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WO 2015/004333 A1 **WO 2014/202082 A1**
WO 2012/050466 A **US 20070138793 A1**
KR 20100126866

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(54) Title of the Invention: **Wave powered electricity generator and support platform**
Abstract Title: **Wave powered electricity generator and support platform**

(57) A wave powered electricity generator comprises a base 20 which is connected to a platform by a torsion mount 21 such that the base is rotatable about a generally vertical first axis 22 in opposite directions from a rest position. A tubular arm 25 formed from carbon fibre is mounted on the base to pivot about a generally horizontal second axis 24. A float 28 is carried by the outboard end of the arm and a magnetic body 29 is attached to the inboard end. Rotation about the first and second axis allows the float 28 to move in continuous loop-like elliptical or circular path. The magnetic body 29 is interacts with an electrical stator coil assembly mounted on the base. A plurality of the generators are mounted on a concrete barge.

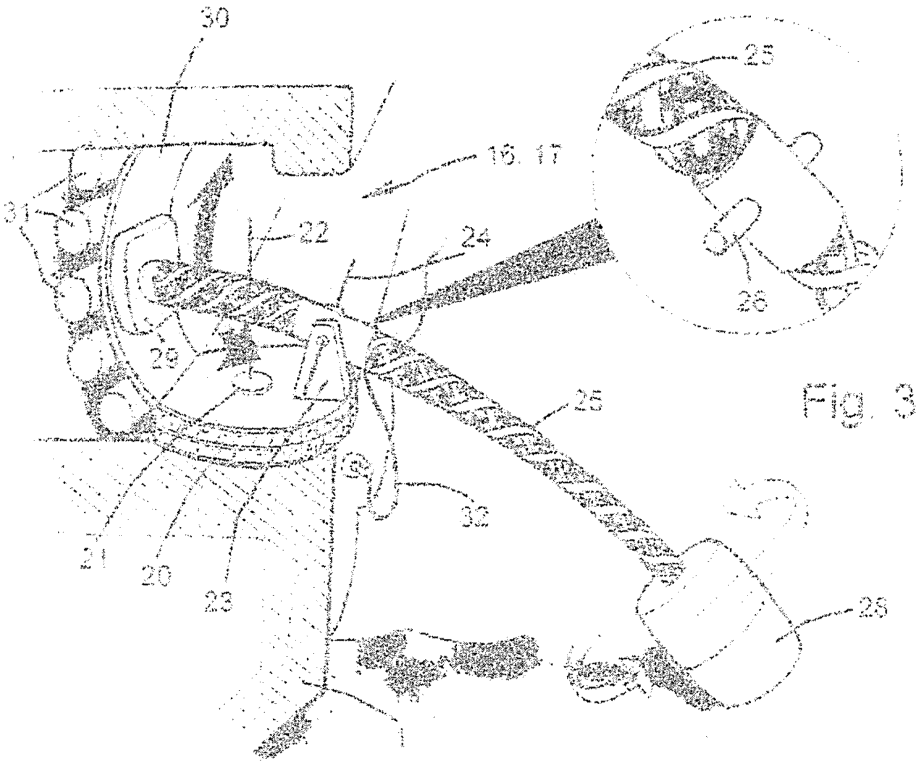


Fig. 3

GB 2551563 A

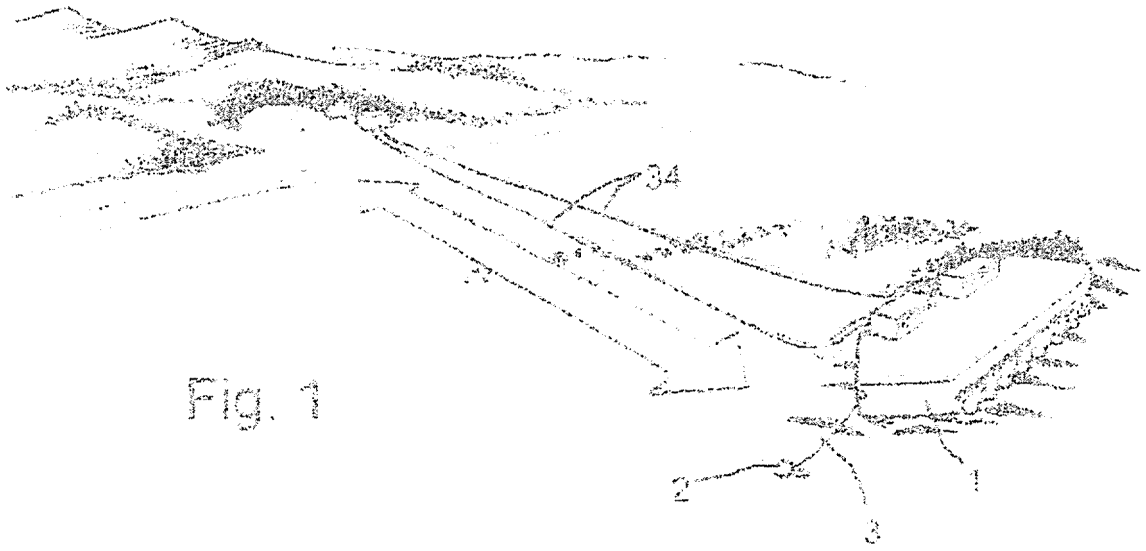


Fig. 1

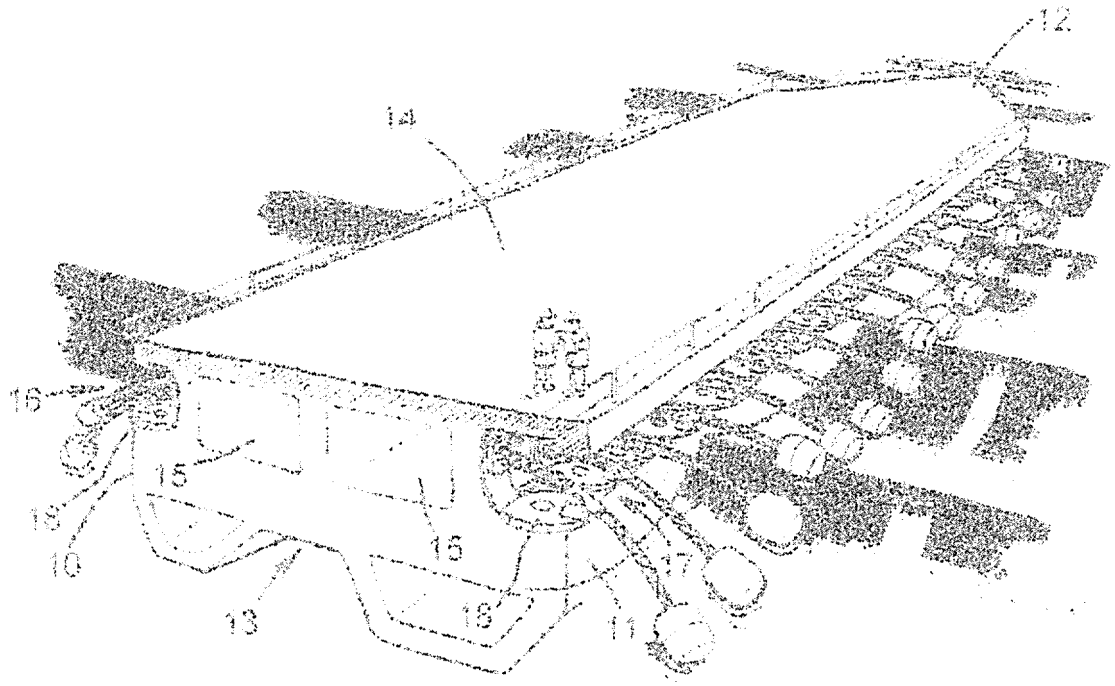


Fig. 2

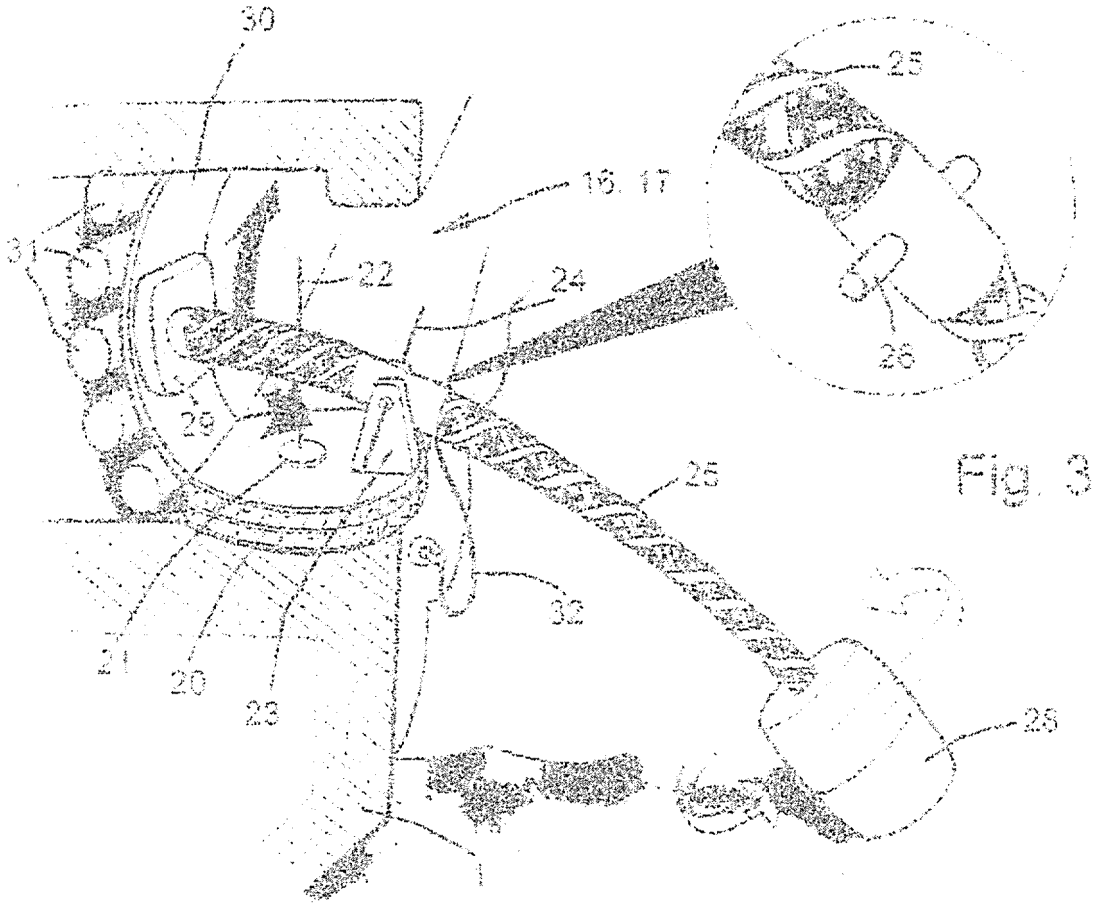


Fig. 3

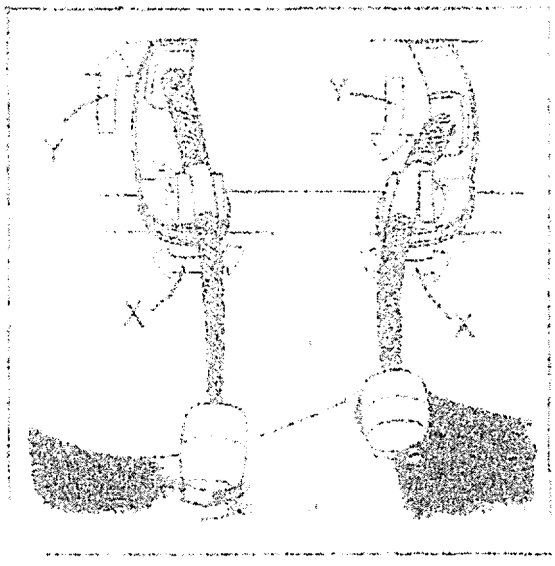
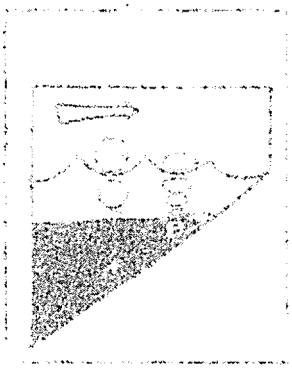


Fig. 4



Simon James Gillett

WAVE POWERED ELECTRICITY GENERATOR AND SUPPORT PLATFORM

TECHNICAL FIELD OF THE INVENTION

This invention relates to a wave powered electricity generator and a support platform which can be used therewith.

BACKGROUND

Known wave powered electricity generators often incorporate a body which moves up and down with a reciprocal motion under the action of the waves. The reciprocal motion is used, directly or indirectly, to generate electrical power. Furthermore, support platforms which incorporate such wave powered electricity generators are often high maintenance and do not allow the generators to operate with optimum efficiency.

The present invention seeks to provide a new and inventive form of wave powered electricity generator and support platform which are efficient and low maintenance with a positive environmental impact.

SUMMARY OF THE INVENTION

The present invention proposes a wave powered electricity generator which includes:

- a base;
- a torsion mount for connecting the base to a structure such that the base is rotatable about a first axis in opposite directions from a rest position;
- an arm mounted on the base by means of a pivotal connection intermediate between two ends of the arm such that the arm pivots about a second axis extending transverse to the first axis;
- a wave float carried by an outboard end of the arm;
- a magnetic body carried by an inboard end of the arm; and
- an electrical stator coil assembly mounted on the base in the field of the magnetic body to generate an electrical current as the arm moves about the second axis;

the arrangement being such that rotation about the first and second axes allows the float to move in a continuous loop-like path.

The invention also provides a wave powered electricity generator which includes an arm formed of a carbon fibre tube.

The invention also provides a wave powered electricity generator in which an arm is mounted on a base by means of a shearing coupling and the arm is secured by a tether.

The invention also provides an installation in which a plurality of electrical wave power generators are mounted on a structure.

The invention also provides an installation in which a plurality of electrical wave power generators are mounted on a floating structure.

The invention also provides an installation in which a plurality of electrical wave power generators are mounted on a floating structure formed of concrete.

The invention also provides an installation in which a plurality of electrical wave power generators are mounted in slot-shaped recesses.

The invention also provides an installation in which a plurality of electrical wave power generators are mounted in slot-shaped recesses extending along opposite sides of a structure.

The invention also provides a support platform having a pair of opposite sides extending between a bow and a stern, and a plurality of electrical wave power generators mounted along each of said opposite sides.

The invention also provides a support platform formed of concrete.

The invention also provides a support platform which contains a

plurality of storage compartments.

The invention also provides a support platform provided with desalination equipment.

The invention also provides a support platform which provides a telecommunications hub.

The invention also provides a support platform which is anchored to the sea bed by a flexible element.

BRIEF DESCRIPTION OF THE DRAWINGS

The following description and the accompanying drawings referred to therein are included by way of non-limiting example in order to illustrate how the invention may be put into practice. In the drawings:

Figure 1 is a general view of a support platform in accordance with the invention;

Figure 2 is a more detailed view of the support platform, shown in cross-section; and

Figure 3 is a general view of a wave powered electricity generator for use in the support platform; and

Figure 4 demonstrates the operation of the electricity generators.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring firstly to **Fig. 1**, the support platform 1 can, for example, be used in disaster relief operations, or to provide general support for other kinds of marine operations, e.g. exploration or drilling. The platform is intended to be low maintenance so that it can remain unmanned for long periods, e.g. when the platform is used primarily for power generation purposes. In use, the platform will normally be tethered to the sea bed, e.g. in an offshore location, by means of an anchor 2 and flexible cable, chain or similar element 3.

The support platform 1 is shown in greater detail in **Fig. 2**, in which the platform is cross-sectioned for illustrative purposes. The hull of the platform is preferably constructed from reinforced concrete since in a marine environment this material is not subject to corrosion and is relatively low maintenance. The hull may also act as a man-made reef which is capable of supporting the growth of sea life such as limpets, mussels and other shellfish, along with marine plants which may in turn provide shelter for fish and other sea creatures.

The platform is shaped like a barge with generally parallel sides 10 and 11 extending between an angular bow 12 and a stern which is

indicated generally at 13 but omitted from the sectional view. The deck 14 of the platform is substantially flat and provides a general work area which may incorporate a helicopter landing space to allow rapid servicing etc. Internally the hull is divided into a number of separate compartments 15 which assist the buoyancy of the platform and can also be used for storage of products, plant and machinery, as described further below. The opposite sides of the platform, 10 and 11, are formed with respective laterally-open recesses 16 and 17 extending from bow to stern, which each house a number of wave powered electricity generators 18 which have been designed to be highly efficient low maintenance units, as will now be described in detail.

Referring to Fig. 3, each wave powered electricity generator incorporates a base 20 which extends generally parallel to the surface of the sea in use. The base 20 is mounted on the bottom of a side recess 16, 17 attached to the structure of the support platform by a torsion mount 21. This torsion mount acts between the base 20 and the support platform 1 such that the base can rotate about a first axis 22 which is normal to the base, being generally vertical in use. The torsion mount 21 allows the base to rotate in opposite directions relative to a rest position in which the base is shown in the drawing. As the base rotates away from the rest position the torsion mount applies an increasing torsional load to the base, thereby tending to return the base to the rest position.

The outboard edge of the base 20 carries a U-bracket 23 providing

a second pivot axis 24 which extends transverse to the first axis 22 and substantially parallel to the base 20. An arm 25 is provided with a pivot pin 26 at a point intermediate between its two ends, which pivotally mounts the arm in the U-bracket 23 for rotation about the second axis 24. A wave float 28 is mounted on an outboard end of the arm 25, and a magnetic body 29 is mounted on an inboard end of the arm. As the float 28 rides up-and-down on the waves the magnetic body 29 moves adjacent to an arcuate support 30 of which the radius of curvature is centred on the second pivot axis 24. The arcuate support 30 carries an array of stator coils 31 which are mounted on the inboard side of the support 30 which therefore shields the coils from the sea. Reciprocating movement of the arm 25 causes the magnetic body 29 to move past one or more of the stator coils 31, depending on the amount of swell, thereby inducing an electrical current in the coil or coils. The stator coils of all the generators are connected such that the induced electrical power provides a continuous electrical output.

The operation of the torsion mount 21 ensures that the generators operate with optimum efficiency under all sea conditions. In their rest positions the arms 25 project substantially perpendicular to the sides 10 and 11 of the platform. As shown in Fig. 4, the torsion mounts 21 allow the floats 28 to move with a fore-and-aft motion relative to the platform 1 (arrows X) as wall as a simple reciprocating up-and-down motion (arrows Y) so that the floats move in a continuous loop-like path. This motion is illustrated in the right hand panel; in deep water it has been found that the

wave dynamics produce a near-circular motion as at A, whereas in shallower water the floats tend to move in a more elliptical path as at B. This movement allows a greater amount of wave energy to be recovered compared with simple vertical reciprocation. As the waves travel along the sides of the platform the floats 28 will move out of phase with each other, which also maximises the electrical energy output.

Returning to **Fig. 3**, the arms 25 are are formed of carbon fibre with a tubular structure making them slightly flexible for maximum energy recovery, very strong and lightweight. A preferred form of construction is described in **US 8 313 600**. The pivot pins 26 are designed to shear when subjected to the stresses produced under extreme conditions so that the generator will be less likely to suffer damage. Should the pins shear the arm remains tethered to the hull by a flexible line 32, making repair of the generator a straightforward and inexpensive operation.

Since the support platform has a bow and a stern the platform will automatically orientate itself to face into the oncoming waves, ensuring that it is best positioned to obtain maximum energy from the wave motion and better withstand storm conditions.

The support platform, or an array of platforms, may be used to provide electrical power to an onshore power hub via umbilical connections 34, as shown in **Fig. 1**. By way of illustration, a 100 metre long platform with thirty generators on each side would typically be capable of supplying 5 megawatts of electrical power.

The barge-like structure of the support platform enables it to be quickly and easily towed to a new location to provide support for disaster relief or other operations. Equipment such as desalination plant can be housed within the compartments 15, which can also be used for the transportation and temporary storage of goods such as frozen food, chilled products and dry goods such as tents and medical supplies, which may be loaded in standard containers. A continuous supply of fresh water and electrical power may be sent ashore via the umbilical connection 34. The deck 14 can carry telecommunications masts, providing a vital communication hub when local telecommunications are disrupted, e.g. during a hurricane or earthquake. The platform can also be used to support local aquaculture projects such as mussel farming which may be carried out on the platform.

Whilst the above description places emphasis on the areas which are believed to be new and addresses specific problems which have been identified, it is intended that the features disclosed herein may be used in any combination which is capable of providing a new and useful advance in the art.

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CLAIMS

1. A wave powered electricity generator which includes:
- a base;
- a torsion mount for connecting the base to a structure such that the base is rotatable about a first axis in opposite directions from a rest position;
- an arm mounted on the base by means of a pivotal connection intermediate between two ends of the arm such that the arm pivots about a second axis extending transverse to the first axis;
- a wave float carried by an outboard end of the arm;
- a magnetic body carried by an inboard end of the arm; and
- an electrical stator coil assembly mounted on the base in the field of the magnetic body to generate an electrical current as the arm moves about the second axis;
the arrangement being such that rotation about the first and second axes allows the float to move in a continuous loop-like path.

2. A wave powered electricity generator according to Claim 1 in which the arm is a carbon fibre tube.

3. A wave powered electricity generator according to Claim 1 or 2 in which the arm is mounted on the base by means of a shearing coupling, and the arm is secured by a tether.

4. An installation in which a plurality of wave powered

electricity generators according to any of Claims 1 to 3 are mounted on a common structure.

5. An installation according to Claim 4 in which the wave powered electricity generators are mounted on a floating structure.

6. An installation according to Claim 5 in which the floating structure is formed of concrete.

7. An installation according to Claim 5 or 6 in which the wave powered electricity generators are mounted along opposite sides of the floating structure which sides extend between a bow and a stern.

8. An installation according to Claim 7 in which the wave powered electricity generators are mounted in slot-shaped recesses extending along said opposite sides of the structure.

9. A wave powered electricity generator substantially as described with reference to the drawings.

10. An installation substantially as described with reference to the drawings.

11. A support platform having a pair of opposite sides extending between a bow and a stern, and a plurality of electrical wave power generators mounted along each of said opposite sides.

12. A support platform according to Claim 11 which is formed of concrete.

13. A support platform according to Claim 11 or 12 which contains a plurality of storage compartments.

14. A support platform according to any of Claims 11 to 13 which is provided with desalination equipment.

15. A support platform according to any of Claims 1 to 14 which provides a telecommunications hub.

16. A support platform according to any of Claims 11 to 15 which is anchored to the sea bed by a flexible element.

17. A support platform substantially as described with reference to the drawings.

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Intellectual Property Office

Application No:	GB1610962.1	**Examiner:**	Laura Goacher
Claims searched:	1-10	**Date of search:**	19 December 2016

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-8	WO 2015/004333 A1 (SA2P) See figs 1, 2, 5, 6, page 12 lines 10-24 and page 8 lines 8-29
X	1 at least	WO 2014/202082 A1 (MØLHEDE PEDERSEN et al) see fig 4
X	1 at least	WO 2012/050466 A (SEA FOR LIFE, LDA) See fig 3
X	1 at least	US 2007/138793 A1 (ZIMMERMAN et al) See abstract and [0002]
A	-	KR 20100126866 A (PARK) See WPI Abstract Accession Number 2010-Q52702 and all drawings

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

F03B

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI, INTERNET

Intellectual Property Office

International Classification:

Subclass	Subgroup	Valid From
F03B	0013/14	01/01/2006
F03B	0013/16	01/01/2006