 11

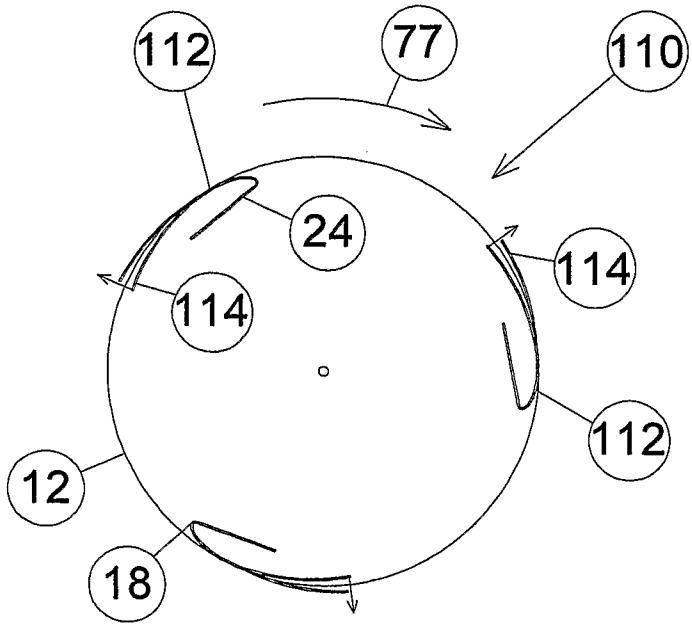


FIGURE 12

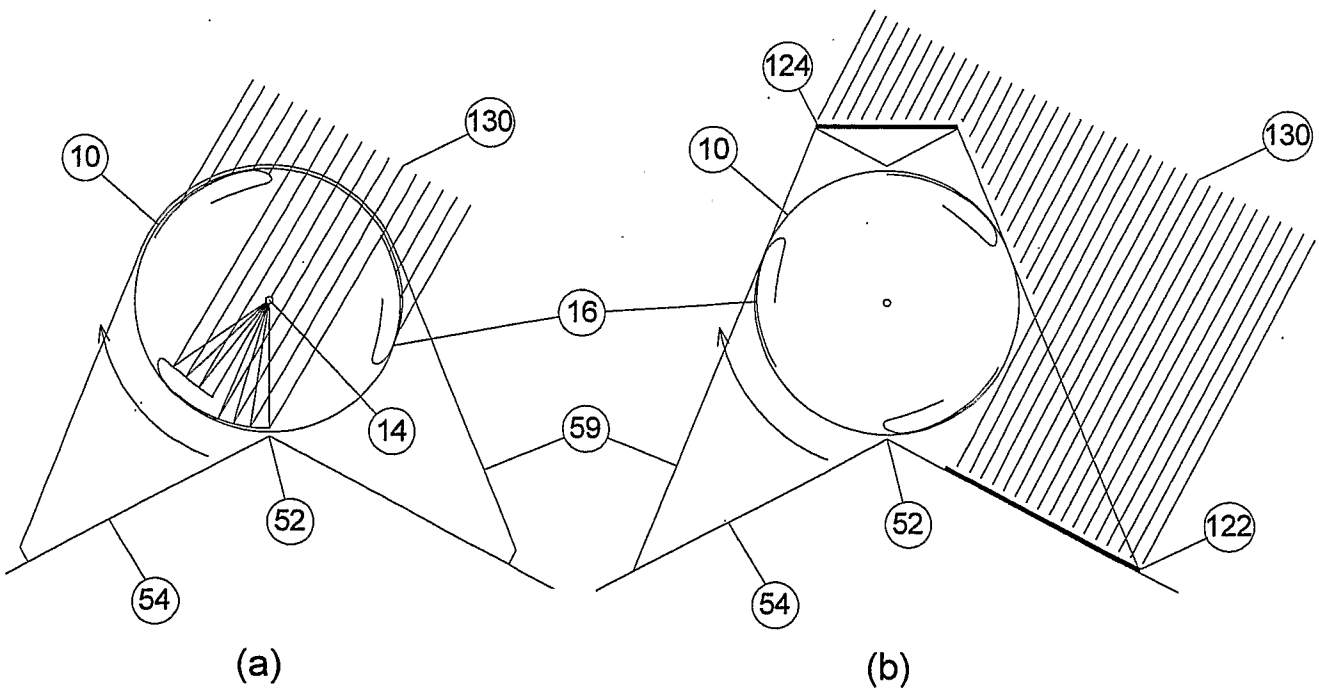
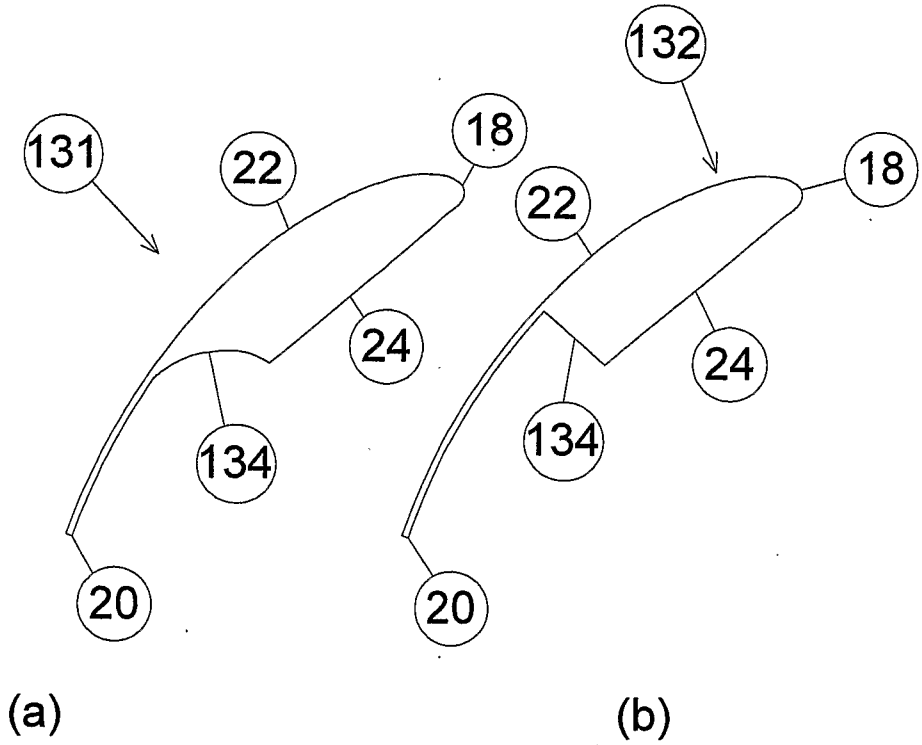


FIGURE 13



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/001865

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

F03D 3/02 (2006.01) *F03D 3/06* (2006.01)

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
AU: PAIS IPC F03D 3/02, F03D 3/06

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

1. DWPI: IPC F03D/- and Keywords (aerofoil, cup, cutaway, endplate, deflect, windward, blade, flexible, solar, heat, liquid) and like terms.
2. USPTO & ESP@CE: IPC F03D/- and Keywords (aerofoil, cup, cutaway, guide, shroud, blade, flexible, solar, heat, water) and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2005/116446 A1 (INTELLECTUAL PROPERTY BANK CORP) 8 December 2005 Figures 1-8, 10-15 Figures 1-8, 10-15	1 2, 3, 7-11, 13-14
X Y	US 2004/0105754 A1 (TAKAHASHI) 3 June 2004 Figures 1-6, Paragraphs [0038]-[0039] Figures 1-6, Paragraphs [0038]-[0039]	1 2, 3, 7-11, 13-14
Y	Derwent Abstract Accession No. 93-150470/18, Class Q55, SU 1733680 A1 (SUMY SECT KHARK POLY) 15 May 1992 See whole abstract	1, 14

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

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 March 2008	8 MAY 2008
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **Dr ARUN SHARMA** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : (02) 6283 3642

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2007/001865

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	RU 2096259 C1 (VICTOROVICH et al.) 20 November 1997 Whole document	1, 2, 3, 14
X Y	US 6309172 B1 (GUAL) 30 October 2001 Figure 2, column 1 lines 38-43	13 1, 7, 8, 9, 13, 14
Y	US 5380149 A (VALSAMIDIS) 10 January 1995 Figure 2, column 4, lines 6-11	1, 7, 8, 9, 13, 14
Y	DE 10328249 A1 (REINHARD) 3 February 2005 Whole document	1
Y	US 5527151 A (COLEMAN et al.) 18 June 1996 Figures, Column 2 lines 31-44	11
X Y	US 6293835 B2 (GORLOV) 25 September 2001 Figures 4, 9, 17, 18; column 5, lines 38-51 Figures 4, 9, 17, 18; column 5, lines 38-51	12 1, 10, 14
Y	Patent Abstracts of Japan, JP 2001193631 A (PENTA OCEAN CONSTRUCTION CO LTD) 17 July 2001 See whole abstract	9
Y	Patent Abstracts of Japan, JP 2002021705 A (KOJI) 23 January 2002 See whole abstract	9
Y	GB 2404700 A (HILDER) 9 February 2005 Figures	1, 9
Y	Patent Abstracts of Japan, JP 2003065206 A (DAIWA HOUSE IND CO LTD) 5 March 2003 See whole abstract	9
Y	Korean Patent Abstracts (English), KR 20050093540 A (SIC et al.) 23 September 2005 Abstract	14
Y	Patent Abstracts of Japan , JP 2004019537 A (KO) 22 January 2004 See whole abstract	14
Y	US 4379972 A (SOSA et al.) 12 April 1983 Figure 3	14
Y	GB 2000556 A (LAGARDE) 10 January 1979 Figures, Page 1 lines 27-32	11

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	For Y indications: WO 2005/116446 A1 or US 2004/0105754 A1 can be combined: with RU 2096259 C1 for claims 2, 3 with US 6309172 B1 or US 5380149 A for claims 7, 8, 13 with either US 6309172 B1 or US 5380149 A, and the resulting pair with JP 2001193631 A or JP 2002021705 A or GB 2404700 A or JP2003065206 A for claim 9 with US 5527151 A or GB 2000556 A for claim 11 and with US 6293835 B2 for claim 10. WO 2005/116446 or US 2004/0105754 A1 or SU 1733680 A1 or RU 2096259 C1 or US 6309172 B1 or US 5380149 A or US 6293835 B2 can be combined with KR 20050093540 A or JP 2004019537 A or US 4379972 A for claim 14. RU 2096259 C1 or US 6309172 B1 or US 5380149 A or US 6293835 B2 or GB 2404700 A can be combined with SU 1733680 A1 or DE 10328249 A1 for claim 1.	

INTERNATIONAL SEARCH REPORT

International application No.
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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please refer to supplement sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.: **1-3, 7-14**

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

Supplemental Box
(To be used when the space in any of Boxes I to IV is not sufficient)

... Continuation of Box No III: Observations where unity of invention is lacking

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

In assessing whether there is more than one invention claimed, I have given consideration to those features which can be considered to potentially distinguish the claimed combination of features from the prior art. Where different claims have different distinguishing features they define different inventions.

Claim 1 is directed to a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface and a cupped or cut-away portion on an inner foil surface. It is considered that claim 1 does not have any "special technical feature" which makes a contribution over the prior art since the features of claim 1 are known in at least the following two documents:

(A) WO 2005/116446 A1 (INTELLECTUAL PROPERTY BANK CORP.) 8 December 2005
(B) Derwent Abstract Accession No. 93-150470/18, Class Q55,
SU 1733680 A1 (SUMY SECT KHARK POLY) 15 May 1992

Consequently, the remaining claims are classified into groups of inventions by different distinguishing features. This International Searching Authority has found that according to different distinguishing features there are 6 different inventions as follows:

1. Claims 1-3 are directed to a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface and a cupped or cut-away portion on an inner foil surface characterised in that *"the apparatus comprises at least two spaced end plates with the axis extending therebetween, the turbine plates being mounted to the end plate discs and extending therebetween"*. It is considered that the feature in italics within inverted commas comprises a first distinguishing feature.

2. Claim 1 and claims 4 to 6 are directed to a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface and a cupped or cut-away portion on an inner foil surface characterised in that each turbine blade has a leading edge, a trailing edge, an outer low pressure lift providing inner surface and an inner relatively high pressure surface, *"the inner relatively high pressure surface extending rearwardly from the leading edge for a portion of the distance to the trailing edge so that there is a gap between a trailing end of the inner relatively high pressure surface and the trailing edge"* It is considered that the feature in italics within inverted commas comprises a second distinguishing feature.

3. Claims 1, 7-9 and claim 13 are directed to a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface (and a cupped or cut-away portion on an inner foil surface) wherein *"wind deflection members are located adjacent the apparatus so as to direct wind flow pattern through the apparatus"*. It is considered that the feature in italics within inverted commas comprises a third distinguishing feature.

4. Claims 1 and 11 are directed to a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface and a cupped or cut-away portion on an inner foil surface characterised in that *"the turbine blades are flexible so that they tend to flex outwardly at increased rotational speeds"*. It is considered that the feature in italics within inverted commas comprises a fourth distinguishing feature.

...continued on next sheet

Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

... Continuation of Box No III: from previous sheet

5. Claims 1, 10 and claim 12 are directed to a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface (and a cupped or cut-away portion on an inner foil surface) wherein "*the turbine blades are disposed at an angle of less than 90^0 to a radius line extending from the axis*". It is considered that the feature in italics within inverted commas comprises a fifth distinguishing feature.

6. Claim 14 is directed to a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface wherein *"the apparatus is arranged to both generate electricity by means of wind energy and heat water by means of solar energy"*. It is considered that the feature in italics within inverted commas comprises a sixth distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

The only feature common to all of the claims is "a wind turbine apparatus characterised by a plurality of elongated turbine blades rotatably mounted about an elongated axis, each turbine blade having an aerofoil shaped profile with a continuously curved outer foil surface". As previously stated this common feature is known from at least the prior art documents (A) and (B) listed above.

This means that the common feature can not constitute a special technical feature within the meaning of PCT Rule 13.2, second sentence, since it makes no contribution over the prior art.

Because the common feature does not satisfy the requirement for being a special technical feature it follows that it cannot provide the necessary technical relationship between the identified inventions. Therefore the claims do not satisfy the requirement of unity of invention a posteriori.

It is considered that search and examination for the additional inventions will require more than negligible additional search and examination effort over that for the first invention, and therefore additional search fees are warranted.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2007/001865

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	2005/116446	CN	1961151	EP	1757806	US	2007224029
US	2004/0105754	CN	1502807	EP	1422422	JP	2004176551
SU	1733680		NONE				
RU	2096259		NONE				
US	6309172	AU	40187/97	CA	2264239	EP	0920585
		FR	2752599	OA	11178	WO	1998/007981
US	5380149	AU	78872/91	CA	2064733	CA	2070019
		EP	0522994	FI	921414	JP	6101622
		NO	920385	NO	922107	WO	1991/019093
DE	10328249		NONE				
US	5527151		NONE				
US	6293835	AU	53788/96	BR	9608842	CA	2222115
		CN	1188526	EP	0830506	HK	1015436
		US	5451137	US	5451138	US	5577882
		US	5642984	US	6036443	US	6155892
		US	6253700	US	2001000197	US	2001001299
		WO	1995/018921	WO	1996/038667		
JP	2001193631		NONE				
JP	2002021705		NONE				
GB	2404700		NONE				
JP	2003065206		NONE				
KR	20050093540		NONE				
JP	2004019537		NONE				
US	4379972		NONE				

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

END OF ANNEX