US009944353B2

(12) **United States Patent**
Beane

(10) **Patent No.: US 9,944,353 B2**
(45) **Date of Patent: Apr. 17, 2018**

(54) **SYSTEM FOR PRODUCING ENERGY THROUGH THE ACTION OF WAVES**

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(72) Inventor: **Glenn L. Beane**, Hanover, NH (US)

(73) Assignee: **GWAVE LLC**, Hanover, NH (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/909,258**

(22) Filed: **Jun. 4, 2013**

(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Provisional application No. 61/655,095, filed on Jun. 4, 2012.

(51) **Int. Cl.**

F03B 13/14	(2006.01)
F03B 13/16	(2006.01)
B63B 1/02	(2006.01)
B63B 1/04	(2006.01)
B63B 39/00	(2006.01)
B63B 1/10	(2006.01)
B63B 21/50	(2006.01)
B63B 35/44	(2006.01)
B63B 21/16	(2006.01)
B63B 1/12	(2006.01)

(52) **U.S. Cl.**

CPC ***B63B 1/04*** (2013.01); ***B63B 1/10*** (2013.01); ***B63B 21/50*** (2013.01); ***B63B 35/44*** (2013.01); ***B63B 39/00*** (2013.01); ***F03B 13/16*** (2013.01); *B63B 1/12* (2013.01); *B63B 21/16* (2013.01); *B63B 2001/123* (2013.01); *B63B 2035/4466* (2013.01); *F05B 2240/40* (2013.01); *F05B 2240/93* (2013.01); *F05B 2250/13* (2013.01); *F05B 2250/14* (2013.01); *Y02E 10/38* (2013.01)

(58) **Field of Classification Search**

CPC Y02E 10/38; Y02E 10/30; F03B 13/18; F03B 13/16; F05B 2250/13; F05B 2250/14; F05B 2240/40; F05B 2240/93; B63B 1/04; B63B 35/44; B63B 21/50; B63B 39/00; B63B 1/10; B63B 2035/4466; B63B 2001/123; B63B 1/12

USPC 114/230.2, 230.21, 230.22, 230.23, 114/230.24, 230.25, 230.26, 61.1, 61.18, 114/61.15; 60/495, 497, 499, 505; 290/53

See application file for complete search history.

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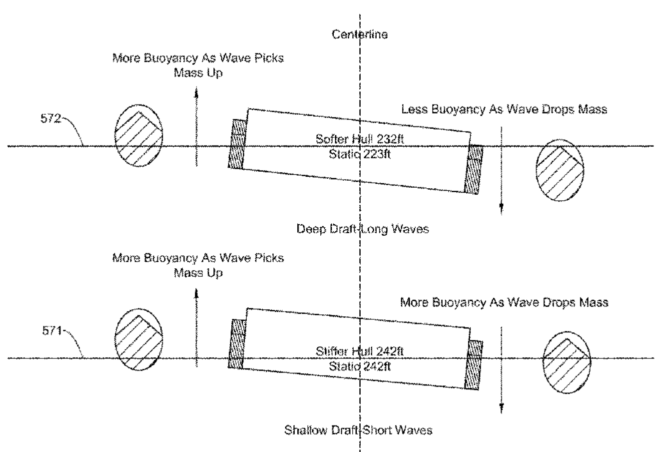
Primary Examiner — Anthony D Wiest

(74) *Attorney, Agent, or Firm* — Grossman, Tucker, Perreault & Pfleger, PLLC

(57) **ABSTRACT**

A hull that is part of a system for producing energy through the action of waves. The hull's shape, dimension and orientation make the system less costly and increase the energy provided by the system.

27 Claims, 11 Drawing Sheets



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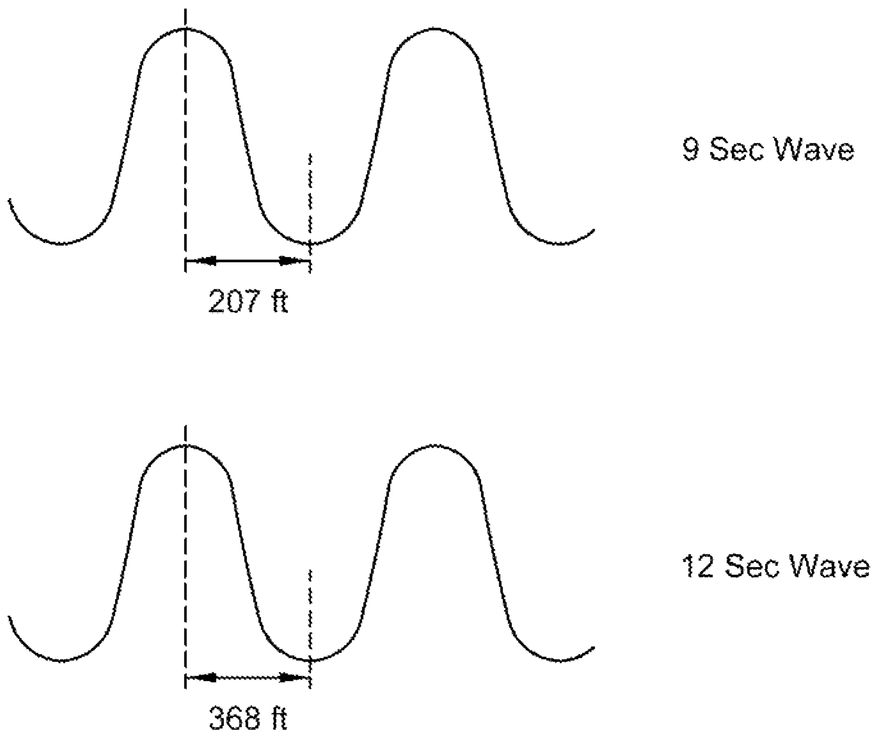


FIG. 1

	9 Sec Wave	12 Sec Wave
1/4 Wave Length	104	184
1/2 Wave Length	207	368
3/4 Wave Length	311	552

FIG. 2

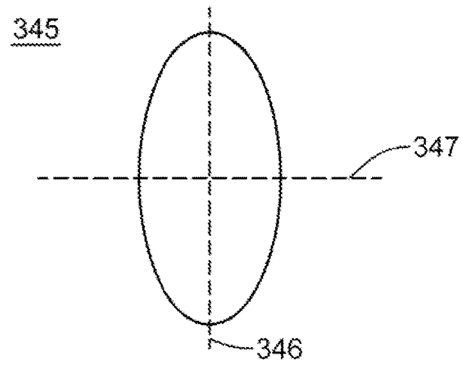


FIG. 3

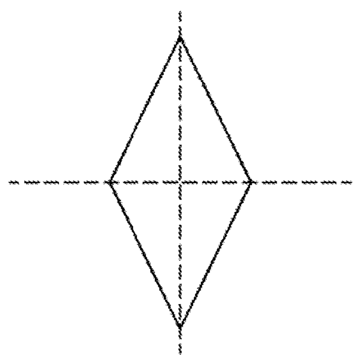


FIG. 3A

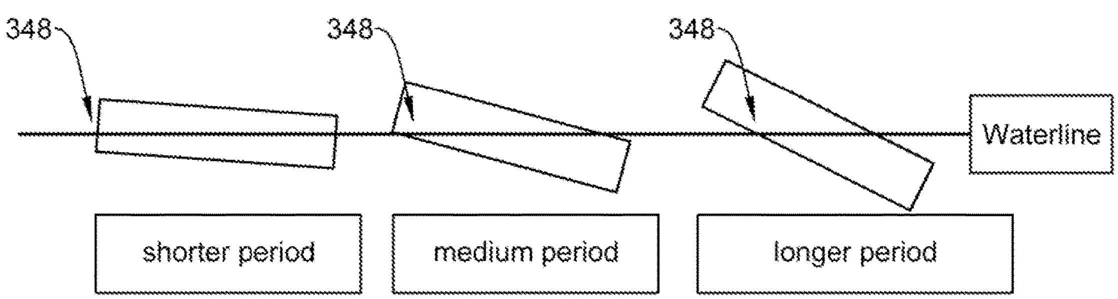


FIG. 4

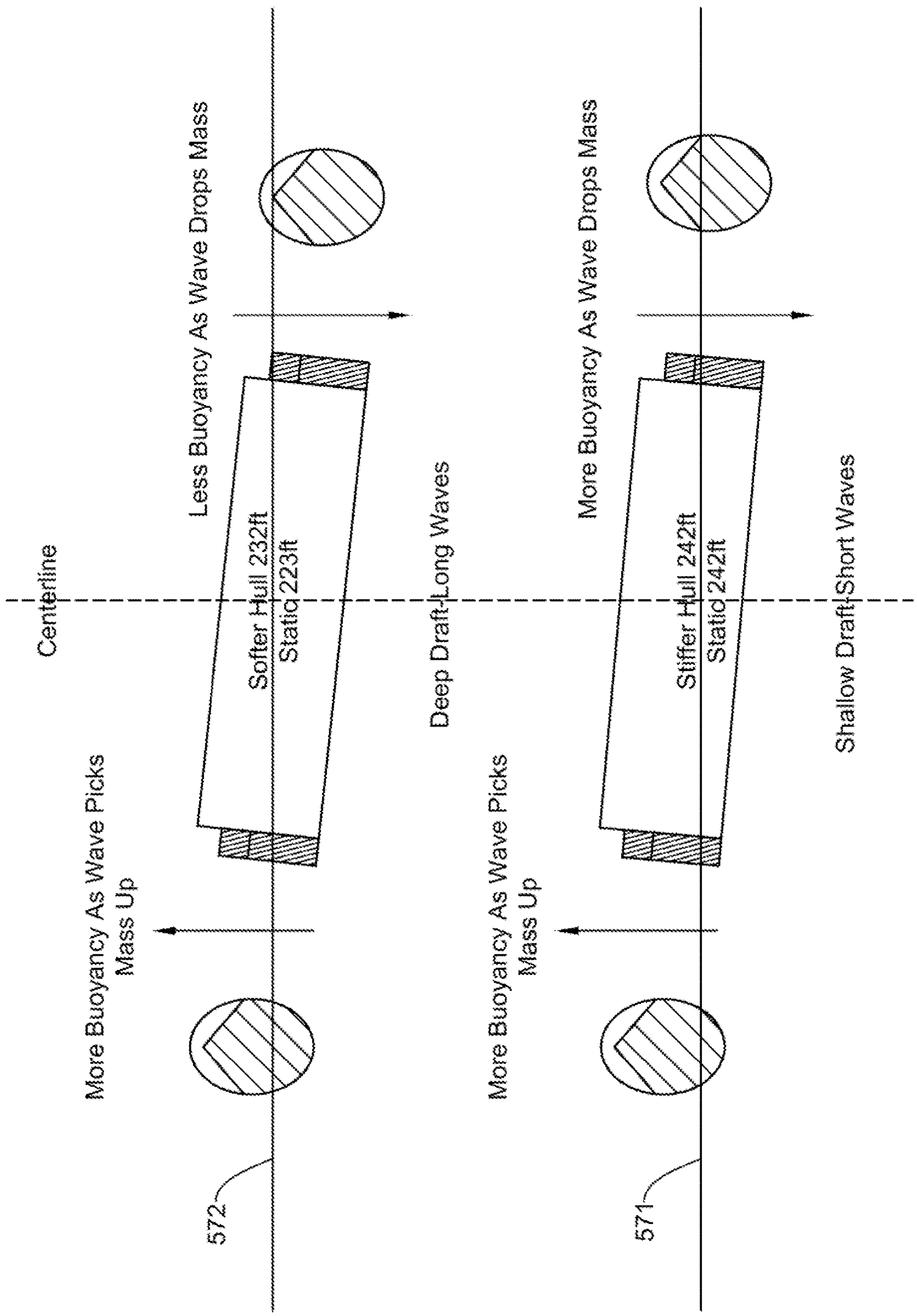

Centerline
Less Buoyancy As Wave Drops Mass
Softer Hull 232ft
Static 223ft
Deep Draft-Long Waves
More Buoyancy As Wave Picks Mass Up
572
More Buoyancy As Wave Drops Mass
Stiffer Hull 242ft
Static 242ft
Shallow Draft-Short Waves
More Buoyancy As Wave Picks Mass Up
571

FIG. 5

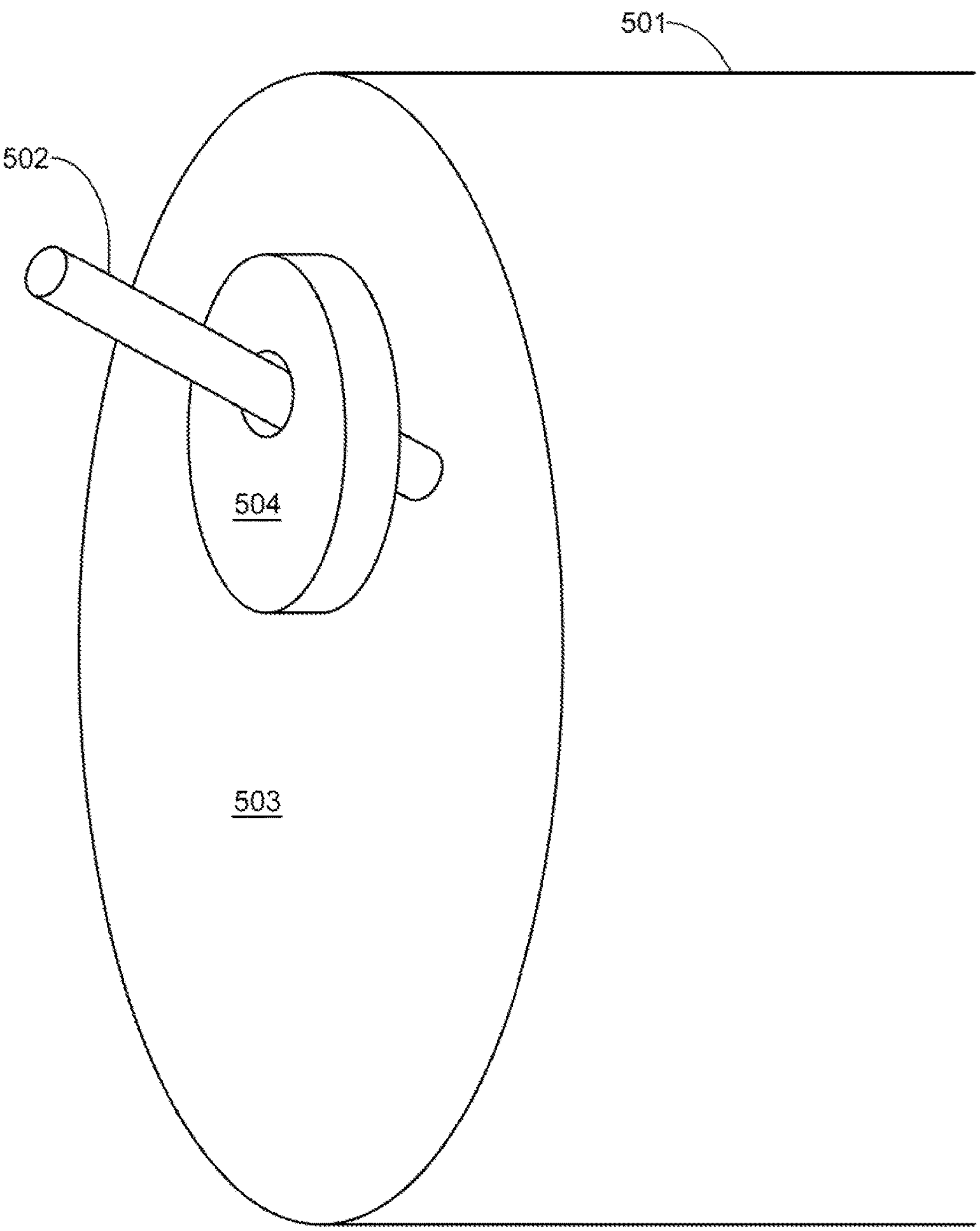


FIG. 5A

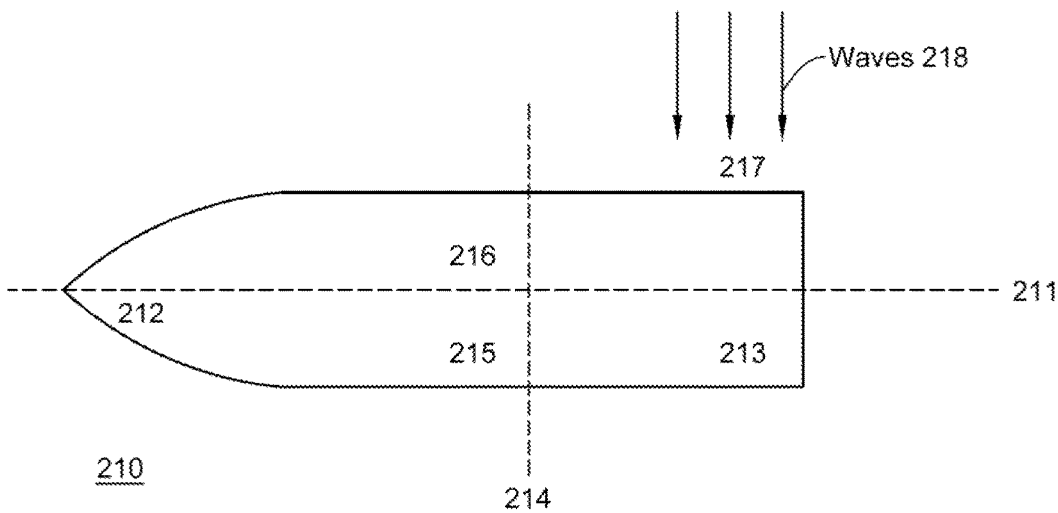


FIG. 6

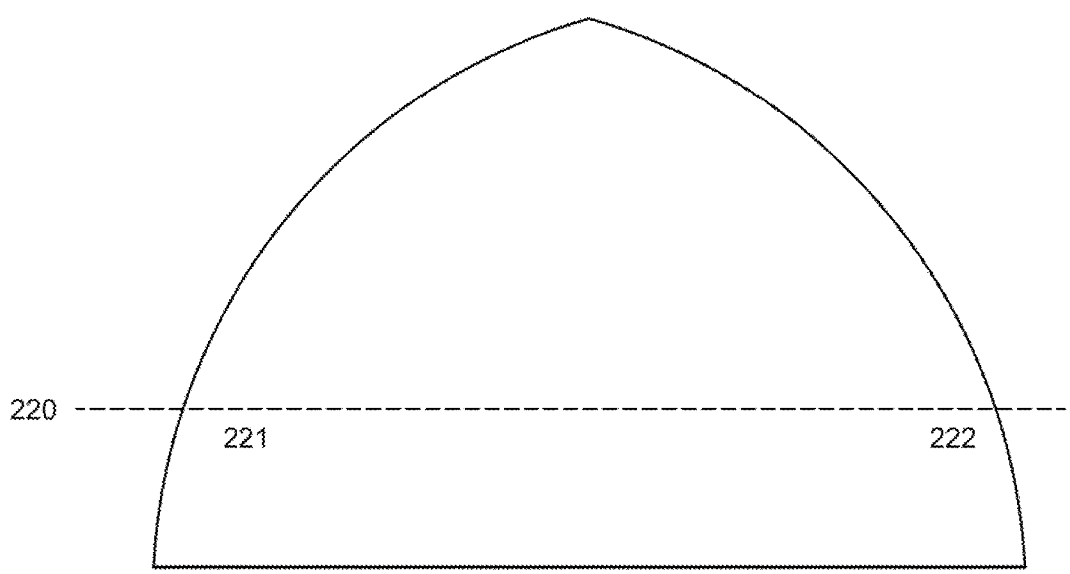


FIG. 7

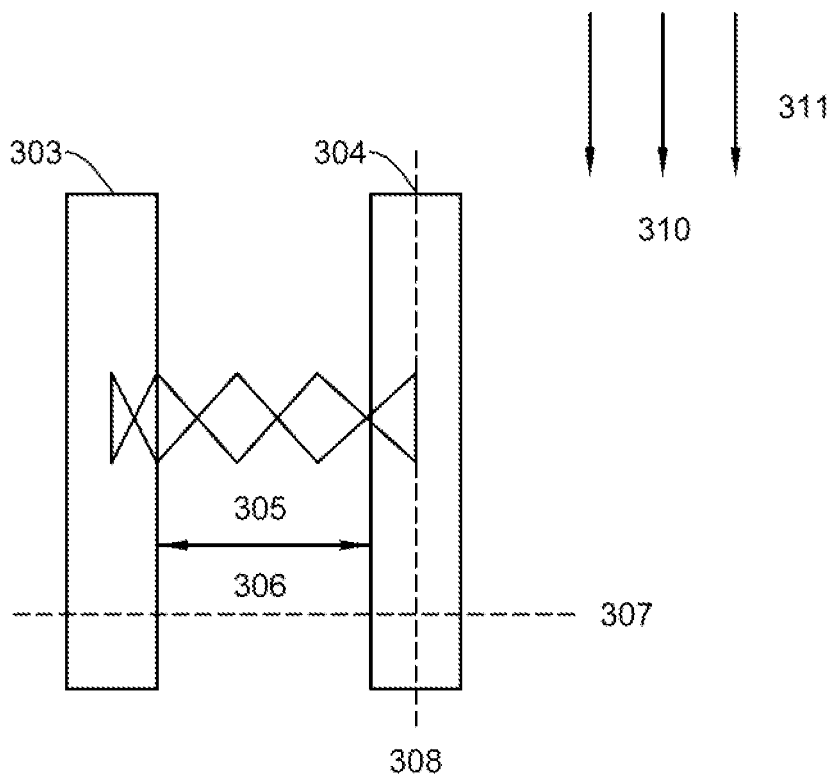


FIG. 8

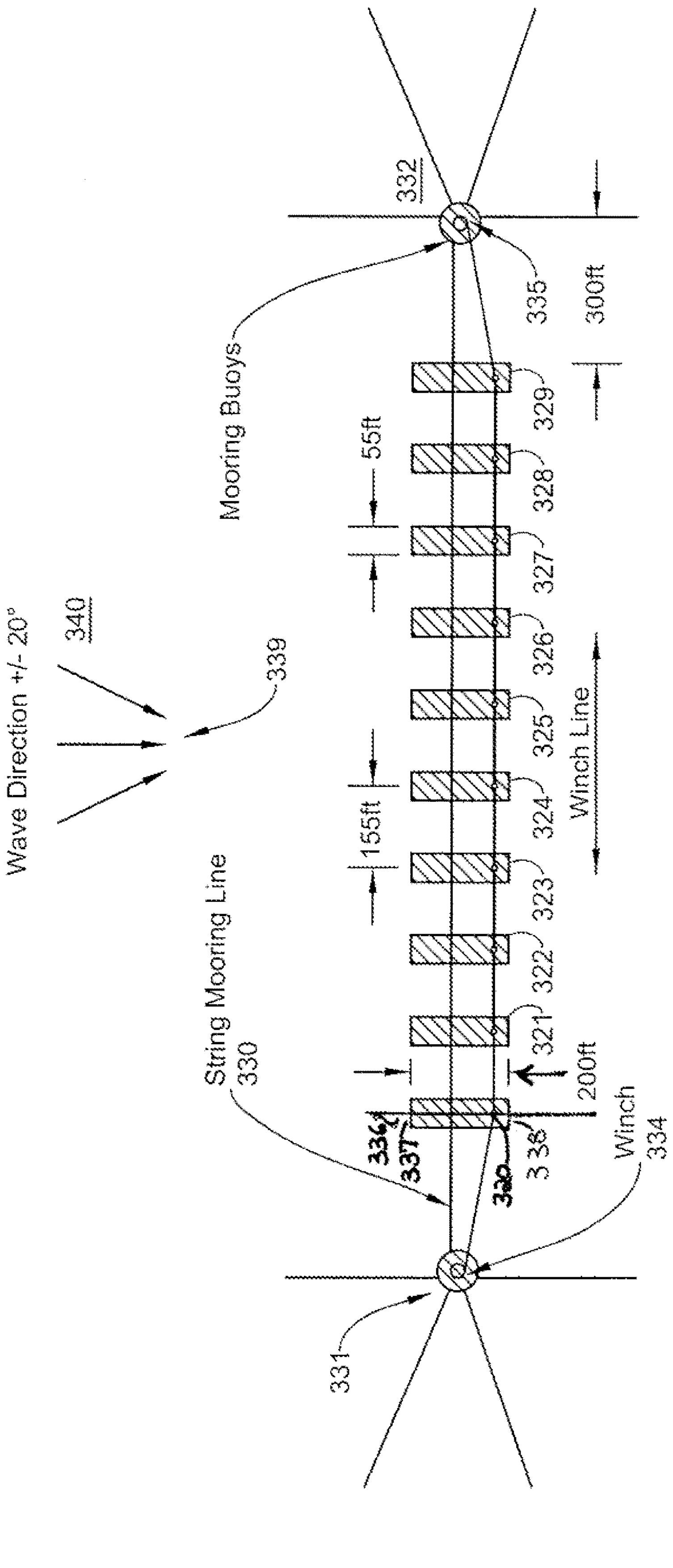
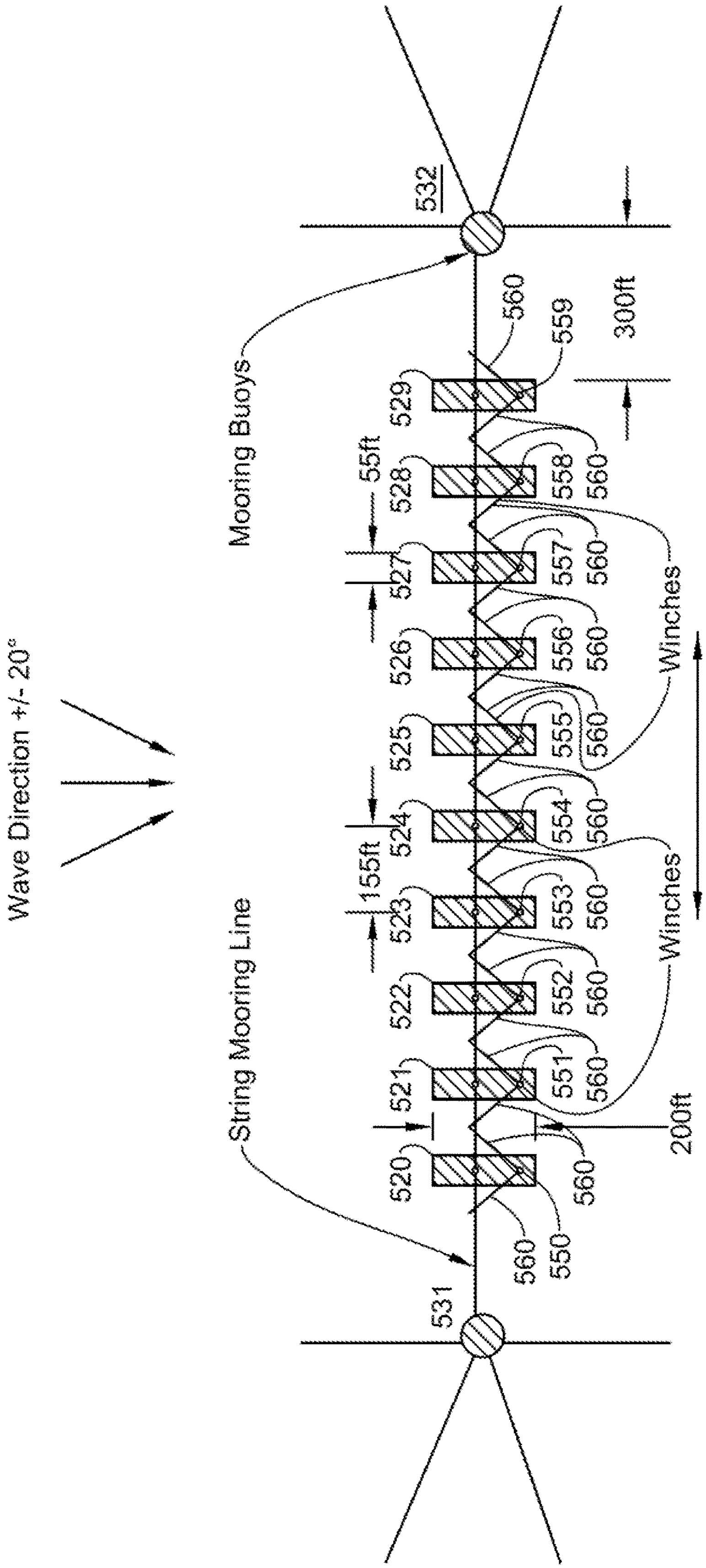

Wave Direction +/- 20°
340
339
Mooring Buoys
332
335
300ft
55ft
155ft
200ft
Winch Line
321
322
323
324
325
326
327
328
329
String Mooring Line
330
336
337
320
3 38
Winch
334
331

FIG. 9


Wave Direction +/- 20°
Mooring Buoys
String Mooring Line
Winches
Winches
Winches
532
531
300ft
200ft
155ft
55ft
520
521
522
523
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554
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556
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558
559
560

FIG. 10

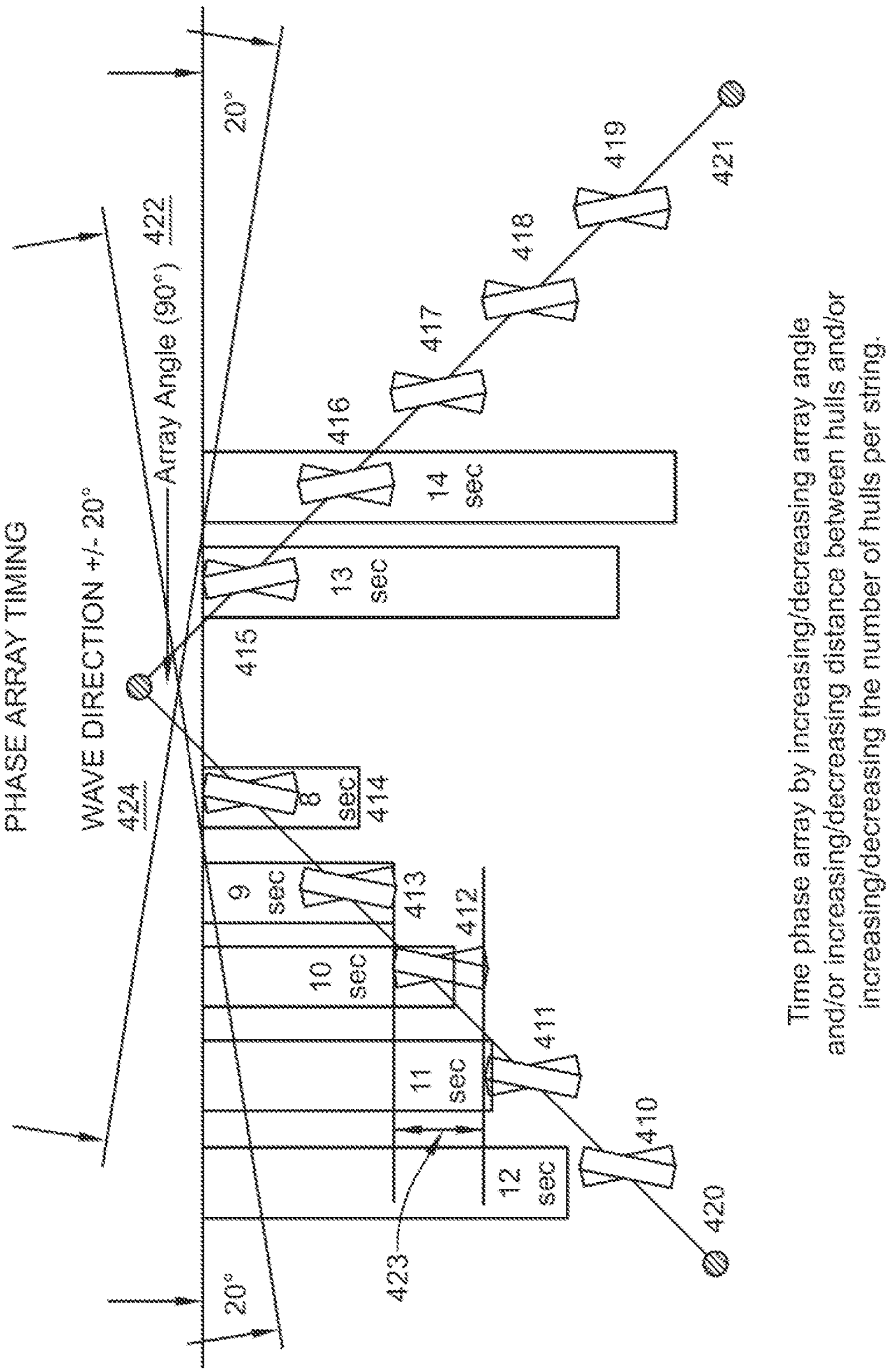
PHASE ARRAY TIMING
WAVE DIRECTION +/- 20°
424
Array Angle (90°) 422
20°
20°
8 sec
9 sec
10 sec
11 sec
12 sec
13 sec
14 sec
410
411
412
413
414
415
416
417
418
419
420
421
423
Time phase array by increasing/decreasing array angle and/or increasing/decreasing distance between hulls and/or increasing/decreasing the number of hulls per string.

FIG. 11

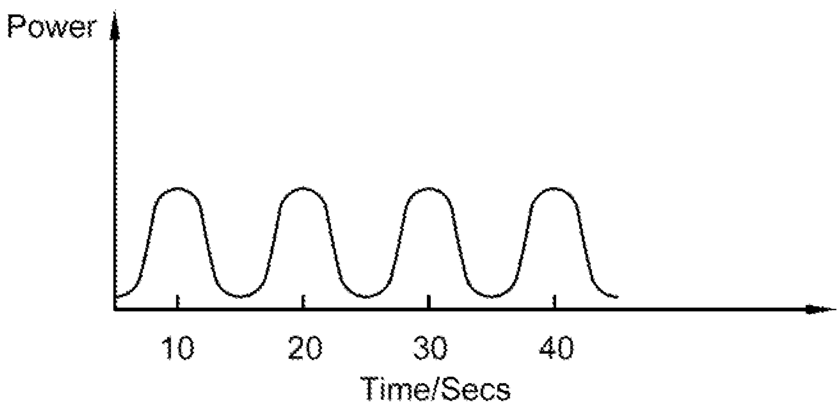

FIG. 12

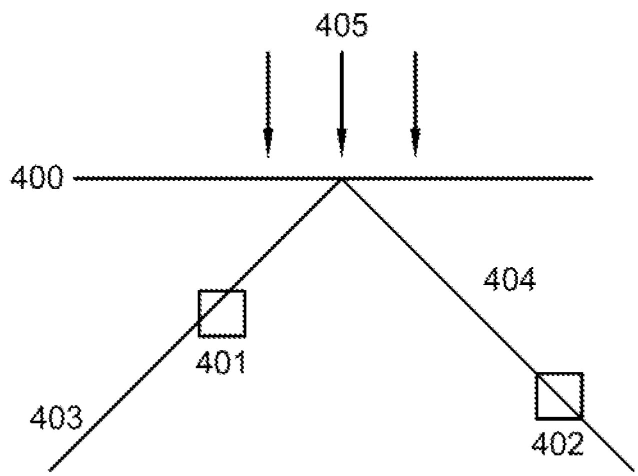

FIG. 13

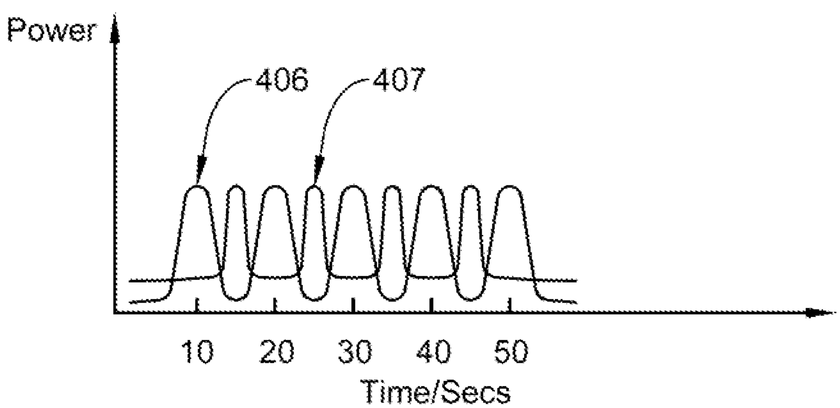

FIG. 14

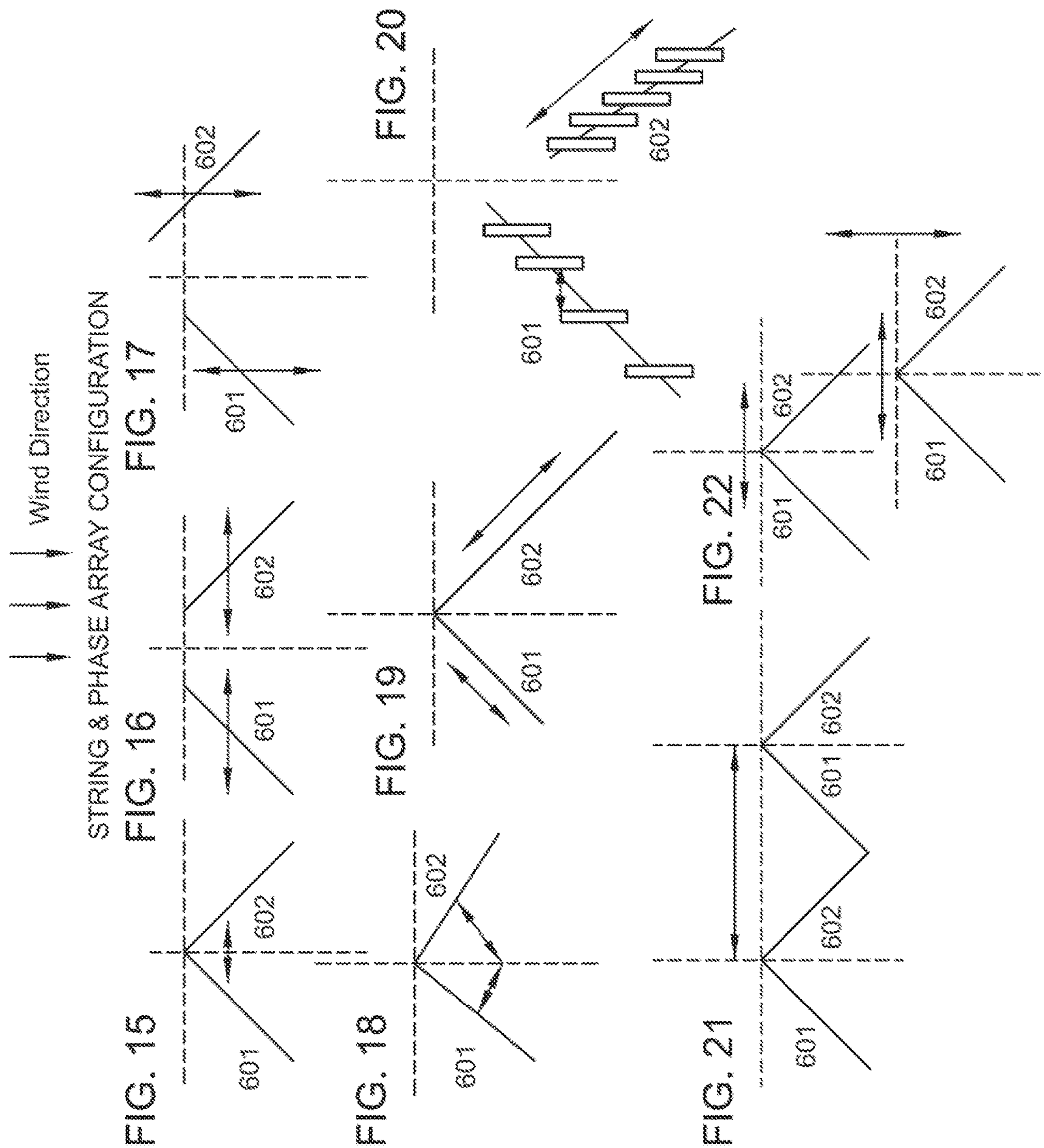

FIG. 15
FIG. 16
FIG. 17
FIG. 18
FIG. 19
FIG. 20
FIG. 21
FIG. 22

SYSTEM FOR PRODUCING ENERGY THROUGH THE ACTION OF WAVES

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of Provisional Patent Application Ser. No. 61/655,095 filed Jun. 4, 2012, which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a system for producing energy through the action of waves. More particularly, it relates to a ship's hull that constitutes part of, or contains, a system for producing energy through the action of waves.

BACKGROUND OF THE INVENTION

There are numerous examples in the art of systems and methods for producing energy through the action of waves on ships' hulls and other floating platforms (collectively, herein "hulls"). For example, U.S. Patent Publication No. US-2009-0160191-A1, which is incorporated herein by reference, describes a system for producing electricity through the action of waves on a hull. A second movable mass is carried by and movable relative to the hull, a first movable, the second movable mass creates kinetic energy as a result of varying its position relative to the hull. A mechanism then converts the kinetic energy of the second mass moving relative to the first mass into electricity in a preferred embodiment. In this example, the hull is an integral part of the system for producing energy.

In other examples of systems for producing energy through the action of waves, hulls merely carry, or contain, the system, Herein, a hull that is an integral part of a system for producing energy through the action of waves, or merely carries or contains such a system, will be referred to as part of the system for producing energy through the action of waves.

Many parts of these systems for producing energy through the action of waves are described in detail. However, little attention, if any, is paid to hulls that are part of these systems even though the shape, dimension and orientation of the hulls may significantly affect both the costs of producing the systems and the amount of energy provided by the systems.

It is a goal of the present invention to produce hulls to reduce the costs of producing systems for the production of energy through the action of waves and to increase the energy produced by the systems.

SUMMARY OF THE INVENTION

The present invention is hulls that are part of systems for producing energy through the action of waves. The hulls' shapes, dimensions and orientations make the systems less costly and increase the energy produced by the systems.

These aspects of the invention are not meant to be exclusive and other features, aspects, and advantages of the present invention will be readily apparent to those of ordinary skill in the art when read in conjunction with the following description, appended claims, and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the present invention will be better understood by reading the following detailed description of embodiments, taken together with the drawings wherein:

FIG. **1** is a schematic view of wave periods;

FIG. **2** is a table showing wave lengths and wave frequencies;

FIG. **3** is a cross-section of a hull;

FIG. **3**A is a cross-section of a hull;

FIG. **4** is a schematic view of a water plane;

FIG. **5** is a schematic view of tuned elliptical hulls;

FIG. **5**A is a schematic view of a hull with external ballast retaining means;

FIG. **6** is a schematic view of the orientation of a single hull;

FIG. **7** is a schematic view of the orientation of another single hull;

FIG. **8** is a schematic view of the orientation of multiple hulls connected by trusses;

FIG. **9** is a schematic view of the orientation of multiple hulls connected to a stationary mooring line and a winch line;

FIG. **10** is a schematic view of the orientation of multiple hulls connected to a stationary mooring line and multiple winch lines;

FIG. **11** is a schematic view of a phase array of multiple hulls;

FIG. **12** is a graph of power produced versus time for a single hull;

FIG. **13** is a schematic view of a phase array of two hulls;

FIG. **14** is a graph of power produced versus time for two hulls;

FIG. **15** is a schematic view of one embodiment of a phase array;

FIG. **16** is a schematic view of another embodiment of a phase array;

FIG. **17** is a schematic view of another embodiment of a phase array;

FIG. **18** is a schematic view of another embodiment of a phase array;

FIG. **19** is a schematic view of another embodiment of a phase array;

FIG. **20** is a schematic view of another embodiment of a phase array;

FIG. **21** is a schematic view of another embodiment of a phase array; and

FIG. **22** is a schematic view of another embodiment of a phase array.

DETAILED DESCRIPTION OF EMBODIMENTS

The present invention is a hull constituting part of a system for producing energy through the action of waves. The other parts of the system may be parts of the system described in U.S. Patent Publication US-2009-0160191-A1 or any other system for producing energy through the action of waves.

A preferred embodiment of the present invention is designed to reduce manufacturing costs. Ocean waves can be divided into two groups based on their frequencies: one group contains waves with frequencies centered around 9 sec. (medium frequency) and one group contains waves with frequencies centered around 12 sec. (long frequency). As shown in FIG. **1**, a 9 sec. wave has a one-half wavelength, the distance from a peak to an adjacent trough of 207 ft. and a 12 sec. wave has a one-half wavelength of 368 ft. The optimum length of a hull is between one-quarter and three-quarters of a wavelength. Here, as shown in FIG. **2**, the optimum length of a hull to be used for both 9 sec. and 12 sec. waves would be longer than one-quarter of a wavelength of a 12 sec. or long wave, 184 ft., and shorter than three-quarters of a wavelength of a 9 sec. or medium wave, 311 ft. A preferred embodiment has a hull length of between 200 and 280 feet.

As shown in FIG. **3**, a cross-section **345** of a hull in another preferred embodiment is an ellipse having a cross-section with a long axis that is vertical **346** of 75 ft. and a short axis that is horizontal **349** of 53 ft. The curved walls of the ellipse cause it to have greater strength than structures with straight sections of wall. This, in turn, allows the use of thinner, less expensive walls.

In addition, this elliptical shape is optimized for displacement and water plane to be self-tuning to multiple wave frequencies ranging from 7 sec. to 15 sec. Other cross-section geometries, such as a diamond shape, as shown in FIG. **3**A, that are similar to an ellipse in increasing or decreasing waterplane as the hull pitches or heaves can also be used. The elliptical geometry of the hull is used to tune the phase of the hull to wave lengths via changes to the waterplane, which is the plane formed by the intersection of the hull and the waterline, as shown in FIG. **4**. As shown in FIG. **5**, as the waterplane of the ellipse increases or decreases for a given moment of inertia, the hull becomes stiffer or softer, tuning it to higher or lower frequency waves. As the waterplane increases and the hull becomes stiffer **571**, it is tuned to higher frequency waves, and as the waterplane decreases and the hull becomes softer **572**, it is tuned to lower frequency waves as it pitches and heaves.

The draft of the ellipse determines the static waterplane of the hull. As the draft increases, the waterline rides higher on the ellipse **572**, which then has a smaller waterplane, which softens the hull. As the draft decreases and the waterline rides closer to the geometric horizontal centerline of the ellipse **571**, the waterplane of the hull increases, which stiffens the hull.

In addition, as the moment of inertia of a hull increases, the hull can be tuned to longer and longer wave frequencies. By adding mass externally at the bow or stern of the hull, the moment of inertia of the hull increases without adding additional volume to the hull. The relocation of the additional mass is much less expensive than adding volume to the hull to accommodate more mass needed to create a similar moment of inertia if the mass were added within the hull.

The addition or subtraction of additional mass, located externally at the bow and stern of the hull, also increases or decreases the displacement of the hull, which, in turn, increases or decreases the moment of inertia of the hull, without adding volume to the hull, which, in turn, tunes the phase of the hull to longer or shorter wave periods, respectively.

In another preferred embodiment, as shown in FIG. **5**A, a hull **501** has an external ballast retaining means **502** at its bow **503**, which can also be at its stern (not shown). The ballast retaining means can consist of a hook **502** for hanging modular ballast **504** such as blocks of concrete or sheets of metal or cages into which such ballast can be placed, or other retaining means known to those skilled in the art. The modular ballast is added to, or subtracted from, the ballast retaining means. The addition or subtraction of such ballast increases or decreases hull length, displacement and moment of inertia, respectively, to tune the phase of the hull to operate in phase with higher frequency or lower frequency waves and increase power generation.

A typical hull **210**, as shown in FIG. **6**, has a greater moment of inertia along the line **211** from bow **212** to stern **213** than the moment of inertia along the line **214** from port **215** to starboard **216**. This will result in the hull turning so that the line **211** from bow **212** to stern **213** is perpendicular to the direction **217** of the waves **218**, causing the hull to roll from port to starboard. It should be noted that, as used herein, the direction of the wind is parallel to the direction of the waves and perpendicular to the wavefront.

In order to build a hull that will orient itself so that the line from bow to stern is parallel to the direction of the waves, the moment of inertia along the line from port to starboard must be increased so that it is greater than the moment of inertia along the line from bow to stern. This has been done in the prior art by increasing the dimension of the hull along the line **220** from port **221** to starboard **222**, as shown in FIG. **7**. However, the cost of materials for such a hull and the cost of manufacturing and transporting it are significant.

In a preferred embodiment, as shown in FIG. **8**, multiple hulls (here two but more than two can be used) **303**, **304** are held in position parallel to each other by simple trusses **305**. The trusses hold the hulls apart such that the first hull is closest to the second hull between the starboard side of the first hull and the port side of the second hull. The distance between the hulls **306** is chosen, in part, so that the moment of inertia along the line **307** from the port side of the left-most hull to the starboard side of the right-most hull exceeds the moment of inertia along the line **308** from the bow to the stern of a hull. This will result in the multiple hulls structure orienting itself so the line **308** from bow to stern is parallel to the direction **310** of the waves **311**.

In another preferred embodiment, as shown in FIG. **9**, multiple hulls **320**-**329** are attached to a stationary mooring, which can be either a mooring line **330** with ends attached to buoys **331** and **332** or individual stationary moorings for each hull (not shown). The multiple hulls **320**-**329** are also attached to a winch line **333** with ends attached to winches **334** and **335** in buoys **331**, **332**. As waves change direction, the winches **334** and **335**, by moving the winch line from one winch to the other, actively orient the hulls to the wave direction so that the line **336** from the stern **338** to the bow **337** of a hull, or the direction in which the hull is headed, is parallel to the direction **339** of a wave **340**. A string mooring, excluding the active winch line, can also be used to moor hulls with trusses, as described above, that are self-orienting. In another embodiment, as shown in FIG. **10**, multiple hulls **520**-**529** are attached to a stationary mooring, which can be either a mooring line **530** with ends attached to buoys **531**-**532** or an individual stationary mooring for each hull (not shown). A winch **540**-**549** can be attached to each individual **520**-**529** hull with winch lines **560** having one end attached to the winch and one end attached to the stationary mooring. Each hull winch **540**-**549**, by moving an individual winch line **550**-**568**, can actively orient each individual hull **520**-**529** so that the line from the stern to the bow of the hull, or the direction in which the hull is headed, is parallel to the direction of a wave.

In another preferred embodiment, multiple hulls that are part of a system to produce electricity through the action of waves are arranged in a phase array as shown in FIG. **11**. The purpose of the phase array is to address the problem of the intermittent nature or granularity, as described below, of the electricity produced by one or more independent hulls.

With one hull, electricity is produced while a wave is acting on the hull. However, no electricity is produced during the period from one wave ceasing to act on the hull to the next wave beginning to act on the hull. The electricity produced is granular, as shown in FIG. **12**, for waves with peaks 10 secs. apart. Such granular electricity cannot be transmitted directly to commercial electric grids but must be stored in batteries or other costly storage devices, adding to the expense of producing the electricity.

The solution is to orient multiple hulls so that the peak of a first wave in a series of waves is acting on a second when the peak of a second wave is not acting on the first hull. For example, if two hulls **401**, **402** are moored by mooring lines **403**, **404** in a phase array **400**, as shown in FIG. **13**, the peak of a wave in a series of waves traveling in direction **405** with peaks 10 secs. apart acts on hull **401** first and 5 seconds later on hull **402**. In this phase array, as shown in FIG. **14**, the granularity of electricity **406** produced, which is a combination of the electricity produced by hulls **401** and the electricity produced by hull **402**, begins to be smoothed out. With a larger number of hulls arrayed appropriately the aggregate total of the electricity produced by all the hulls loses its graininess and the need for costly storage devices goes away.

In another preferred embodiment, shown in FIG. **11**, multiple hulls **410-419** are attached to mooring lines **420**, **421**, the ends of which form a right array angle **422** to form phase array **424**. The phase array allows the hulls **410-419** to be moved so that waves of different frequencies or waves coming from different directions, in this embodiment +/−20°, will still produce electricity from hulls **410-419** that is not granular. For example, if the time between wave peaks increases, the distance **423** from the bow of one hull **411** to the bow of another hull **412** can be increased by moving the hulls apart on mooring line **420**. Also, the array angle **402** can be decreased, in effect increasing the distance from the bow of one hull to the bow of another hull.

Other mooring line configurations in other phase arrays are shown in FIGS. **15-22** as examples. In FIG. **15** the ends of the mooring lines **601**, **602** form a 90° angle, which can be increased or decreased to change the distance between the bow of one hull on one of the mooring lines to the bow of another such hull. In FIG. **16**, the mooring lines **601**, **602** do not intersect so they can be moved perpendicular to the direction of the wind to take into account changes in wind direction. In FIG. **17**, the mooring lines **601**, **602** do not intersect so that one or both can be moved parallel to the general direction of the wind.

In FIG. **18** the mooring lines **601**, **602** each form a different angle with a line parallel to the general direction of the wind. Each of those angles can be increased or decreased. In FIG. **19** the mooring lines **601**, **602** are of different lengths. The lengths of each of the mooring lines can be increased or decreased. In. FIG. **20**, the hulls along one mooring line **601** can be spaced apart or the entire mooring line can be moved.

In FIG. **21** there are multiple phase arrays. Each one consists of two mooring lines **601**, **602** with ends meeting at a 90° angle. The phase arrays can be moved closer together or further apart in the direction perpendicular to the general direction of the wind. In FIG. **22**, there are multiple phase arrays. Again, each one consists of two mooring lines **601**, **602** with ends meeting at a 90° angle. The phase arrays can be moved closer together or further apart in the direction parallel to the general direction of the wind.

While the principles of the invention have been described herein, it is to be understood by those skilled in the art that this description is made only by way of example and not as a limitation as to the scope of the invention. Other embodiments are contemplated within the scope of the present invention in addition to the exemplary embodiments shown and described herein. Modifications and substitutions by one of ordinary skill in the art are considered to be within the scope of the present invention.

What is claimed is:

1. A system for producing energy through the action of waves comprising,

a hull having a bow and stern, wherein at least a portion of the hull has a cross-section such that a static waterplane of the hull increases or decreases as a draft of the hull decreases or increases, respectively;

at least one system to produce electricity from the action of waves and resulting pitching movement of the hull, wherein at least a portion of the at least one system is secured to the hull; and

a system to tune the pitching of the hull relative to hydraulic forces of the waves to increase energy generated by the system to produce electricity, wherein:

in response to the frequency of the wave decreasing and a wave period increasing, the system to tune is configured to cause the draft of the hull to increase and the static waterplane of the hull to decrease; and

in response to the frequency of the wave increasing and the wave period decreasing, the system to tune is configured to cause the draft of the hull to decrease and the static waterplane of the hull to increase.

2. The system for producing energy through the action of waves of claim **1**, wherein the hull has an elliptical cross-section having a long axis and a short axis wherein the long axis is vertical and the short axis is horizontal.

3. The system for producing energy through the action of waves of claim **1**, wherein the system to tune the hull comprises a controller and one or more sensors configured output a signal representative of the wave height.

4. The system for producing energy through the action of waves of claim **1**, wherein the hull has a generally diamond shaped cross-section.

5. The system for producing energy through the action of waves of claim **1**, wherein the hull has a length extending between the bow and the stern and the length of the hull is between 200 and 280 feet.

6. The system for producing energy through the action of waves of claim **1**, wherein the hull has a length extending between the bow and the stern that is between one quarter and three quarters of a length of the wave frequency.

7. The system for producing energy through the action of waves of claim **1**, further comprising:

a bow external modular ballast;

a stern external modular ballast; and

an external bow ballast hanger and an external stern ballast hanger disposed at the bow and the stern for retaining the bow and the stern external modular ballast, respectively.

8. A system for producing energy through the action of waves comprising,

a hull having a bow and stern, wherein at least a portion of the hull has a cross-section such that a static waterplane of the hull increases or decreases as a draft of the hull decreases or increases, respectively;

a generator secured to the hull, the generator to produce electricity from a pitching movement of the hull induced by the action of waves;

a controller to monitor wave frequency and to tune the pitching of the hull relative to hydraulic forces of the waves to increase electricity generated by the generator, wherein:

in response to the frequency of the wave decreasing and a wave period increasing, the controller is configured to cause the draft of the hull to increase such that a static waterplane of the hull decreases; and in response to the frequency of the wave increasing and the wave period decreasing, the controller is configured to cause the draft of the hull to decrease such that the static waterplane of the hull increases.

9. The system for producing energy through the action of waves of claim **8**, wherein the hull has an elliptical cross-section having a long axis and a short axis wherein the long axis is vertical and the short axis is horizontal.

10. The system for producing energy through the action of waves of claim **8**, wherein the hull has a generally diamond shaped cross-section.

11. The system for producing energy through the action of waves of claim **8**, wherein the hull has a length extending between the bow and the stern and the length of the hull is between 200 and 280 feet.

12. The system for producing energy through the action of waves of claim **8**, wherein the hull has a length extending between the bow and the stern that is between one quarter and three quarters of a length of the wave frequency.

13. The system for producing energy through the action of waves of claim **8**, further comprising an external bow ballast hanger and an external stern ballast hanger disposed at the bow and the stern for retaining a bow and a stern external modular ballast, respectively.

14. A system for producing energy through the action of waves comprising,

a hull having a bow and stern, wherein a top portion of the hull has a cross-section that decreases as a draft of the hull increases;

an electrical generator secured to the hull to produce electricity from a pitching movement of the hull induced by the action of waves;

a controller to monitor wave frequency and to tune the pitching of the hull relative to hydraulic forces of the waves to increase electricity generated by the electrical generator, wherein:

in response to the frequency of the wave decreasing and a wave period increasing, the controller is configured to cause the draft of the hull to increase such that a static waterplane of the hull decreases; and

in response to the frequency of the wave increasing and the wave period decreasing, the controller is configured to cause the draft of the hull to decrease such that the static waterplane of the hull increases.

15. The system for producing energy through the action of waves of claim **14**, wherein the hull has an elliptical cross-section having a long axis and a short axis wherein the long axis is vertical and the short axis is horizontal.

16. The system for producing energy through the action of waves of claim **14**, wherein the hull has a generally diamond shaped cross-section.

17. The system for producing energy through the action of waves of claim **14**, wherein the hull has a length extending between the bow and the stern and the length of the hull is between 200 and 280 feet.

18. The system for producing energy through the action of waves of claim **14**, wherein the hull has a length extending between the bow and the stern that is between one quarter and three quarters of a length of the wave frequency.

19. The system for producing energy through the action of waves of claim **14**, further comprising an external bow ballast hanger and an external stern ballast hanger disposed at the bow and the stern for retaining a bow and a stern external modular ballast, respectively.

20. The system for producing energy through the action of waves of claim **19**, further comprising the bow and the stern external modular ballast.

21. A method for producing energy through the action of waves on a hull, the method comprising:

adjusting the pitching motion of the hull by adjusting an amount of ballast of the hull to adjust a draft of the hull based on, at least in part, a frequency of the waves, at least a portion of the hull having a cross-section such that a static waterplane of the hull increases or decreases as a draft of the hull decreases or increases, respectively, wherein adjusting the pitching motion of the hull by adjusting the amount of ballast of the hull comprises:

increasing the draft of the hull and decreasing the static waterplane of the hull in response to the frequency of the wave decreasing; and

decreasing the draft of the hull and increasing the static waterplane of the hull in response to the frequency of the wave increasing; and

generating electricity from the action of waves and resulting pitching movement of the hull.

22. The method of claim **21**, wherein the hull has a length that is between one quarter and three quarters of a wave length.

23. The method of claim **21**, further comprising adjusting an amount of ballast to alter a moment of inertia of the hull and to tune a phase of the hull to operate in phase with the frequency of the waves.

24. The method for producing energy through the action of waves of claim **21**, wherein the hull has an elliptical cross-section having a long axis and a short axis wherein the long axis is vertical and the short axis is horizontal.

25. The method for producing energy through the action of waves of claim **21**, wherein the hull has a generally diamond shaped cross-section.

26. The method for producing energy through the action of waves of claim **21**, wherein the hull has a length of between 200 and 280 feet.

27. The method for producing energy through the action of waves of claim **21**, wherein generating electricity from the action of waves and resulting movement of the hull comprises:

moving a second movable mass that is carried by relative to a first movable mass to create kinetic energy as a result of varying its position relative to the first movable mass, wherein the first movable mass is the hull; and

converting the kinetic energy of the second mass moving relative to the first mass into electricity.

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