

[54] **WAVE-ACTUATED HORIZONTAL ARRAY
STRETCHER**

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114/235 B, 235 F, 230; 60/497-506**

[56] **References Cited**

UNITED STATES PATENTS

212,847	3/1879	Greene	115/4
2,524,863	10/1950	White	114/235 B

FOREIGN PATENTS OR APPLICATIONS

11,437	5/1908	Great Britain	115/4
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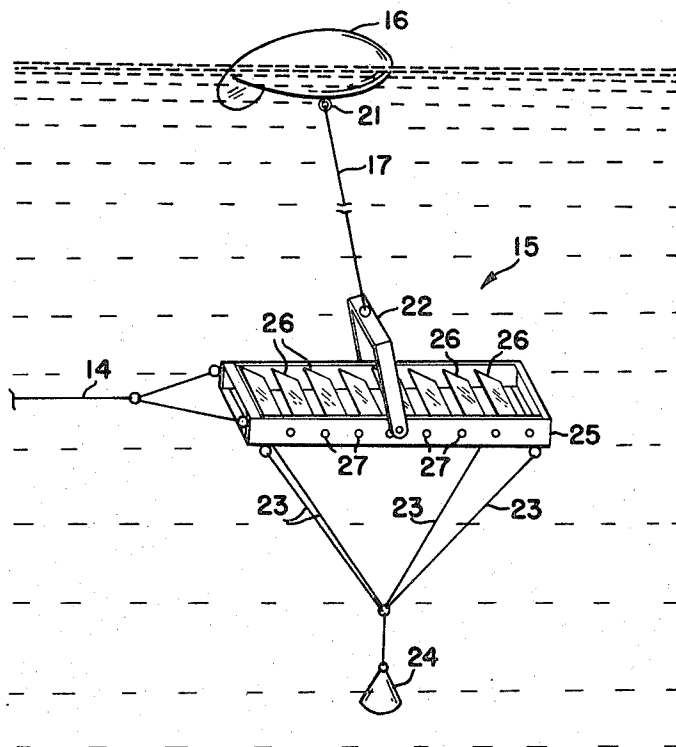
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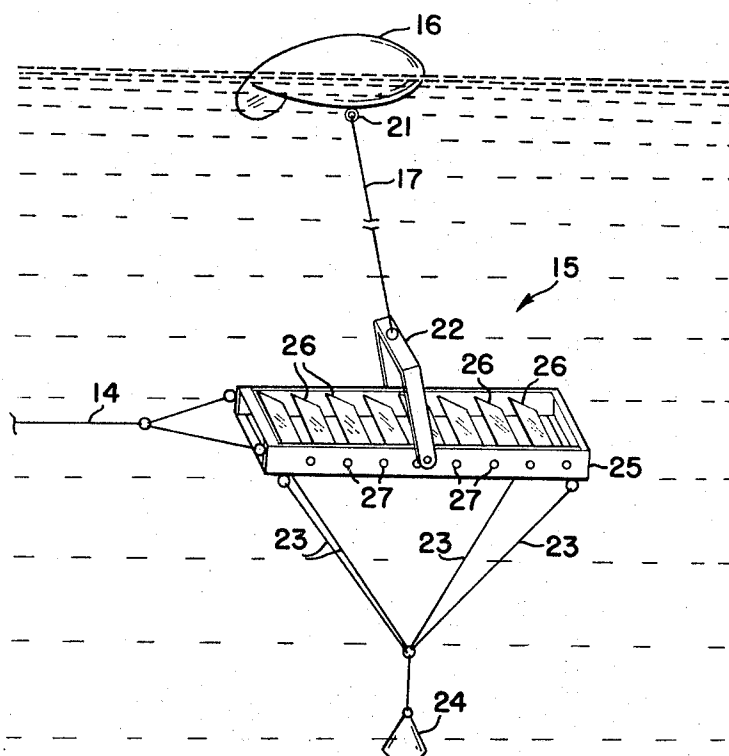
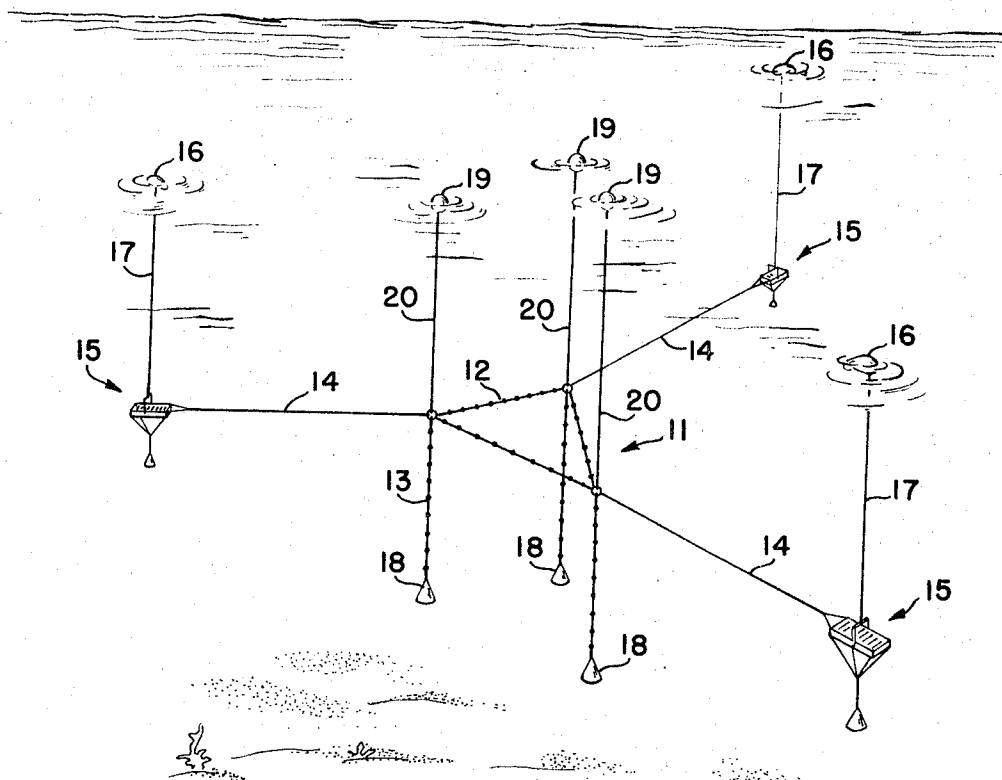
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ABSTRACT

A wave-actuated propulsion motor includes a surface float having a support depending therefrom carrying a plurality of freely pivotable fins. A weight suspended from the underside of said support stabilizes the support in a horizontal plane and provides a downward force counter to the buoyant force provided by the surface float. Pivotal or flexible fins are moved between two limit positions or flexed by water displaced by vertical movements of the support in following wave-induced motions of the surface float. A towing connection is made to the framework to transmit horizontal forces caused by deflection of the fin-controlled water movements in a horizontal plane.

12 Claims, 3 Drawing Figures





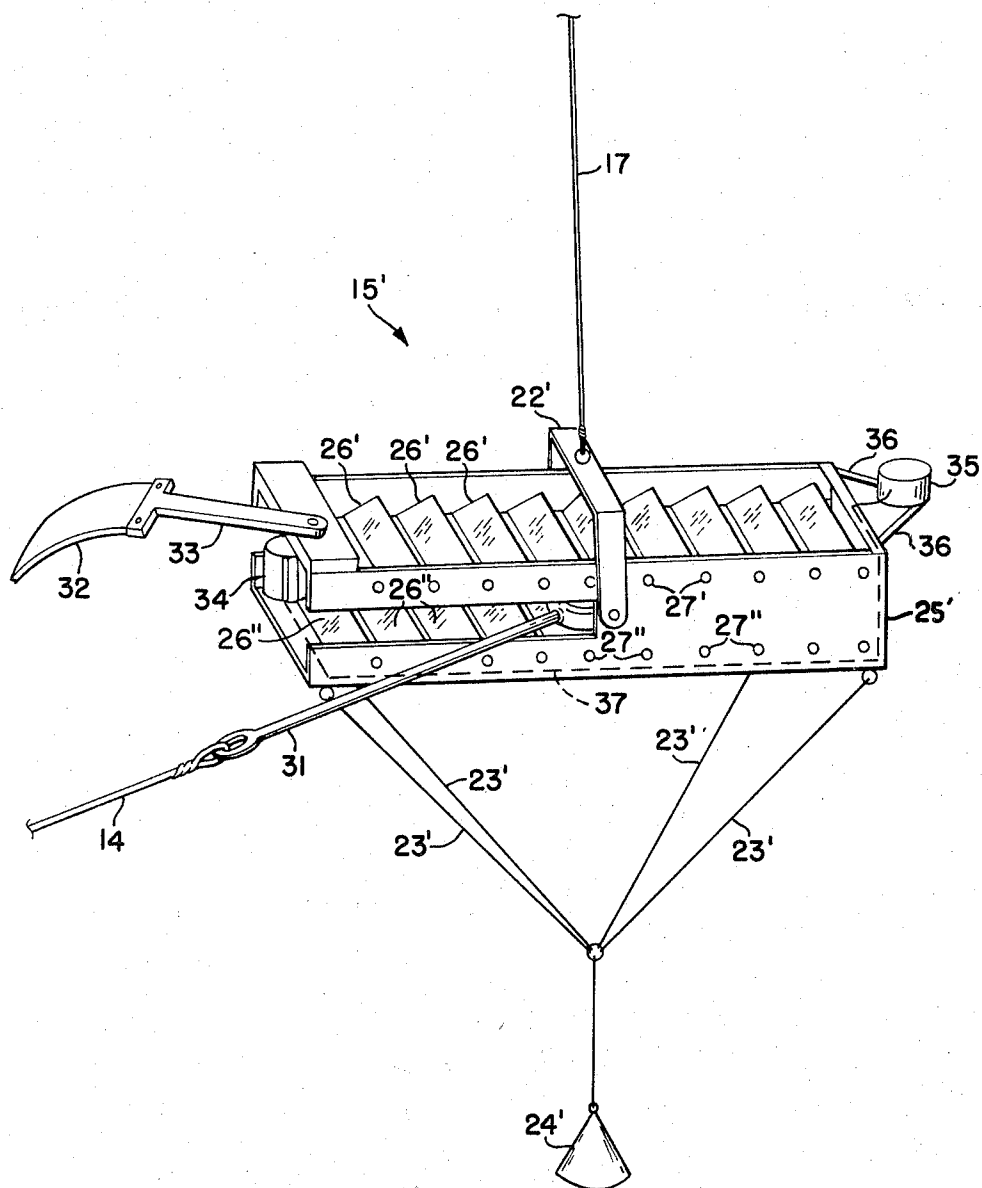


FIG. 3

WAVE-ACTUATED HORIZONTAL ARRAY STRETCHER

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

FIELD OF THE INVENTION

This invention pertains to the field of naval architecture. In greater particularity, the invention pertains to marine propulsion plants. In still greater particularity, but without limitation thereto, this invention pertains to a wave-actuated propulsion motor which converts the force of wave actions producing vertical movements of a surface float to a propulsion force substantially at right angles to said direction of movement. By way of characterization and illustration, the invention will be described as it pertains to positioning and stretching of underwater acoustic arrays.

DESCRIPTION OF THE PRIOR ART

In general, underwater horizontal hydrophone arrays are held in position by means of anchors and buoys or, alternatively, by means of surface towing ships which may be underway or simply drifting with the surface currents.

In cases where the array is positioned by the means of anchors, and cooperating buoys, the various anchor lines are slanted and connected to the array such that horizontal force components are generated by the anchors and the anchor lines and upwards pull of subsurface buoys. In such instances, depth is regulated by using cables connecting surface buoys and the underwater arrays. The systems, while satisfactory in some applications, require operation in water shallow enough to position anchors on the bottom so as to maintain a slanted anchor line. These conditions are not always available and, furthermore, difficulties arise in transportation and deployment of such large amounts of equipment. These difficulties preclude short term deployment of these arrays.

The use of surface towing ships to stretch and position the array requires the expenditure of considerable manpower and expense in keeping the various ships on station and prohibits long term or covert placement.

Therefore, a need in the oceanographic arts has long been felt for a method of placement of horizontally disposed electroacoustic arrays which may be maintained in place for relatively long periods and do not require a plurality of station-keeping surface vessels.

SUMMARY OF THE INVENTION

The invention comprises a framework having pivotal or flexible blades thereon which divert water displaced by vertical movements of the framework and thereby produce a propulsive force in reaction to this water deflection. The framework is maintained at the desired depth by means of a vertically depending support line and is stabilized in a horizontal position by a vertically depending bridle and anchor or weight on the underside thereof. The framework is caused to experience periodic vertical displacements by means of buoying floats on the surface of the water and attached to the framework by dependent lines and the restoring force produced by the vertically depending anchor.

STATEMENT OF THE OBJECTS OF THE INVENTION

The primary purpose of this invention is to provide a wave-actuated propulsion motor for marine environments.

Another object of the present invention is to provide a wave-actuated marine propulsion device suitable for stretching and positioning underwater electroacoustic arrays.

Another object of the present invention is to provide a device for converting vertical wave motions to horizontal propulsive force.

Another object of this invention is to provide a device for tensioning an underwater cable in response to surface movements of the body of water.

Yet another object of the present invention is to provide a marine propulsion unit which derives propulsion force by deflection of displacement of the currents.

These and other objects of the invention will become more readily apparent from the ensuing specification when taken together with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the device of the invention being utilized to position and stretch a horizontally configured electroacoustic array;

FIG. 2 is a lateral view of one of the array stretchers used in FIG. 1; and

FIG. 3 is a lateral perspective view of another configuration of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a hydrophone array is indicated generally at 11. In the illustrated arrangement, hydrophone array 11 includes a horizontal triangular portion 12 having vertically dependent hydrophone arrays 13 extending downwardly from each corner thereof.

The elements comprising hydrophone array 11 may be of any flexible linear type. However, for purposes of completeness, it should be noted that the array disclosed in U.S. Pat. application Ser. No. 391,198 filed the 24th of Aug. 1973, by Frank R. Abbott for "Towable Sonar Array" has proven satisfactory in the developmental models.

The corners of the triangular array 12 are held in a horizontal and spaced-apart position by means of radially extending lines 14. Lines 14 are tensioned by a wave-actuated propulsion motor, indicated generally at 15, attached to the other end thereof.

As shown, wave-actuated motors 15 are supported by surface floats 16 via length of cable 17. Similarly, vertical portions 13 of the hydrophone array 11 are maintained in a vertical position by means of an anchor 18 attached to the lower end thereof in a float 19 on the surface of the water connected to the upper end of hydrophone array 13 by means of a cable 20.

Referring to FIG. 2, the structural details of wave-actuated motor 15 are better illustrated. As shown, cable 17 attaches to an eye 21 located on the under surface of float 16. It should be understood that such an illustration is somewhat diagrammatic and that float 16 may be any of several well known oceanographic floats. For example, that shown in U.S. Pat. No. 3,613,629 issued to William A. Rhyne, et al., on Oct. 19, 1971 for "Buoyant Cabling System," has proven satisfactory.

The other end of cable 17 is attached to a pivotable yoke 22 which extends upwardly from the support 25. Support 25 is a hollow rectangular construction made of any suitable material, such as steel or aluminum, for example.

Support 25 is stabilized in a horizontal position by a vertically depending yoke made of flexible lines 23 which attach to the upper end of the dependent weight or anchor 24. As shown, each of the lines 23 is attached to a corner of rectangular support 25 to provide uniform leveling force thereon as a result of the tension imparted to the arrangement by weight 24.

A plurality of fins 26 are carried by rectangular support 25 and are pivotally journaled thereon by means of an axle 27 extending through each fin 26 and rotatably journaled in the side members of support 25. Alternatively, fins 26 may be made of flexible material such as rubber and axle 27 may be a rigidly held mounting shaft.

As float 16 follows the wave actions on the surface of the body of water and the downward pull exerted by anchor 24, the support frame 25 is caused to reciprocate vertically. This vertical reciprocation displaces a volume of water which cause fins 26 to pivot or flex between a position in which they slant upwards in response to downward movements of frame 25 or downwards in response to upward movements thereof. Of course, this water displaced by the vertical motion is deflected by fins 26 and a resultant to this deflected water movement is a propulsive force tending to move support frame 25 to the right in FIG. 2. This movement tensions line 14 which is attached to horizontal frame 25 by a self-formed, flexible bridle.

In normal seas and for short lengths of time, the aforedescribed construction satisfactorily tensions horizontal array into the desired configuration. However, as might be well understood, prolonged deployment in the ocean causes the position of wave-actuated motors 15 to be moved somewhat from the stations at which they were originally deployed. By employing conventional marine hardware, this variation in position may be corrected.

Referring to FIG. 3, a modified wave-actuated motor according to the invention is illustrated. As shown rectangular support 25' differs somewhat from support frame 25. Two layers of pivotable fins 26' and 26'' are carried in parallel planes on either side of the median plane of rectangular support 25'. This arrangement permits twice the deflection surface to generate increased propulsive force and to better respond to the change in motion from upward to downward directions.

It will also be observed that line 14, rather than attaching to support 25' by means of a self-formed bridle as in the previous configuration, is attached to a pivoted towing yoke 31 which may comprise a single strut member. Yoke 31 is pivoted about the center of effort of the propulsion force to permit support 25' to assume a crab angle with respect to line 14.

A flexible rudder 32 is attached to a pillar 33 which is positioned by means of a suitable electric motor 34. Rudder 32 is a horizontal, flexible member known, for obvious reasons, as a "beaver tail" in the marine engineering arts. Thus, the heading of rectangular support frame 25' may be controlled in response to the vertical oscillation thereof and maintain a given compass heading which will enable the motor of FIG. 3 to maintain

a desired array configuration for a longer period of time. A magnetometer compass 35, or other magnetic compass, is supported from the other end of rectangular frame 25 by means of a suitable mounting bracket 36. Magnetometer compass 35 is used to produce an error signal to control motor 34 to this end. The magnetometer compass detection circuitry and interconnection to electric motor 34 are of a conventional nature as indicated by broken line 37 and any of several known arrangements may be employed for this purpose. However, for purposes of completeness, that shown in U.S. Pat. No. 3,596,069, issued on July 27, 1971 to Wayne E. Burt for "Computer-Stabilized Magnet Compass" has proven satisfactory.

Alternatively, compass 35 may be mounted on towing yoke 31 to maintain the bearing of tensioning line 14 rather than the entire propulsion unit 15' to assume a crab angle with respect to line 14.

The electric power source for motor 34 and compass 35 may be conveniently provided by conventional battery arrangement carried on support frame 25', or on anchor 24', which is suspended from rectangular support 25' by means of a flexible cable unit 23' similar to that described in connection with FIG. 2.

The foregoing description taken together with the appended claims constitutes a disclosure such as to enable a person skilled in the marine engineering and naval architecture arts having the benefit of the teachings contained therein to make and use the invention. Further, the structure herein described meets the aforestated objects of the invention, and generally constitutes a meritorious advance in the art which is unobvious to such workers bereft of the benefits of these teachings.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings, and, it is therefore understood that within the scope of the disclosed inventive concept, the invention may be practiced otherwise than specifically described.

What is claimed is:

1. A wave-actuated tensioning device for applying a tensional force to a submarine structure comprising:

a surface float;

a pendent line attached to said surface float and extending downwardly therefrom;

a support attached to the distal end of said pendent line having a substantially horizontal median plane; a plurality of pivotable fins attached to said support in a manner to permit pivoting between two limit positions where the fins are inclined upwardly or downwardly from the median plane thereof;

attachment means connected to said support and extending outwardly therefrom substantially in the median plane thereof for providing a tensioning connection to said submarine structure; and

stabilizing means attached to said support and extending downwardly therefrom for providing a downward force thereon, whereby vertical motions imparted to said support by virtue of the buoyant movement of said surface float in following the action of surface waves and the restorative downward force provided by said stabilizing means cause the pivotable or flexible fins to move between their two positions and divert the water displaced by said vertical motions along directions at an angle to said vertical movement.

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2. A wave-actuated tension device, according to claim 1, wherein said support includes an open rectangular frame.

3. A wave-actuated tension device, according to claim 2, wherein said plurality of pivotable fins extend transversely across the opening of said open rectangular frame.

4. A wave-actuated tension device, according to claim 3, wherein said plurality of pivotable fins include two or more layers of fins positioned symmetrically with respect to the median plane of the aforesaid support.

5. A wave-actuated tensioning device, according to claim 2, in which said stabilizing means includes a weight attached to each corner of said rectangle by means of a cable bridle.

6. A wave-actuated tension device, according to claim 1, wherein said attachment means includes a cable towing bridle.

7. A wave-actuated tension device, according to claim 1, wherein said attachment means comprises a pivoted towing bar, whereby said support may assume a crab angle with respect to the submarine structure about its center of effort.

8. A wave-actuated tension device, according to claim 1, wherein said stabilizing means includes an anchor attached to the underside of said support by means of a depending cable bridle to also provide downward movement of said support.

9. A wave-actuated towing device, according to claim 1, further including:

a sensing means attached to said support for sensing the compass bearing thereof; and

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a rudder ("beaver tail") pivotably attached to said support and effectively connected to said sensing means for movement thereby to effect a constant heading of said support means in response to the vertical movements thereof.

10. A wave-actuated tensioning device, according to claim 9, wherein said sensing means is a magnetometer compass.

11. A wave-actuated tensioning device, according to claim 10, further including a motor means mounted on said support and effectively connected to said rudder to provide a controlled movement thereof.

12. A wave-actuated tensioning device for tensioning underwater cables comprising:

a rectangular frame;

a yoke attached to said rectangular frame and extending thereabove to support said frame;

a line attached to said yoke at one end;

a buoy attached to the other end of said line to support said rectangular frame via said line and yoke at a fixed distance beneath the surface of the water;

stabilizing means attached to said rectangular frame for maintaining said rectangular frame in a desired spatial orientation;

connection means attached to said frame for securing the underwater cables thereto; and

pivotable fin means attached to said frame to pivot in response to vertical motion thereof and positioned with respect to said rectangular frame to produce a laterally directed propulsive force which is transmitted via said connection means to the underwater cable as a tensioning force.

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