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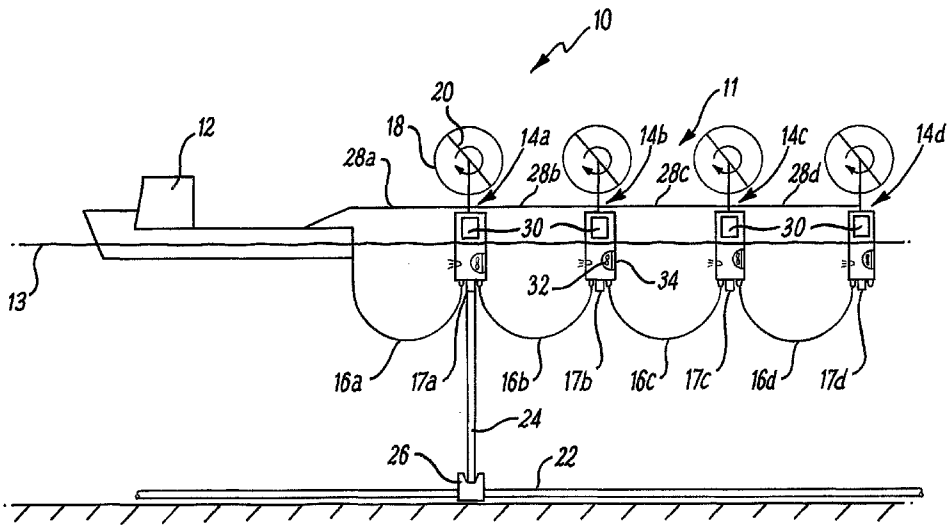
(54) **Title:** OFFSHORE APPARATUS FOR CAPTURING ENERGY



(57) **Abstract:** The present invention relates to offshore apparatus (10) for capturing energy to generate an exportable product. In one embodiment, the offshore apparatus includes a mobile arrangement of energy capture devices, such as wind turbines (18), wave energy converters (14), or solar energy panels. The arrangement provides a plurality of points that may be connected to an offloading unit (26) to move the product, which can be stored electricity in batteries or a stored pressurised gas away from the energy capture devices.

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Offshore apparatus for capturing energy

The present invention relates to offshore apparatus for capturing energy, and, in one particular embodiment, to apparatus having an array of energy capture devices.

There is significant interest in capturing and extracting energy from renewable sources for use by consumers, and it is desirable to do so in an environmentally clean manner. Natural renewable energy sources are provided by the oceans and weather systems, and include for example wind, wave and solar sources. In the offshore environment, these sources are available simultaneously, and various methods exist for capturing energy in the offshore environment.

Typically, offshore power plants for capturing energy are installed in a particular offshore locality, and are moored or anchored to the seabed. However, the weather conditions experienced at a particular locality can be generally unpredictable, and there can be long periods, for example associated with seasonal or daily cycles, in which wind, waves or sun do not provide a significant source of energy. In addition, the ocean in that locality may experience with fluctuations in temperature, salinity and variations in wave height.

Accordingly, these power or energy capture and conversion plants can be susceptible to periods of low power production, and for large periods of time may not operate at full capacity.

It has been proposed to provide power plants that are movable to locations where conditions for the capture of energy are more favourable. However, significant distances may need to be covered to capture energy. Another drawback is that the power plant typically needs to travel long distances to offload converted power. This can be inconvenient and costly. In addition, once in a location for offloading, it can be a time-consuming process to make a connection for exporting the power from the plant.

Accordingly, existing techniques for energy capture and offloading are not optimal.

It is an aim of the present invention to obviate or at least mitigate drawbacks and deficiencies associated with prior art methods.

It is an object of at least one embodiment of the invention to provide apparatus that can provide for more efficient capture of energy and export of power.

Other aims and objects will become apparent from the description below.

According to a first aspect of the invention, there is provided offshore apparatus for capturing energy, the apparatus comprising an arrangement of energy capture devices operable to capture energy to generate an exportable product; wherein the arrangement comprises a plurality of interface points, which are spaced apart from each other, each interface point being adapted to be selectively connected to an offloading unit for moving the exportable product away from the energy capture devices.

Thus, in use, a suitable interface point can be chosen to make a connection for exporting the product. Advantageously, the interface point for connection can be selected, for example, to be the interface point that is closest to the offloading unit, and/or the interface point that is easiest to connect, such that distance of travel and/or time can be minimised and so that energy capture and removal of the product can be carried out efficiently.

The term "energy capture device" should be understood to include energy capture and energy extraction devices.

Preferably, the arrangement of energy capture devices is a mobile arrangement. More specifically, the arrangement may be configured for mobility. Further, the arrangement may be movably located over a seabed location. Thus, the arrangement may be readily moved from a first to a second location.

The arrangement of energy capture devices may comprise an array of energy capture devices. The array may be adapted to be towed and/or transported by a vessel, or may be autonomously movable under own propulsion.

The exportable product may comprise one or more of: electrical power; gas; liquids; and fuels.

The energy capture device may take the form of a floating buoy, or may be a ship or vessel. The energy capture devices may be manned or unmanned devices.

Preferably, each of the plurality of interface points form part of separate energy capture devices. The interface points may be movable. The energy capture devices may each comprise an interface point.

The arrangement and/or array may comprise a first energy capture device connected to a second energy capture device. The first and second energy capture devices may be electrically and/or fluidly connected to each other. This allows an export product such as power and/or a fluid to be transmitted between the energy capture

devices. Thus, in use, the first energy capture device may be connected to the offloading unit, and an export product generated by the second energy capture device may be exported from the array via the first energy capture device. In this way, the export product produced by a series of energy capture devices may be exported while an interface point is connected to an offloading unit.

The energy capture devices may be movable laterally and/or rotationally, and may be movable laterally and/or rotationally, e.g., within an array. This allows the energy capture devices to be independently moved into favourable orientations for capturing energy. The energy capture devices may be adapted to capture solar, wind and/or ocean energy, and may comprise solar panels and/or cells, wind turbines, wave energy capture devices and/or other suitable energy capture units, e.g., for capturing energy from tidal currents, salinity gradients, and/or thermal differences. Thus, different forms of energy can be captured according to requirements, and as appropriate to a particular location offshore.

Each energy capture device is preferably adapted to float on the sea surface, and may comprise a motor and/or propeller for moving the energy capture device within the array. The energy capture device may be adapted to be steered, and may comprise a rudder to facilitate steering. The device may be adapted to be steered from a remote location, such as a second energy capture device. More specifically, the energy capture device may be adapted for remote control of the energy capture device. In other embodiments, the energy capture device may be

configured to automatically steer into a favourable orientation for energy capture.

The arrangement may comprise a first energy capture device adapted to control a second energy capture device, e.g., as a "mother ship" or a "master and slave" relationship. The first energy capture device may be adapted to control the second energy capture device remotely, e.g. by remote means, and the first device may control the second device following pre-programmed instructions. The first energy capture device may comprise a computer, which may be pre-programmed or configured to control the second device.

In certain embodiments, the apparatus may be adapted to produce hydrogen and/or oxygen by using generated power to electrolyse water.

Preferably, the arrangement comprises storage means for storing the export product. The energy storage means may be adapted to store energy in the form of heat, compressed air or gas, such as hydrogen or oxygen, liquid and/or other suitable storage forms. The storage means may comprise a power storage unit, which may comprise one or more batteries, accumulators and/or other energy storage means. The storage unit may comprise a flywheel for energy storage. Thus, the export product can be stored temporarily until it can be offloaded when connection is made to the offloading unit. Alternatively, the storage means may comprise an intermediate product adapted to provide for storage of energy, e.g., a fluid.

The storage means may comprise a tank for storing gas and/or other fluid export products.

The energy capture device may comprise export apparatus for facilitating export of the export product. The export apparatus may comprise a pump operable to pump the product from the device. Further, the export apparatus may comprise a connector for facilitating connection of the interface to the offloading unit.

More specifically, the connection apparatus may comprise an export line or conduit adapted to connect to the offloading unit and the energy capture device at the interface point. The conduit may be configured to permit transmission of fluid and/or electrical power from the energy capture device to the offloading unit through the export conduit.

In a preferred embodiment, the apparatus may comprise a ship adapted to tow the arrangement of energy capture devices. The ship may be adapted to repeatedly deploy the arrangement and/or recover the arrangement of energy capture devices. The ship may be adapted to repeatedly receive and/or store the arrangement onboard for transport and/or transit, and to deploy the arrangement in the water for operation and energy capture. The ship may be a "mother ship", and may be adapted to control the energy capture devices, e.g., remotely. The apparatus may be operable to capture energy while the arrangement is being towed.

According to a second aspect of the invention, there is provided a method of capturing energy offshore, the method comprising the steps of:

(a) locating an arrangement of energy capture devices in an offshore location;

(b) capturing energy to generate an exportable product using the energy capture devices;

(c) selecting one of the plurality of interface points for connection to an offloading unit; and

(d) connecting the selected interface point to the offloading unit to move the exportable product away from the energy capture devices.

The method may comprise the step of locating apparatus according to the first aspect of the invention in an offshore location.

The method may comprise the step of towing the arrangement from a first to a second location.

The method may comprise the step of connecting an interface point of a first energy capture device to the offloading unit. The method may further comprise the steps of generating an exportable product using a second energy capture device, and moving the exportable product from the first energy capture device via the connected interface point of the first device.

The method may comprise the steps of: providing an interface point on a first energy capture device; connecting the first energy capture device to a second energy capture device; connecting the interface point of

the first energy capture device to the offloading unit; transmitting an exportable product generated by a second energy capture device to the first energy capture device; and removing the exportable product generated by the second energy capture device from the first energy capture device via the connected interface point.

The method may comprise the steps of storing the arrangement of energy capture devices on board a vessel, and using the vessel to transport the stored arrangement from a first to a second location.

The method may comprise the step of deploying and/or recovering the arrangement of energy capture devices from the vessel, e.g. in first and/or second locations.

The method may include the steps of relocating the apparatus and/or arrangement to a second offshore location and capturing energy at the second location using the apparatus.

The method may include the step of relocating the apparatus to a maintenance location and carrying out maintenance on the apparatus.

The offloading unit may comprise an energy transmission station, and the method may include the steps of relocating the apparatus to an energy transmission station and/or offloading unit. The method may include the additional step of transmitting captured, converted and/or stored energy to an onshore location via the energy transmission station and/or offloading unit. Alternatively, or in addition, the method may include the

additional step of transmitting stored energy to an offshore facility for use in that facility.

The method may include the step of capturing wave energy. Alternatively, or in addition, the method may include the step of capturing wind energy. Alternatively, or in addition, the method may include the step of capturing solar energy.

The method may include the step of optimising energy capture of the apparatus by successively relocating the apparatus to a plurality of offshore locations and capturing energy at those locations.

The method may include the step of monitoring or forecasting weather conditions over a geographical area to provide weather information, and relocating the apparatus in response to the weather information.

In one embodiment, the method includes the step of relocating the apparatus to a dock or harbour and transmitting stored, generated, converted or captured energy to an onshore location via an energy transmission station at the dock or harbour.

According to a third aspect of the invention, there is provided a system for offshore capture and export of energy, the system comprising:

- an offshore apparatus comprising an arrangement of energy capture devices operable to capture energy and generate an exportable product, the arrangement comprising a plurality of interface points which are spaced apart from each other; and

- an offloading unit;

wherein a selected interface point of the arrangement is connected to the offloading unit to move the generated exportable product away from the energy capture devices.

The system may comprise offshore apparatus according to the first aspect of the invention;

The offloading unit may comprise one or more of the following:

- a seabed station or installation;
- a tanker/transport ship;
- a transport pipeline;
- an electrical transmission cable;
- an energy transmission station;
- a floating buoy or pontoon; and
- an onshore facility.

The offloading unit is adapted to facilitate transport of the export product for subsequent use. The offloading unit may comprise connection equipment adapted to receive and/or connect with the interface points of the arrangement of energy capture devices. The offloading unit may form a part of a pre-installed transport or transmission system. The offloading unit may comprise a subsea termination assembly and/or a connection system for facilitating connection with an interface point of the arrangement.

According to a fourth aspect of the invention, there is provided a method of capturing energy offshore, the method comprising the steps of:

Locating an apparatus at an offshore location, the apparatus comprising energy capture means and energy storage means;
Capturing energy from a renewable energy source using the energy capture means;
Storing energy using the energy storage means;
Relocating the energy capture apparatus.

The method may include the additional step of coupling the apparatus to an electricity transmission apparatus at the energy transmission station. The method may include the additional step of transmitting electrical energy or power to an onshore location. Alternatively, or in addition, the method may include the additional step of transmitting electrical energy to an offshore facility for use on that facility.

The method may include the step of coupling the apparatus to a pipeline at the energy transmission station. The method may include the additional step of transmitting stored energy to an onshore location via the pipeline. Alternatively, or in addition, the method may include the additional step of transmitting stored energy to an offshore facility for use in that facility.

According to a fifth aspect of the invention, there is provided a vessel adapted to carry out the method of the fourth aspect.

According to a sixth aspect of the invention, there is provided apparatus for capturing energy offshore, the apparatus comprising energy capture means and energy storage means, wherein the apparatus is mobile.

The apparatus may be adapted to carry out the steps of the second or fourth aspects of the invention or any of its preferred embodiments.

According to a seventh aspect of the invention, there is provided an offshore system for energy capture and delivery, the system comprising apparatus in accordance with the second or third aspects of the invention and at least one offshore energy transmission station, wherein the offshore delivery station is configured to receive energy from the apparatus and deliver it to an onshore location.

There will now be described, by way of example only, embodiments of the invention with reference to the accompanying drawings, of which:

Figure 1 is a cross-sectional view of offshore apparatus for capturing energy according to an embodiment of the invention;

Figure 2 is a cross-sectional view of the apparatus of Figure 1 connected to a subsea pipeline station;

Figure 3A is an overhead view of an offshore region with offshore apparatus, according to another embodiment of the invention, operating in a high energy zone;

Figure 3B is an overhead view of the offshore region and apparatus of Figure 3A with an arrangement of energy capture devices operating in the high energy

zone and connected to a pipeline for offloading a gas product;

Figure 4 shows an energy capture ship during deployment of a towable array of energy capture devices according to a further embodiment of the invention.

With reference firstly to Figure 1, there is depicted offshore apparatus 10 for capturing energy. In this embodiment, the apparatus 10 comprises a ship 12, which is shown in an offshore location towing a line array 11 of energy capture devices in the form of buoys 14a-d fitted with wind turbines 18 having turbine blades 20 that rotate in response to the flow of air past the blades to generate electrical power. The ship 12 is shown connected to the array 11 via a first chain tether 16a to the energy capture buoy 14a. The buoys 14b-d are connected in succession to adjacent buoys by tethers 16b-d to make up the array. In this case, each of the energy capture buoys are provided with interface points 17a-d that can be used in providing a connection with a subsea transport cable 22 for exporting power from the array.

With further reference to Figure 2, the ship 12 is shown having towed the array 11 into an offloading position, where the first energy capture buoy 14a is electrically connected to an offloading station 26 of a transport cable 22. Each of the energy capture buoys 16a-d carries an export line to allow the buoys to be connected to the transport cable 22.

An upper end of the electrical export line 24 is connected to the energy capture device 14a and the opposing end is connected to the pipeline 22 at the connection station 26. Thus, power that is generated by the operation of the wind turbine 18a can be transmitted from the turbine 18, through the export line 24, into the pipeline cable 22 and then to shore for use. The array, having a number of interfacing points provided on the energy capture buoys, offers a number of possible points and buoys that can be used to connect, and in this case the closest buoy 14a is selected. In other instances, power could be transmitted from one of the other energy capture buoys.

In the present example, the buoys 16a-d are electrically connected to the ship by a power cable 28a and to each other by power cables 28a-d. The power cables enable electrical power generated from each of the energy capture buoys 14b-d to be transmitted successively through the cables 28b-d and to the buoy 14a that is connected to the subsea offloading station. Thus, power produced by the array as a whole can be offloaded through a single connecting energy capture buoy. A portion of the generated power can also be transmitted to the ship 12 via cable 28a for operation of ship equipment.

It will be appreciated that in another embodiment, the ship itself is adapted to connect to the seabed station and power produced by the array is transmitted to the ship for offloading.

The buoys 14a-d also include batteries 30 to temporarily store the electrical power produced by the turbines 18

until a connection has been made to the subsea station for transmitting the power to shore.

The energy capture buoys 14a-d also have propellers 32 and rudders 34 that are used to move the buoys within the tethered array into an optimum orientation for capturing energy, in this case the prevailing wind and to maintain separation between the devices. These buoys can be moved in a lateral and rotational sense so that the blades of individual wind turbines face the local wind direction. Movement of the individual buoys is controlled and steered remotely from the ship 12. The buoys are controlled so that the spacings between buoys in the array are maintained. The ship 12 and the buoys are also controlled to keep the tethers 16 and power cables 28a-d under tension, to facilitate maintaining the shape and lateral extent of the array, which may have a lateral extent in the order of several kilometres.

In Figures 3A and 3B, there is shown an offshore region 300 with a transport pipeline 322 and offshore apparatus 310 also located in the region 300. The offshore apparatus is similar to the apparatus 10 described above, although the array 311 of energy capture devices 314 are fluidly connected, have equipment for using generated power to produce gas and have storage tanks for temporarily containing the gas. Also, the ship 312 in this case is shown towing a two-line array of capture devices 314.

In this case, the apparatus 310 is positioned initially in Figure 3A with four of the five of each line of energy capture buoys located within a high energy wind zone 38,

providing a high output of power, which is converted to gas. When offloading of the gas is required, the apparatus 210 is moved to a second location as shown in Figure 3B to connect to the gas transport pipeline 322. The array length and dimensions, together with the availability of several connectible energy capture buoys that provide a number interface points, means that the ship only needs to tow the array a short distance 380 in order for the energy capture device 314b to connect with the pipeline. In this example, this is particularly beneficial as the capture devices are still located within the high energy zone allowing production of power to be maintained. In this way, power production and offloading of converted gas is carried out in efficient manner.

In Figure 4, there is shown a further embodiment of offshore apparatus 110 for capturing energy. Many of the features of the apparatus 110 are similar to those of the apparatus 10 described above, and like features are denoted with the same reference numerals incremented by one hundred.

In this example, the ship 112 is shown during deployment of energy capture buoys 114. The buoys are initially stored, in a transport configuration, in slots in a hold 180 of the ship. While stored, the ship 112 can travel relatively rapidly to a high energy location where it is desirable to capture energy for generating power. In that location, the array of energy capture buoys 114 is deployed into the sea for operation, such as in the manner described with reference to the above embodiments.

In this example, when it is desired to offload the power, the ship recovers the energy capture buoys, and the power stored by the buoys 114 is transmitted through a solid electrical connections provided in individual storage slots (which receive the buoys) on the ship, and through a connection cable carried on board the ship to a subsea station. The ship 112 may then move to another location and re-deploy the array of buoys for energy capture.

In this embodiment, the ship 112 is additionally fitted with a wind turbine 190 and thereby contributes to the production of power together with energy capture buoys.

Overall, the presently described offshore apparatus and method provides significant benefits in efficiency of capture and offloading of power or converted gas. The mobility of the arrangement of energy capture devices, its significant lateral extent and the number of interface points provided in the arrangement helps to reduce costs associated with energy extraction and transport to shore. Further, transport into high energy locations and orientation of individual devices assist with capture efficiency and maintaining operation at a high level of productivity.

Various modifications and improvements may be made without departing from the scope of the invention described.

It will be appreciated that in certain embodiments, the energy capture devices could be connected to the ship or each other via a fibre rope or wire tether. In other embodiments the arrangement of energy capture devices is

autonomous in that it may move under its own propulsion, and does not rely on being towed by a ship. In this case, one of the energy capture devices may be propelled to move the arrangement.

Claims

1. Offshore apparatus for capturing energy, the apparatus comprising an arrangement of energy capture devices operable to capture energy to generate an exportable product; wherein the arrangement comprises a plurality of interface points, which are spaced apart from each other, each interface point being adapted to be selectively connected to an offloading unit for moving the exportable product away from the energy capture devices.

2. Offshore apparatus as claimed in Claim 1, wherein the arrangement of energy capture devices is a mobile arrangement.

3. Offshore apparatus as claimed in Claim 1 or Claim 2, wherein the arrangement is readily movable from a first offshore location to a second offshore location.

4. Offshore apparatus as claimed in any one of Claims 1 to 3, wherein the arrangement is autonomously movable under its own propulsion.

5. Offshore apparatus as claimed in any one of the preceding claims, wherein the arrangement is adapted to be towed by a vessel.

6. Offshore apparatus as claimed in any one of the preceding claims, wherein the plurality of interface points are spaced apart laterally.

7. Offshore apparatus as claimed in any one of the preceding claims, wherein each of the plurality of interface points form part of separate energy capture devices.

8. Offshore apparatus as claimed in any one of the preceding claims, wherein the energy capture devices each comprise an interface point.

9. Offshore apparatus as claimed in any one of the preceding claims, wherein the exportable product comprises one or more of: electrical power; gas; liquids; and a fuel.

10. Offshore apparatus as claimed in any one of the preceding claims, wherein the arrangement of energy capture devices comprises export apparatus for facilitating removal of the export product from the energy capture devices via the interface points.

11. Offshore apparatus as claimed in Claim 10, wherein the export apparatus comprises a connector for facilitating connection to the offloading unit via an interface point.

12. Offshore apparatus as claimed in Claim 10 or Claim 11, wherein the export apparatus comprises an export line adapted to connect, at one end, to the offloading unit and, at a second end, to an interface point.

13. Offshore apparatus as claimed in any one of the preceding claims, wherein the arrangement comprises a

first energy capture device connected to a second energy capture device.

14. Offshore apparatus as claimed in Claim 13, wherein the first and second energy capture devices are electrically connected for transmitting power between the devices.

15. Offshore apparatus as claimed in Claim 13 or Claim 14, wherein the first and second energy capture devices are fluidly connected for conveying fluids between the energy capture devices.

16. Offshore apparatus as claimed in any one of the preceding claims, wherein the arrangement of energy capture devices comprises an array of energy capture devices.

17. Offshore apparatus as claimed in any one of the preceding claims, wherein the energy capture devices are independently movable laterally within the arrangement.

18. Offshore apparatus as claimed in any one of the preceding claims, wherein at least one of the energy capture devices comprises a propeller for moving the energy capture device.

19. Offshore apparatus as claimed in any one of the preceding claims, wherein at least one of the energy capture devices is adapted to be steered from a remote location.

20. Offshore apparatus as claimed in any one of the preceding claims, wherein the arrangement comprises a first energy capture device adapted to control movement of a second energy capture device.

21. Offshore apparatus as claimed in any one of the preceding claims, wherein the energy capture devices are adapted to capture one or more of: solar energy; wind energy; and ocean energy.

22. Offshore apparatus as claimed in any one of the preceding claims, wherein the apparatus comprises storage means for temporarily storing the exportable product.

23. Offshore apparatus as claimed Claim 22, wherein the storage means comprises a power storage unit.

24. Offshore apparatus as claimed Claim 22 or Claim 23, wherein the storage means comprises a tank for storing exportable products in fluid form.

25. Offshore apparatus as claimed in any one of the preceding claims, wherein the energy capture devices take the form of buoys.

26. Offshore apparatus as claimed in any one of the preceding claims, wherein the apparatus comprises a ship adapted to deploy and recover the arrangement of energy capture devices.

27. Offshore apparatus as claimed Claim 26, wherein the ship is adapted to recover and store the arrangement

onboard for transit, and to deploy the arrangement into the water for operation and energy capture.

28. A method of capturing energy offshore, the method comprising the steps of:

(a) locating an arrangement of energy capture devices in an offshore location;

(b) capturing energy to generate an exportable product using the energy capture devices;

(c) selecting one of the plurality of interface points for connection to an offloading unit; and

(d) connecting the selected interface point to the offloading unit to move the exportable product away from the energy capture devices.

29. A method as claimed in Claim 28, wherein the method comprises the step of connecting an interface point of a first energy capture device to the offloading unit.

30. A method as claimed in Claim 29, wherein the method comprises the steps of generating an exportable product using a second energy capture device, and moving the exportable product from the first energy capture device via the connected interface point of the first device.

31. A method as claimed in any one of Claims 28 to 30, wherein the method comprises the step of towing the arrangement from a first to a second location.

32. A method as claimed in any one of Claims 28 to 31, wherein the method comprises the steps of: deploying the arrangement of energy capture devices; and recovering the arrangement of energy capture devices.

33. A method as claimed in any one of Claims 28 to 32, wherein, the method comprises the steps of: relocating the apparatus to a second offshore location and capturing energy at the second location using the apparatus.

34. A method as claimed in any one of Claims 28 to 33, wherein the method comprises the steps of: storing the arrangement of energy capture devices onboard a vessel, and using the vessel to transport the stored arrangement from a first to a second location for deployment in the second location.

35. A method as claimed in any one of Claims 28 to 34, wherein the method comprises the step of optimising energy capture of the apparatus by successively relocating the apparatus to a plurality of offshore locations and capturing energy at those locations.

36. A system for offshore capture and export of energy, the system comprising:

- an offshore apparatus comprising an arrangement of energy capture devices operable to capture energy and generate an exportable product, the arrangement comprising a plurality of interface points which are spaced apart from each other; and
- an offloading unit;

wherein a selected interface point of the arrangement is connected to the offloading unit to move the generated exportable product away from the energy capture devices.

37. A system as claimed in Claim 36, wherein the offloading unit comprises one or more of the following:
- a seabed station or installation;
- a tanker/transport ship;
- a transport pipeline;
- an electrical transmission cable;
- an energy transmission station;
- a floating buoy or pontoon; and
- an onshore facility.

38. A system as claimed in Claim 35 or Claim 37, wherein the offloading unit is adapted to facilitate transport of the export product for subsequent use.

39. A system as claimed in any one of Claims 35 to 38, wherein the offloading unit comprises connection equipment adapted to connect with an interface point of the offshore apparatus.

40. A system as claimed in any one of Claims 35 to 39, wherein the offloading unit forms a part of a pre-installed seabed transport system.

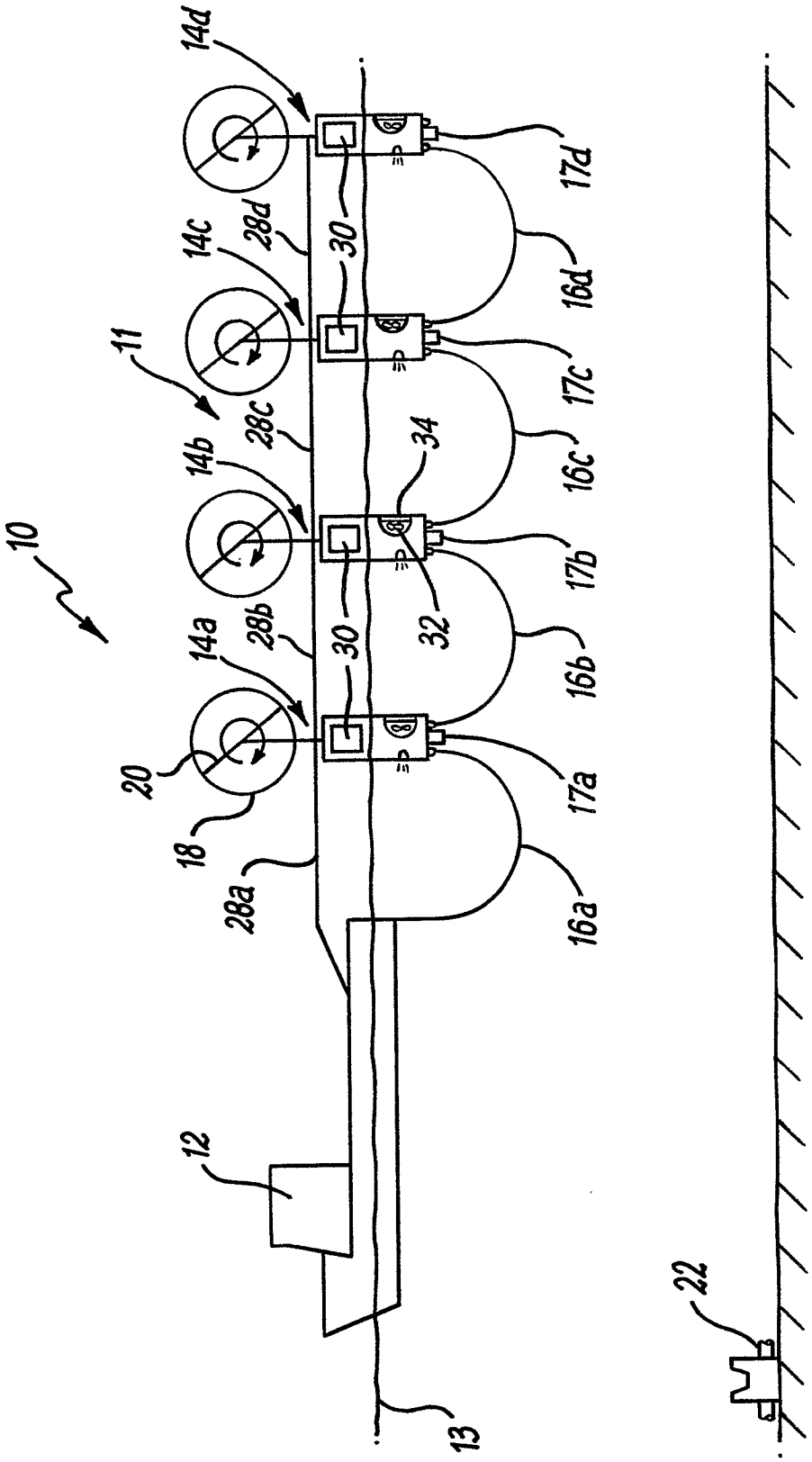
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Fig. 1

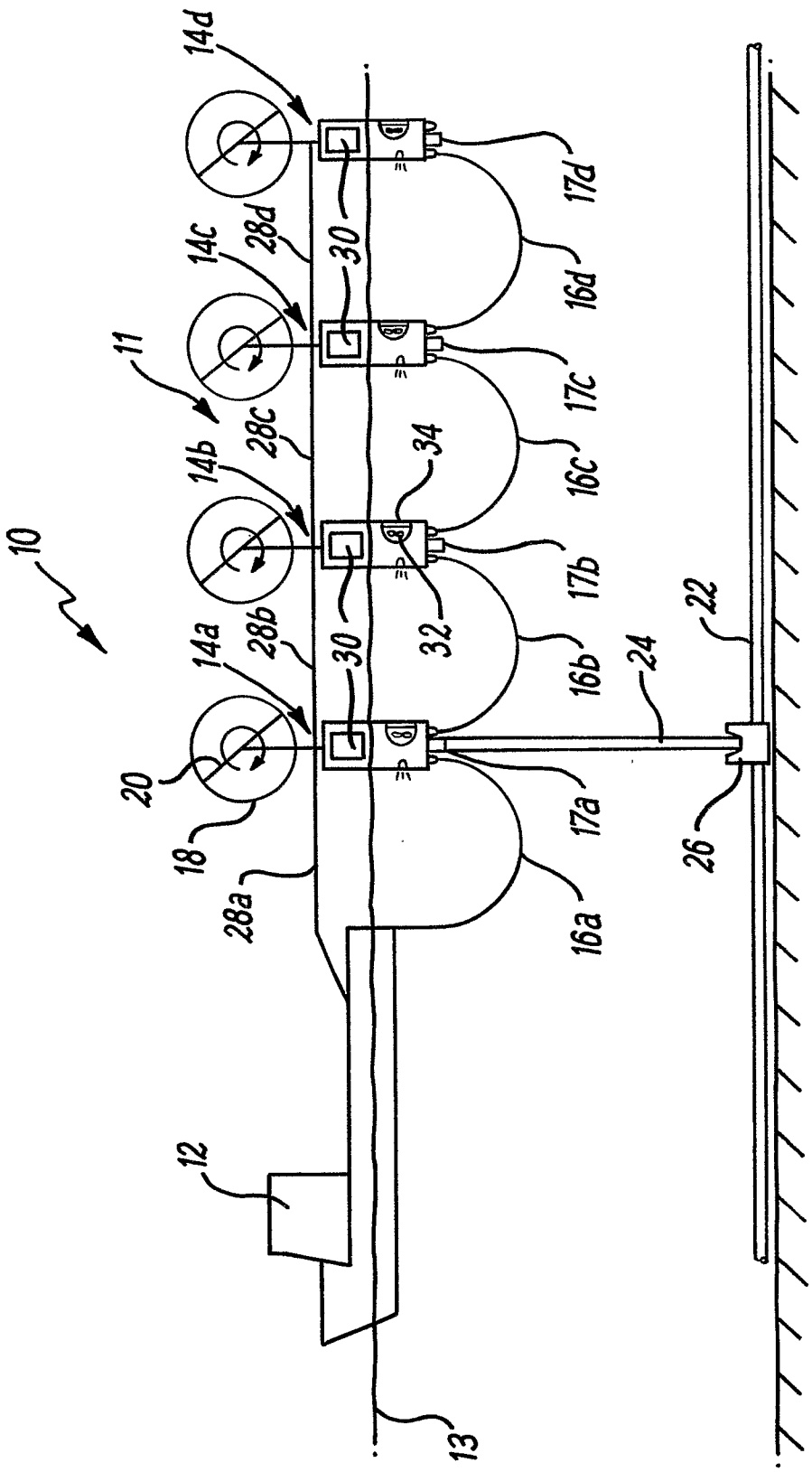
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Fig.2

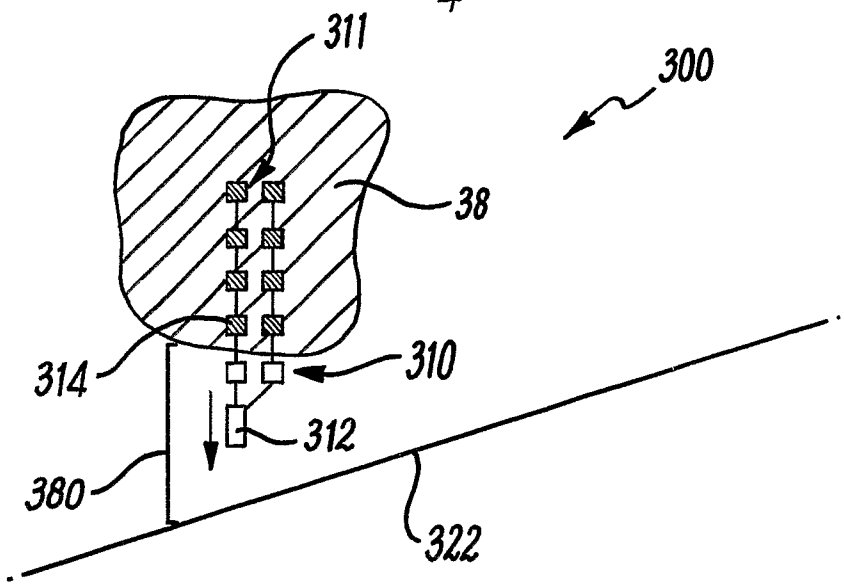

FIG. 3A

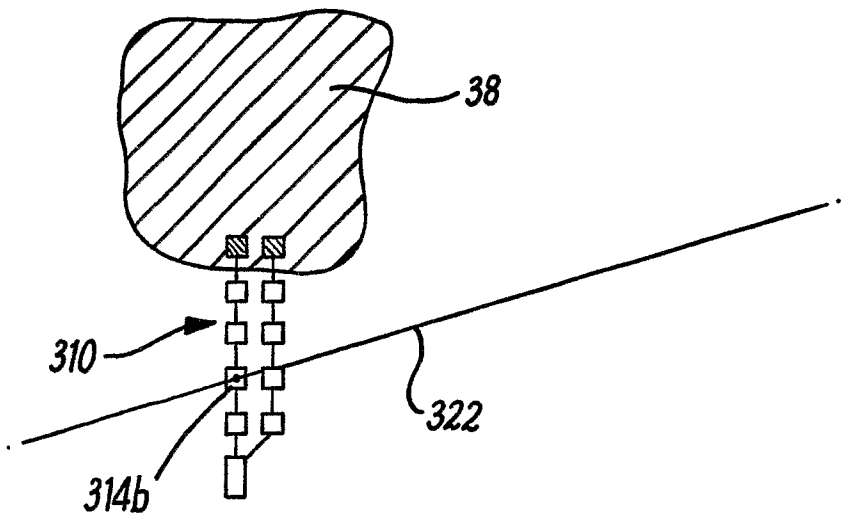

FIG. 3B

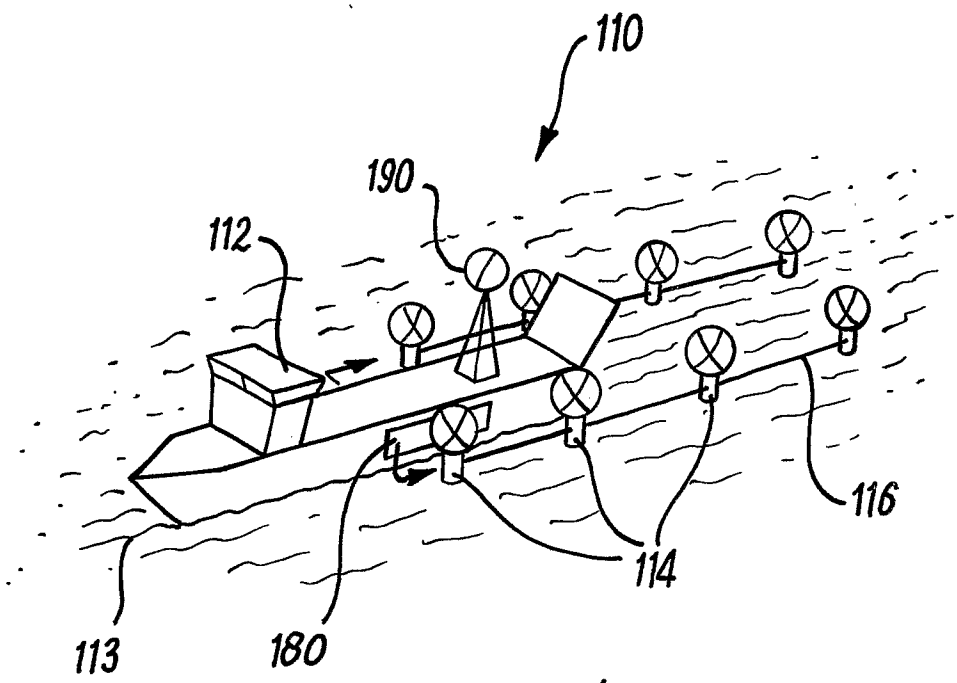

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/001356

A. CLASSIFICATION OF SUBJECT MATTER
INV. F03D9/00 F03D9/02 B63B35/00 F03B13/12

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 B63B F03B

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 383 978 A (MICHAELIS DOMINIC [FR]) 16 July 2003 (2003-07-16) abstract; figures page 4, paragraph 4 page 6, paragraph 1 - paragraph 3 ----- -/--	1-3,5-7, 9-12,16, 21,22, 24, 26-30, 32,36-40

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

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search	Date of mailing of the international search report
13 August 2007	21/08/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	de Rooij, Mathieu

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/001356

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/001356

C(Continuation). 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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