United States Patent [19]

Fuller

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[54] **FLOATABLE BREAKWATER**

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[52] **U.S. Cl.** **61/5**
[51] **Int. Cl.** **E02b 3/04**
[58] **Field of Search** .... 61/1 F, 5; 114/.5; 9/8 R

[56] **References Cited**

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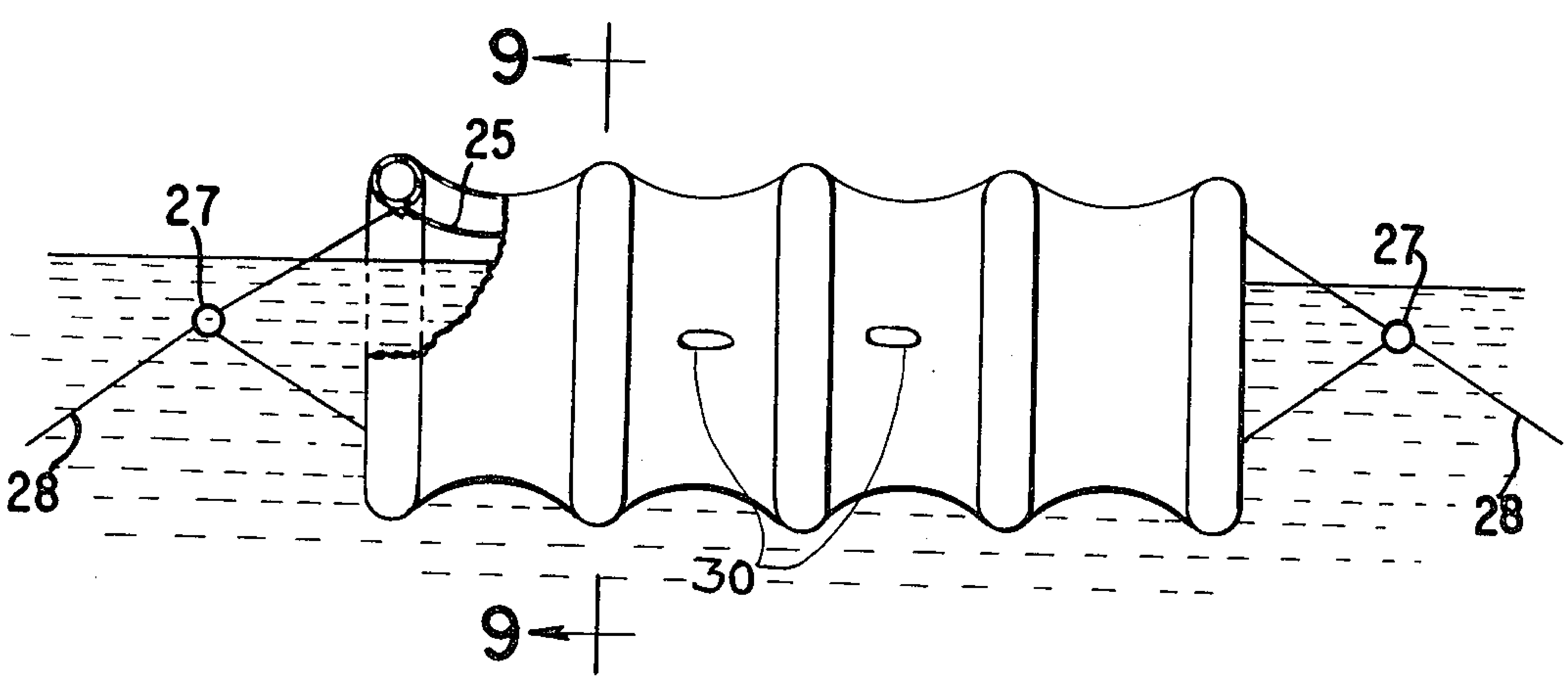
[57] **ABSTRACT**

A floatable breakwater comprises a flexible tubular element supported upon a number of water buoyant rings at the surface of the water so that the envelope can be filled with water. Both ends of the envelope are open and have drawstrings attached thereto which in turn are anchored to secure the breakwater in position. The envelope has sufficient flexibility to enable the rings therein to move with respect to each other in an accordian-like movement.

8 Claims, 11 Drawing Figures



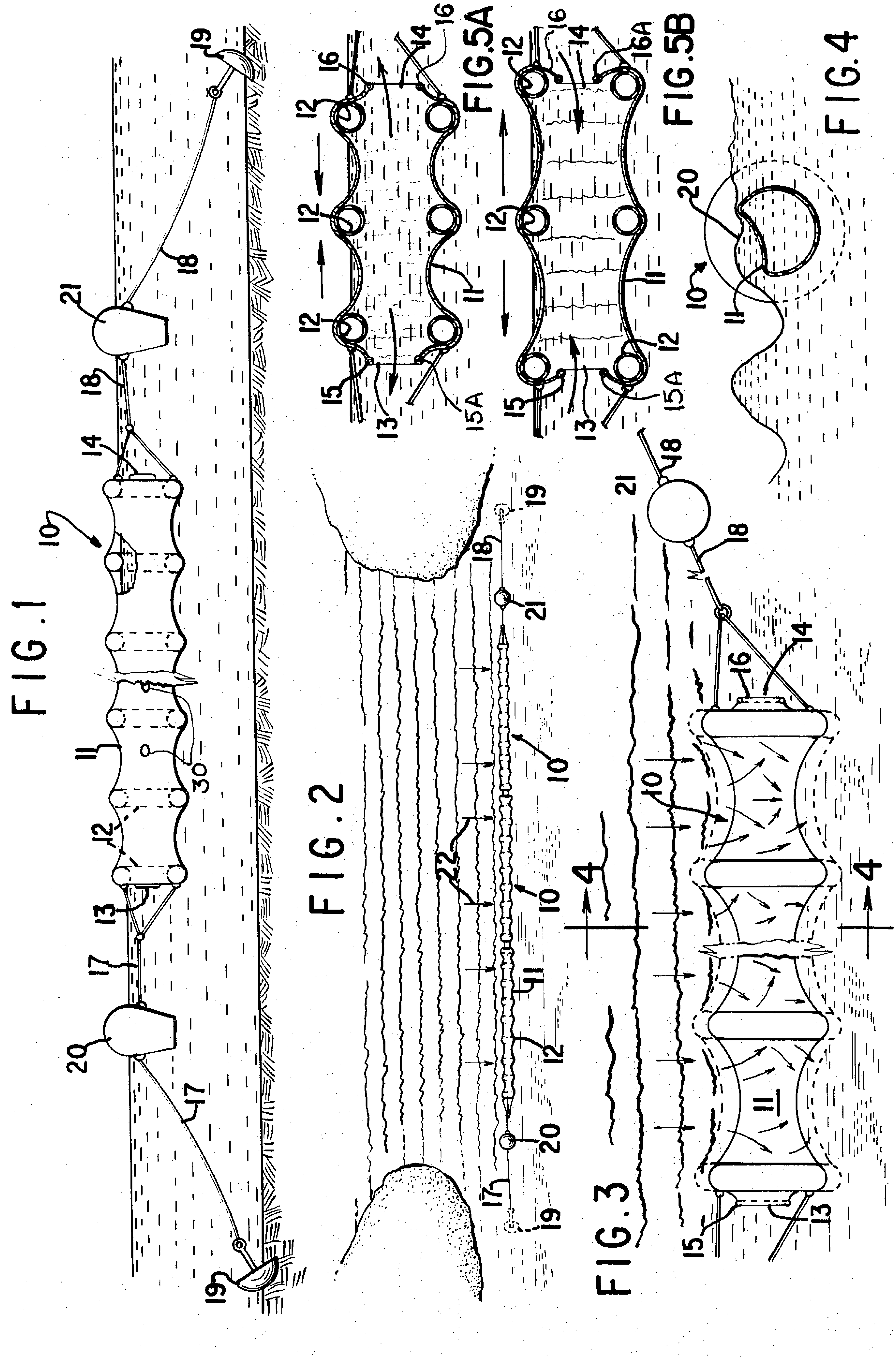


FIG.1
FIG.2
FIG.3
FIG.4
FIG.5A
FIG.5B
10
11
12
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15A
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16A
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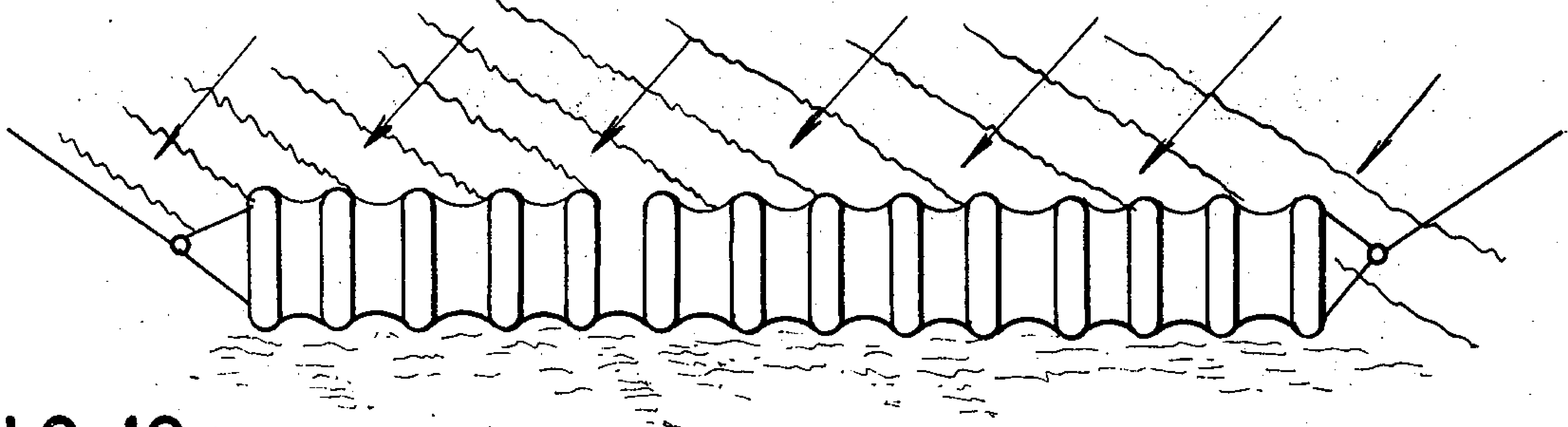

FIG. 6

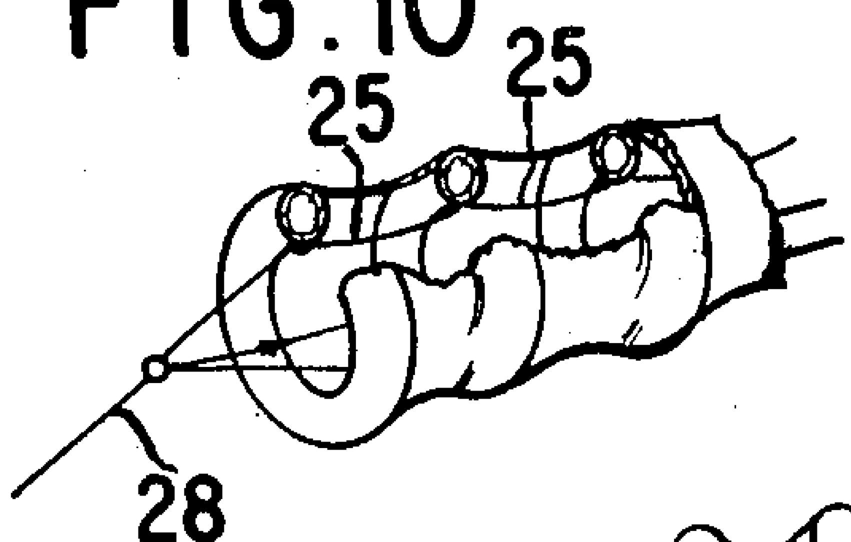

FIG. 10

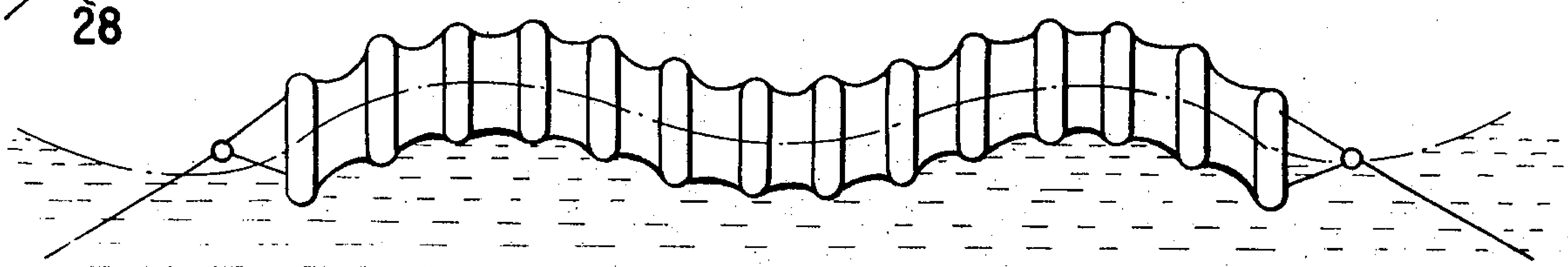

FIG. 7

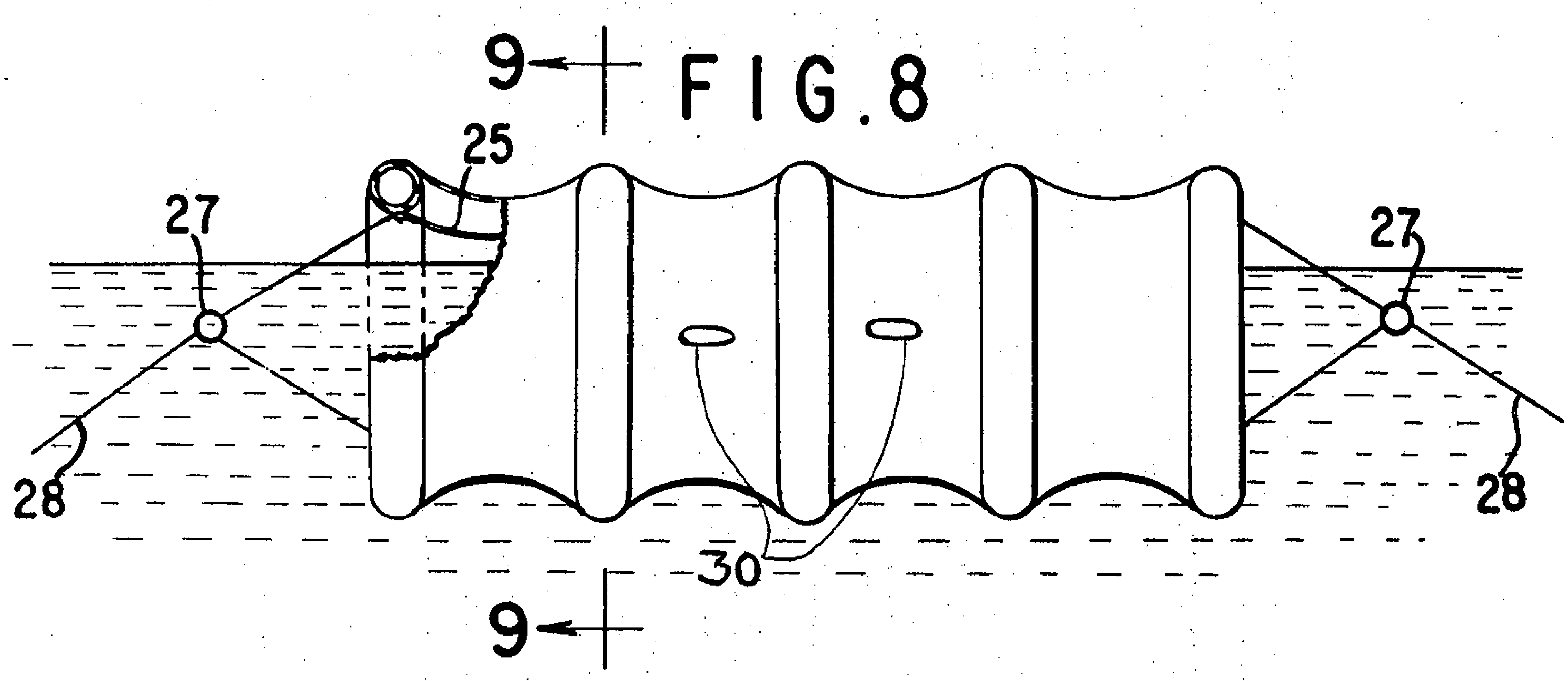

FIG. 8

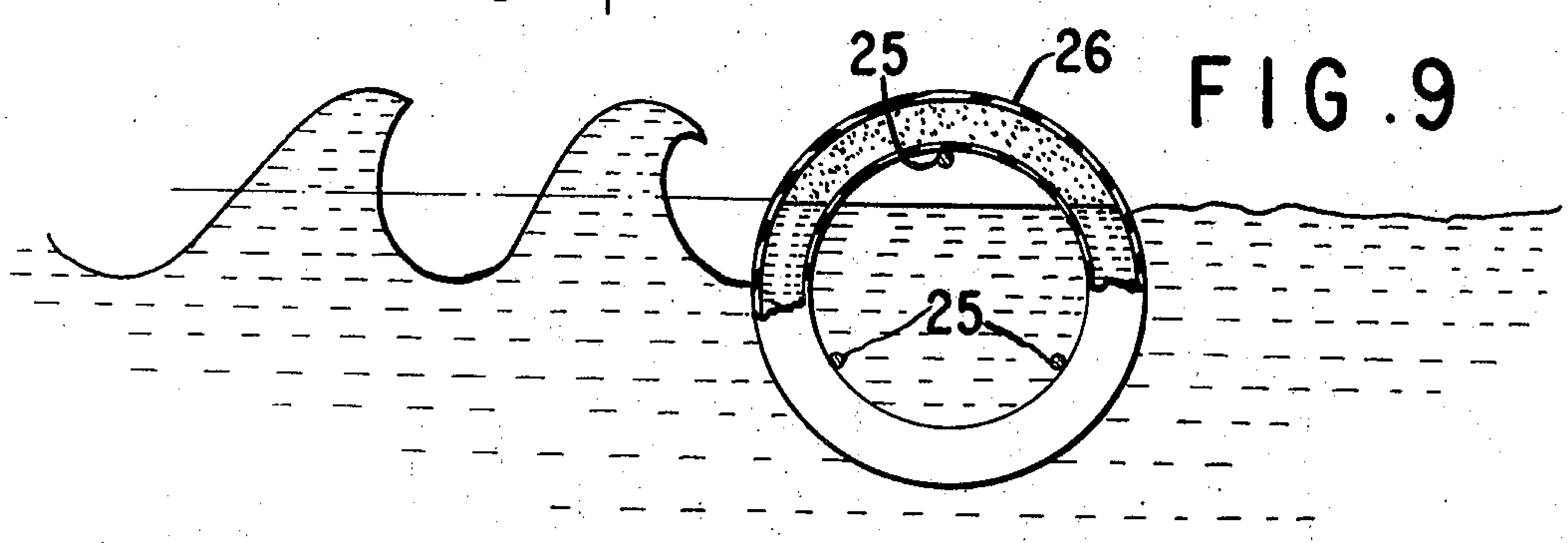

FIG. 9

FLOATABLE BREAKWATER

The present invention relates to breakwaters and, more particularly, to a floatable breakwater.

The use of breakwaters to shelter selected bodies of water, such as harbors, has been long known. Such breakwaters are generally permanent in construction and are disposed in the water at such a depth so as to have an attenuating action upon the waves. Various forms of floating breakwaters have also been proposed in an attempt to provide a less expensive and relatively temporary breakwater construction. Such floating breakwaters are generally intended to be constructed at a central location and then towed into position at which point they are suitably anchored. However, it has been found that such floating breakwaters are generally unsatisfactory since they are relatively complicated in structure so as to be expensive to manufacture and do not truly fulfill their function of effectively diminishing wave action so as to protect a harbor or the like.

It is known that the vertical motion of a wave is caused by a substantially elliptical movement of particles of water. An effective breakwater, floating or anchored to the bottom, must have a structure which effectively breaks up this elliptical movement of the water particles.

One of the objects of this invention is to provide an improved floatable breakwater.

Another one of the objects of this invention is to provide a floating breakwater which is substantially filled with water which effectively breaks up the wave motion.

According to one of the aspects of this invention, a floatable breakwater may comprise a flexible open-ended tubular envelope enclosing a plurality of axially spaced buoyant annular members or rings therein. The rings are movable axially with respect to each other while supporting the envelope so that the movement of the envelope creates an accordion effect. Means are connected to the open ends of the envelope for anchoring each end of the envelope. The breakwater is positioned in the water with its longitudinal axis perpendicular to the direction of the wave movement and is floating at such a depth that the breakwater will be substantially filled with water. The filled envelope is expandable and contractable axially because of the relative movement of the rings therein when the breakwater is acted upon by the waves.

The ends of the envelope may be provided with a suitable drawstring-like attachment which can restrict the opening in the ends of the tubular member when it is filled with water and control flow of water therethrough.

Other objects and advantages of the present invention will become apparent upon reference to the accompanying description and drawings which are merely exemplary.

In the drawings:

FIG. 1 is a longitudinal vertical view of one form of the breakwater made in accordance with the present invention and anchored in position in the water;

FIG. 2 is a top plan view of the breakwater shown in FIG. 1;

FIG. 3 is a fragmentary top view of the breakwater of FIGS. 1 and 2;

FIG. 4 is a schematic sectional view taken along the line 4—4 of FIG. 3;

FIGS. 5A and 5B are schematic side views of the invention showing the manners of operation;

FIG. 6 is a top plan view of the breakwater showing waves acting on the breakwater in a direction angularly disposed to the central axis;

FIG. 7 is a vertical view of FIG. 6 showing the action of the waves thereon;

FIG. 8 is a vertical view of a breakwater with a portion broken away to show an alternate form of securing means;

FIG. 9 is a sectional view taken along the line 9—9 of FIG. 8; and

FIG. 10 is a perspective view of the form shown in FIGS. 8 and 9.

Proceeding next to the drawings wherein like reference symbols indicate the same parts throughout the various views, a specific embodiment of the present invention will be described in detail.

According to the present invention, the floatable breakwater is indicated generally at **10** which comprises a flexible open-ended tubular envelope **11** supported on a plurality of buoyant rings or annular members **12**. The envelope **11** is formed of a relatively strong fabric or synthetic plastic material and is mounted upon the rings **12** so that the rings are capable of a relative axial movement between each other. The movement of rings **12** toward and away from each other creates an accordion-like effect in the surface of the envelope.

Rings **12** may be formed of a suitable water-buoyant material or construction and may comprise tubes from the tires of motor vehicles, such as automobiles, trucks or tractors. The material for the envelope **12** may be a transparent plastic material so that the motion of the water within the breakwater can be observed.

The ends **13** and **14** of the tubular envelope are both open, and each end has attached thereto drawstring-like arrangement **15, 16,** comprising a valve-like closure with drawstrings **15A, 16A,** such as resilient lines adjacent the inner peripheral edge of the closure. As water runs in or out, it will cause the drawstring in the inner periphery of the opening to tend to open, the extent of the opening depending upon the velocity or rate of volume flow. It is also possible to arrange the drawstrings so as to operate in the opposite direction, i.e., to attach the anchor cables **17** or **18** to the drawstring (not shown) so that it will pull closed. Anchoring cable or cables **17** and **18** are connected to the ends of the envelope and to suitable means such as anchors **19** as shown in FIG. **1.** It should be evident that by use of an anchor of the type illustrated, that the breakwater can be readily moved to another location.

Suitable water buoys of buoyant material may be attached at **20** and **21.** The buoy material may comprise cork or foamed plastic as known in the art.

In operation, the breakwater can be constructed elsewhere and transported to its point of use. The breakwater is anchored within the water so that its longitudinal axis is perpendicular to the direction of the wave movement as indicated by the arrows **22** in FIG. **2.** There is sufficient flotation in the breakwater so that when it becomes substantially filled with water, as can be seen in FIG. **1,** it will float with preferably a portion of the breakwater protruding above the surface of the water.

When waves hit the breakwater, they will cause the breakwater to move in the direction of the waves. By positioning the breakwater as shown in FIG. **1,** the waves will hit upon the top of the breakwater and the force thereof will be distributed along the entire length of the breakwater.

It has been found that for effective operation, the rings should be positioned a distance apart which is substantially equivalent to the diameter of the respective rings. The breakwater can be made in 50-foot and longer sections, depending upon the intended use.

FIG. **3** illustrates movement of the breakwater in the direction of the waves as it is hit by the waves. FIGS. **5A** and **5B** show the accordion-like movement of the envelope **11.**

FIG. **4** illustrates the manner in which a wave at **20** may change the shape of the envelope **11** and cause movement of the breakwater elements in an accordion-like fashion.

It has been found that it may be desirable to fill the tubes about two-thirds full of water so as to provide inertia. Waves of about one-half the overall height of the tube diameter will be broken.

The effect of breaking waves moving at an angle to the axis of the breakwater is shown in FIGS. **6** and **7.** The inert water mass captured by the sausage-like structure will convert water force into an attempt to lift and move at 180° in the case of FIG. **2** or at an angle (FIG. **6**) to the impingement of the waves on the breakwater. The local caterpillarlike lifting of the elements will cause water to surge toward the ends whose flexiblé openings tend to valve the in and out flow so as to further dissipate energy.

FIGS. **8, 9** and **10** show another means of anchoring the breakwater. The lines or cables **25** are fastened at spaced points to the rings **26** and then are led to a common connector **27.** Liner or cables **28** then are connected to the anchoring means.

The force of the waves in lifting the large body of water enclosed in the envelope would result in water pouring out of the ends. Thus, the vertical impingment of force would be dissipated at 90° to the impinging waves.

Flap or check valves **30** (FIG. **1**) could be used, if desired, to permit water to flow in at the center but prevent water going out at the center. Similarly, flap valves (not shown) would be provided on the outside of the ends which would let water go out easily but would not let water come in except at the center.

It is therefore apparent that the present invention discloses a floatable breakwater which effectively distributes the force of waves along its length and which is resilient so as to be somewhat compressible in response to the force of the waves. A resilient and compressible characteristic of the breakwater effectively dissipates the wave force while at the same time permits construction of the breakwater to be relatively light.

It will be understood that various details of construction and arrangement of parts may be made without departing from the spirit of the invention except as defined in the appended claims.

What is claimed is:

1. A floatable breakwater comprising a flexible open-ended tubular envelope enclosing a plurality of axially spaced buoyant annular members therein, water from the outside of said envelope flowing in and out through the open ends of said envelope, said annular members being movable axially with respect to each other while supporting said envelope, and means connected to the end of said tubular envelope for anchoring each end of the envelope, the breakwater being positioned in the water with its longitudinal axis angularly disposed to the direction of the wave movement and floating at such a depth that the breakwater will be substantially filled with water through its open ends so as to be extendable and contractable axially by the relative movement of said annular members within said envelope when the breakwater is acted upon by waves.

2. A floatable breakwater as claimed in claim **1** wherein said annular members are formed of automotive tube-like structures.

3. A floatable breakwater as claimed in claim **1** wherein the buoyant members are connected to a buoyant means which in turn is fastened to a raisable anchor means.

4. A floatable breakwater as claimed in claim **1** wherein a plurality of spaced lines extend through the annular members and are attached thereto, the ends of the lines at each end being connected to anchoring means.

5. A floatable breakwater as claimed in claim **1** wherein there are check flap valve means adjacent the center of the envelope only to permit water to enter at the center.

6. A floatable breakwater as claimed in claim **5** wherein the water flows out the end under force of waves impinging on the envelope.

7. A floatable breakwater comprising a flexible open-ended tubular envelope enclosing a plurality of axially space buoyant annular members therein, water from the outside of said envelope flowing in and out through the open ends of said envelope, said annular members being movable axially with respect to each other while supporting said envelope, means connected to the end of said tubular envelope for anchoring each end of the envelope, the breakwater being positioned in the water with its longitudinal axis angularly disposed to the direction of the wave movement and floating at such a depth that the breakwater will be substantially filled with water through its open ends so as to be extendable and contractable axially by the relative movement of said annular members within said envelope when the breakwater is acted upon by waves, and drawstring means attached to at least one of the ends of said envelope.

8. A floatable breakwater as claimed in claim **7** wherein both ends of said tubular member having drawstring means.

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