May 13, 1969 J. A. MORROW 3,444,511

TRANSDUCER ARRAY AND ERECTING MEANS

Filed Jan. 2, 1962 Sheet 1 of 2

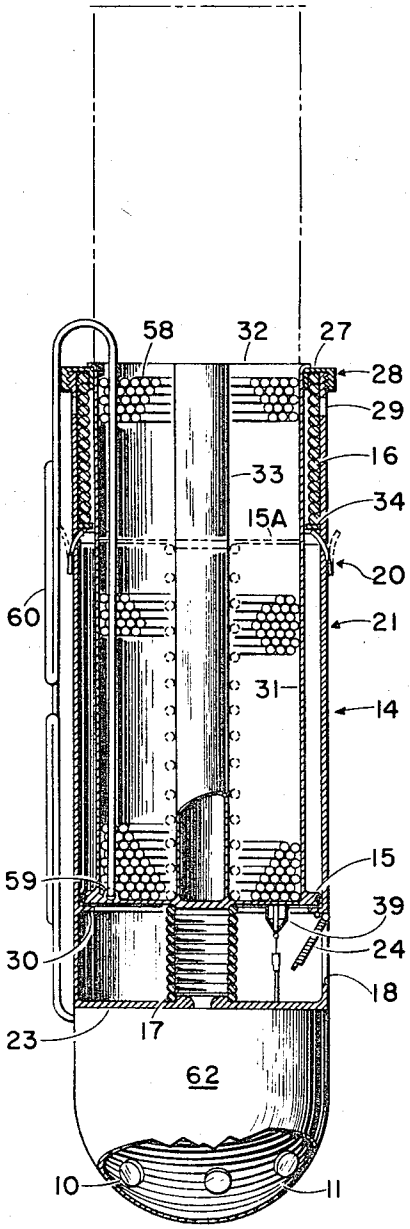


FIG 2

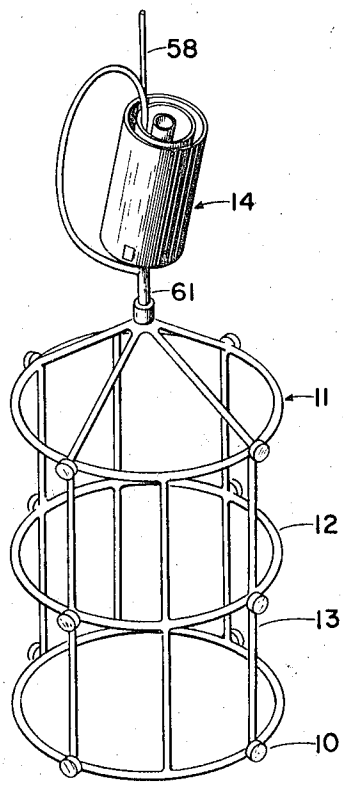


FIG 1

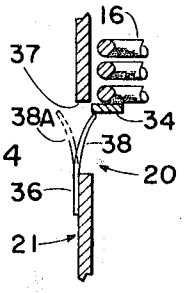


FIG 4

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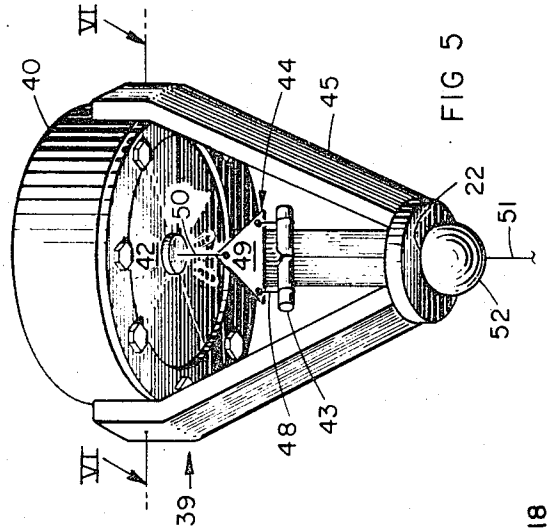


FIG 5

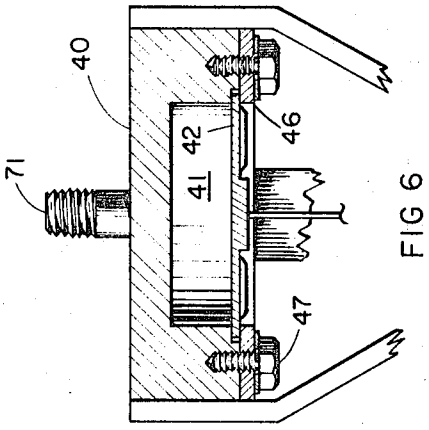


FIG 6

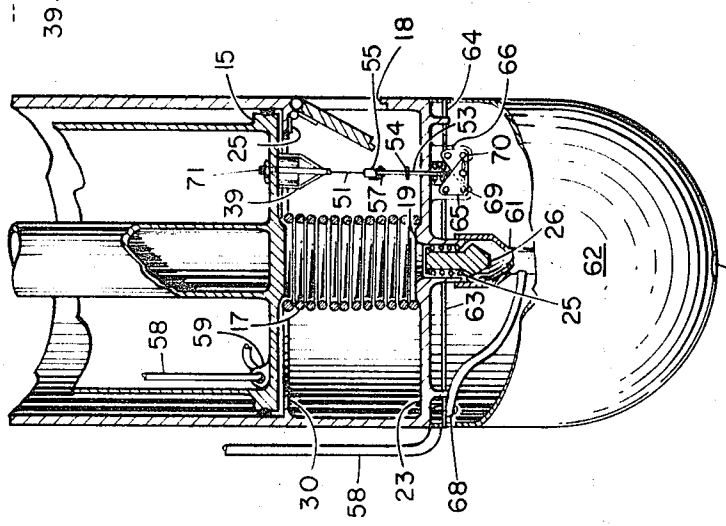


FIG 3

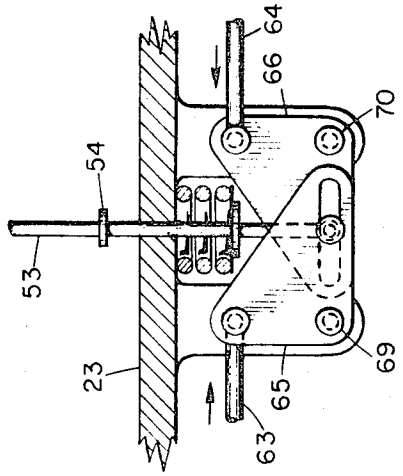


FIG 7

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TRANSDUCER ARRAY AND ERECTING MEANS

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Int. Cl. H04b 13/00; F42b 21/00
U.S. Cl. 340—9 14 Claims

This invention relates to underwater sensing apparatus and more particularly to a distensible transducer array and means for erection of the same.

In the underwater acquisition of data representative of sound and related water-transmitted signals or energies, it is ordinarily necessary to lower one or more transducers below the surface of a body of water to a desired depth which, in some cases, may be very considerable. Hydrophones, for example, are sometimes employed at depths of the order of 15,000 feet, and (as well known in the art) certain important advantages accrue to their utilization in horizontal and/or vertical arrays.

To hold the transducers in an array of desired configuration, a supporting body (e.g., a framework) of appropriate size and shape is needed, and this necessity introduces important problems in bringing the transducers into operation at the desired depth and in the required array configuration. A rigid framework, of course, is readily made to hold transducers in a desired array configuration throughout the descent to the desired depth, but its drag is so great as to excessively slow its sinking and thus to prolong greatly the time of descent. Without the addition of considerable ballast, many hours may be required for the sinking of an array of hydrophones to 15,000 feet, and it is obvious that important advantages would result if this time could be reduced to, for example, 15 minutes or less.

Another difficulty which has tended to occur where an array of hydrophones is employed is that the array occupies a comparatively large volume and hence is expensive of space in surface craft and especially in aircraft. Also, when dropped from an aircraft, the array framework and transducers are apt to be damaged by the relative wind and by impact with the water. It previously has been proposed that transducer arrays be mounted on a framework of rigid rods jointed to render them foldable into a compact configuration, housed for rapid sinking, and associated with a mechanical device for effecting unfolding of the framework after its entry into the water. Such devices tend to be of excessive weight and bulk, and their construction is excessively complicated and expensive.

In view of the above, it would be desirable to provide a compactly folded array so housed as to withstand air- and water-imparted forces and to offer but little resistance to sinking. The desired depth thus would be safely and quickly attained, and upon removal and unfolding of the array, the transducers would be placed in operating position both as to depth and as to array configuration. For the unfolding operation, it would be desirable to employ a fluid stored under pressure for inflation or distension of the array, but this becomes impractical at great depths because of the great pressure of the water. An ordinary gas or air bottle with an interior pressure of, for example, 4,000 p.s.i. obviously is ineffective at 12,000 feet, where the water pressure is approximately 6,000 p.s.i., for water would flow into (rather than gas out of) the bottle, and no inflation of an array connected to the bottle would occur.

It is, accordingly, an object of the present invention to provide an array of transducers quickly sinkable to a desired operating depth beneath the surface of a body of water.

A related object is to provide a device housing a collapsed, distensible structure, which housing is of high initial density and low drag and of adequate protection to the distensible structure from wind- and water-imparted forces.

Another object is to provide a method of distending a distensible body at underwater depths which may be so great as to make distension by a fluid stored under pressure impractical.

A further object is to provide a simple, compact device comprising a collapsed transducer array, a cable for connecting the array with the surface, and means for erecting the array at a desired depth under water.

Other objects and advantages will be apparent from the accompanying drawing illustrative of the invention.

In the drawing,

FIGURE 1 is a perspective view of the device showing the array-mounting framework in distended condition, the housing having been released from the cylinder;

FIGURE 2 is a view of the device in partial longitudinal section, the array-mounting framework being folded and contained in the housing;

FIGURE 3 is an enlarged view, similar to FIGURE 2, of the cylinder closed end and associated components;

FIGURE 4 is a longitudinal sectional view of a fragment of the cylinder and showing the first spring, washer, and a representative latch means for the first spring;

FIGURE 5 is an enlarged, perspective view of the means holding the piston in its first position;

FIGURE 6 is a cross-sectional view of the rigid body and diaphragm of the holding means taken as at line VI—VI of FIGURE 5; and

FIGURE 7 is an enlarged view of the housing release mechanism.

With reference to FIGURE 1, the array of transducers **10** is supported by a framework **11** formed by distensible members such as **12, 13** which may be collapsed to occupy a minimum of volume and to expel substantially all air from their interiors. Associated with the framework **11** are submersible means, to be described, actuatable for distension of the framework under water.

The means actuatable for distension of the array includes means for taking water from a body of water at a desired depth and injecting the same into the distensible body. For this purpose, an electrically driven pump receiving water at the desired operating depth of the array is employable for forcing the received water into the array at sufficient pressure for distension of the same. In the preferred embodiment, however, there is employed a pump **14** comprising a cylinder **21** (FIGURE 2), piston **15**, first and second coil springs **16, 17**, cylinder inlet and outlet ports **18, 19** (FIGURE 3), and latch means **20** (FIGURE 2).

The cylinder **21** has a closed lower end **23** in the region of which there are provided, in the cylinder wall, the inlet port **18** (FIGURE 3) and outlet port **19**. Both these ports **18, 19** are so positioned as to lie below the piston **15** throughout its range of travel, and the outlet port **19** is conveniently located at the center of the wall portion forming the cylinder closed end **23**. The inlet port **18** preferably is located in the sidewall of the cylinder **21** between the cylinder closed end **23** and the lowermost position of the piston **15**. A check valve, such as the flapper valve **24**, is movably mounted relative to the wall of the cylinder **21** to permit fluid flow into the cylinder but preventing outward flow through the inlet port **18**. A light spring **25** preferably holds the check valve **24** closed when fluid pressures on both sides of the valve are equal.

A second check valve **26** is employed in the outlet port **19** and is arranged to prevent backflow into the cylinder **21** through the outlet port.

The cylinder **21** is provided with a first fixed stop **27** (FIGURE 2) which extends into the cylinder and is spaced from the closed end **23**. The stop **27** is in the form of an inwardly projecting shoulder preferably located at the upper end of the cylinder **21** and integral with a threaded collar **28** which is screwed onto the cylinder. One or more vent holes are provided to effectively render the upper end of the cylinder **21** open. Shown in the cylinder upper end as at **29**, these holes could alternatively or additionally be provided in the collar **28**.

The piston **15** is slidably mounted in the cylinder **21** between the first spring **16** and the cylinder closed end **23**. In its lowermost position, the piston **15** rests on a second stop **30** which is fixed relative to and preferably made integrally with the cylinder **21**. The second stop **30** is spaced from and limits the travel of the piston **15** toward the cylinder closed end **23**. The piston **15** is movable between a first position in which it rests, as shown, on the second stop **30** and a second position, shown in broken lines at **15A**, more removed from the cylinder closed end **23**.

An inner cylinder **31** is mounted on the piston and is coaxial with and smaller in diameter than the outer cylinder **21**; the inner cylinder outer, open end **32** extends away from the outer cylinder closed end **23**. A cylindrical core **33** is mounted within and coaxial with the inner cylinder **31** shown in the specific example and is of a diameter so selected as to result in a desired extent of filling of the inner cylinder **31** by a cable of given diameter and desired length. The free end of the core **33** is open.

The first coil spring **16** constitutes means for moving the piston **15** from its second position **15A** toward the cylinder closed end **23** for forcing water through the outlet **19** into the hollow, interconnected members of the framework **11** to distend the same and erect the array. The first coil spring **16**, which is mounted in the outer cylinder **21**, has an end which engages the first fixed stop **27** and a second, free end which extends toward the cylinder closed end and is movable axially of the cylinder **21** to a given position in which, as shown, it is compressed to store the energy required for forcing water from the cylinder **21** into the framework **11** for distension of the latter. To provide a bearing surface for latch means described below, a flat ring or washer **34** of the same general diameter as the spring **16** is provided under the free, lower end of the latter. The first coil spring **16** must be long and strong enough to force the piston **15** through the range of travel required for adequate filling of the hollow members making up the framework **11** and to effect this motion against resistance of the second spring **17** (to be described).

The latch means **20** for releasably holding the first spring **16** in the given position in which it is compressed for storing energy preferably is in form of a leaf spring having a base portion **36** (FIGURE 4) welded or otherwise attached to the exterior of the cylinder **21**. An opening **37** is provided in the wall of the cylinder **21** adjacent the leaf spring free end **38**. With the first spring **16** compressed, the leaf spring free end **38** is deflected under the washer **34**, in which position it prevents the washer being forced toward the cylinder closed end. The leaf spring free end **38** is thus a movable element which is placed in a first position, shown in solid line, for locking the first coil spring **16** in its compressed condition. When moved out of engagement with the washer **34**, the free end **38** springs to its second position, shown in broken lines at **38A**, thus releasing the spring **16** and allowing expansion of the latter toward the cylinder closed end. As many leaf springs **38** and associated cylinder wall openings **37** are employed as are required for adequately strong latching of the first coil spring **16**.

The second coil spring **17** (FIGURES 2, 3) functions as a means for moving the piston **31** away from the cylinder closed end **23** to draw water into the cylinder **21** through the inlet **18** at the desired working depth. The second coil spring **17** is mounted between the piston **15** and the cylinder closed end **23** and is compressed against the cylinder closed end **23** when the piston **15** is in its first position, the piston thus being, as shown, in the region of the cylinder closed end **23**. The second coil spring **17**, compressed between a pair of bodies (i.e., the piston **15** and cylinder closed end **23**), urges an increase of the interval separating these bodies and is of sufficient length and strength, when released, to be capable of such expansion as to force the piston **16** from its first position to its second position **15A**. In order that it may be overcome by the first coil spring **16** upon release of the latter, the second coil spring **17** is weaker than and compressible by the first coil spring **16**.

A preferred form **39** of the means releasably holding the piston **15** in its first position, in which position the piston is spaced from the first spring latch **20**, will now be described. This means **39**, actuatable for effecting release of the piston **15** from its first position, comprises a rigid body **40** (FIGURES 5, 6) with a cavity **41** closed by a diaphragm **42**, a frangible member **43**, means **44** connecting the frangible member **43** with the diaphragm **42**, and means connecting the frangible body **43** to either the piston **15** or cylinder closed end **23**, the rigid body **40** being connected to the other.

The rigid body **40** is provided with means (i.e., a stud **71**) for attaching it to, for example, the piston **15** as in FIGURE 3. The rigid body **40** of course could be made integrally with the piston **15**. The body **40** is provided with a rigid framework whose members **45** (FIGURE 5) are welded or otherwise attached to the rigid body **40**; extending outwardly from the diaphragm **42**, the framework members **45** at their lower ends support a plate with an opening forming an eyelet **22**.

The diaphragm **42** faces the cylinder closed end **23**, and as seen in FIGURE 6, means such as a ring **46** and fasteners **47** mount the diaphragm on the rigid body **40** in such position as to close and hermetically seal the opening of the cavity **41**. The pressure in the sealed cavity **41** preferably is atmospheric.

The frangible member **43** preferably is a ceramic rod disposed between the diaphragm **42** and cylinder closed end **23**; where the rigid framework **45** is employed, the rod is between the diaphragm **42** and outer end of the one or more framework members **45**.

The means **44** for connecting the rod **43** with the diaphragm **42** includes, in the example, a pair of wires **48** which connect two axially spaced locations on the rod **43** (e.g., the rod ends) with a triangular plate **49** which in turn is connected to the diaphragm, preferably at the center of the latter, by a wire **50**. A central wire **51** is connected to the center of the rod **43** and to the cylinder closed end **23**, the wire **51** extending through the eyelet **22** in the end of the frame members **45**. In fabricating the holding device **39**, the wire **51** is pulled taut through the eyelet **22** in the end of the frame **45**. With the wire **51** held taut by the swaged bead **52**, therefore, the wire **51** is also a means for connecting the rod **43** with the end of the one or more rigid frame members **45**. The strength and diameter of the rod **43** are chosen so as to obtain breaking of the rod at a desired, predetermined level of fluid pressure exerted on the diaphragm **42** externally of the rigid body **40**. Calibration of the rod **43** in this regard is facilitated by forming a peripheral groove, to appropriate depth, in the rod **43** at the location of the central wire **51**.

The manner in which the wire **51** is connected to the cylinder closed end **23** is best seen in FIGURES 3 and 7. A rod **53** is slidably mounted in an appropriate opening through the cylinder closed end **23** and is spring-loaded to a position of maximum extension downwardly below the cylinder closed end **23**, in which position a ring **54** mounted on the rod is moved downwardly onto cylinder closed end **23** to close off the hole in which the rod **53** is mounted. The upper end of the rod **53** forms a flat tongue which engages a clevis **55** provided on the lower end of

wire 51, the tongue and clevis being joined by a self-locking pin 57. With the pin 57 inserted, the rod 53 stands at its full limit of upward travel.

It thus will be evident that, regarding the cylinder closed end 23 and piston 15 as first and second relatively movable bodies which are urged to wider separation by the second spring 17, the holding device 39 (FIGURE 3) is connected between these first and second bodies, and may as well be turned one way between them as the other. To provide a specific example, an orientation has been shown wherein connection of the diaphragm 42 is to the cylinder closed end 23, while the rigid body 40 is connected to the piston 15.

The cable 58 (FIGURES 1–3) is of the type containing as many electrical conductors as are needed for the transducers 10 and also preferably contains one or more strands of steel provided for contributing strength. Of sufficient length to reach from the surface to the desired working depth of the array in a body of water, the cable is coiled in the inner cylinder 31. Its upper end is free and may be pulled out of the cylinder 31 to withdraw the cable as the device sinks into the water, the free end being attached to, for example, a surface floatation buoy. Near its other, lower end, the cable 58 is rigidly attached, as at 59 (FIGURES 2, 3) to the inner cylinder 31, and from this point it extends, by any convenient and desired routing, to the array framework 11; preferably routed through the hollow members of the framework 11 to the transducers 10, its entry into the framework 11 must be watertight. Enough slack is provided as at 60 (FIGURE 2) in the cable 58 between its fixed attachment 59 to the inner cylinder 31 and its entry into the array framework 11 to allow for motion of the piston 15 without placing any pull on the framework 11. Electrical connection, of course, is provided between the transducers 10 and the electrical conductors of the cable 58.

The hollow members of framework 11 together form a distensible body whose interior communicates with the interior of the cylinder 21 through the outlet 19 (FIGURE 3). Interconnected and initially collapsed, the hollow members are made of a flexible, substantially nonstretchable, tubular plastic material and upon being filled with fluid under pressure are distended to form a framework of predetermined configuration. One of the hollow members 61 (FIGURES 1, 3) serves as a means connecting the distensible body interior to the interior of the cylinder 21 through the outlet 19. The transducers 10 are so positioned on the hollow members as to form an array of desired configuration when the framework 11 is distended.

Entry of the cable 58 into the framework 11 is preferably at the framework upper tube 61.

The collapsed framework 11 made up by the hollow members is enclosed in a preferably dome-shaped housing 62 (FIGURE 3) which is releasably attached on the exterior of the cylinder closed end 23.

For releasing the framework 11 from the housing 62 at a desired depth, means are provided for releasing the housing 62 from the cylinder closed end 23, thus allowing the housing 62 to drop away. Any means is satisfactory which will result in the framework 11 becoming free for distension upon release, to be described, of the piston 15. The housing 62, for example, may be lightly attached to the cylinder closed end 23 and forced away from the latter by forces imparted by expansion of the framework 11.

In the preferred embodiment, however, the housing 62 is attached to the cylinder closed end 23 by a pair of oppositely extending latch rods 63, 64 (FIGURES 3, 7) slidably mounted in openings through suitable lugs on the lower face of the cylinder closed end 23 and having respective outer ends engaging oppositely located holes in the rim of the housing 62. A pair of bell cranks 65, 66 are pivotally mounted as at 69, 70 on suitable supports footed on the cylinder closed end 23 on each side of the spring-loaded rod 53. An end of each bell crank 65, 66 is connected to the inboard end of a respective latch rod 63 or 64. The remaining connection points on the two bell cranks 65, 66 have connection with the rod 53. With the spring-loaded rod 53 pulled to its uppermost position (as shown), the ends of the rods 63, 64 engage the rim of the housing 62 to hold the latter on the cylinder closed end 23. Release of the spring-loaded rod 53 allows its movement, by spring action, to its lowermost position, thus rotating the bell cranks 65, 66 and pulling the rods 63, 64 out of engagement with the rim of the housing 62. Thus released, the housing 62 drops away.

The device sinks quickly. All its interior fills with water through the check valve 24, the open ends of the inner cylinder 31 and core 33, and vents 29 in the outer cylinder. A vent hole 67 and the slot 68 through which the cable 58 enters the housing 62 allow the housing to fill with water. Entrapped air therefore is not present to add undesirable buoyancy to the device. The weight of the cable 58 is considerable, and as this is housed in the inner cylinder, it very significantly speeds descent of the device into the water. Occupying only a small space and completely enclosed in the housing, the framework formed by the hollow members offers no drag and hence does not impede descent. Attached to a flotation buoy or other body on the surface of the water, the end of the cable 58 is pulled out of the inner cylinder as the device is released into the water and pulls the rest of the free portion of the cable after it as the device sinks.

For erecting the structure formed by the hollow members of framework 11 and thereby placing the transducers 10 in an array of predetermined configuration, the device is submerged to a desired working depth in the water. The device then is actuated to take in water at the operating depth and pump the water into the structure 11, thus distending and effecting erection of the same. The diameter and stroke of the piston 15 are such as to provide adequate filling of the framework 11.

Since water is admitted into the bottom of the cylinder 21 through the check valve 24, water at ambient pressure surrounds the means 39 holding the piston in its first position in the region of the cylinder closed end 23. The cavity 41 (FIGURE 6) in the rigid body 40 is filled with air under atmospheric pressure; water pressure on the outer surface of the diaphragm 42 increases with the depth to which the device has sunk and hence places an increasing force on the diaphragm which tends to bend it inwardly of the cavity. As the wires 51, 48, 50 connecting the cylinder closed end 23, through the diaphragm 42 and rod 43, with the piston 15 are originally taut, and as the piston 15 is bottomed against the stop 30, the increasing pressure on the diaphragm 42 results in an increasing tension in the wires, and the outward pull exerted by the wire 50 on the diaphragm 42 prevents inward deflection of the latter. Where the swaged bead 52 is omitted, the increased tension is present in the entire length of the wire 51 extending between the frangible member 43 and cylinder closed end 23. Where the bead 52 is employed, the tension added by the diaphragm 42 with increasing depth is imposed only on the portion of the wire 51 extending from the rod 43 to the bead 52; the remaining portion is under only the tension imposed by the resilient means 17 (FIGURE 2) tending to force the piston 15 away from the cylinder closed end 23. At a given depth, the water pressure on the diaphragm 42 produces enough tension in the wires connected to the rod 43 to place a bending force on the rod which causes the latter to break into two pieces at the wire 51 attached to its center.

Upon fracture of the rod 43, the wire 51 is no longer constrained by the diaphragm 42. Impelled by the second spring 17, the piston 15 moves away from the cylinder closed end 23 and pulls the free end of the wire 51 through the eyelet 22. Upward motion of the piston 15 creates a lowered pressure in the cylinder 21 which causes water

to flow into the cylinder through the inlet port **18** past the check valve **24**, thus filling the cylinder. At the same time, breaking of the rod **43** results in release of the housing **62** as previously described.

Upon moving into its second position **15A** (i.e., upon reaching the top of its stroke), the edge of the piston **15** strikes the latch means movable elements **38** (FIGURE 4) and moves the latter diametrically outward, relative to the cylinder, into the cylinder wall openings **37**. Once free of the edge of the washer **34** below the first spring **16**, each latch means movable element **38** springs outwardly to the position **38A** shown in broken line, and the lower end of the first spring **16** is free to move downwardly.

Downward motion of the first spring **16** drives the piston **15** toward the cylinder closed end **23**, thus forcing water from the cylinder **21**. Initiation of outflow at the check valve **24** forces the latter closed, thus preventing outflow at the inlet port **18**. Pressure built up in the cylinder **21** by the descending piston **15** forces the outlet port check valve **26** (FIGURE 3) to its open position, and water enters the collapsed hollow members of the array framework **11** from the cylinder **21** under pressure exerted by the first spring **16** through the piston **15**.

Continued downward travel of the piston **15** fills and distends the hollow members of framework **11** until, as shown in FIGURE 1, the framework is expanded to form a body upon which the transducers **10** are arranged in a predetermined configuration. The volume of the cylinder **21** included in the stroke of the piston **15** may be made larger than the volume required to fill and rigidify the distensible body **11**; where this is the case, the piston **15** will be stopped by back pressure before reaching the stop **30**. The outlet port check valve **26** prevents return flow from the distensible body **11** into the cylinder **21** where for any reason the pressure in the distensible body becomes the higher.

Since the water is taken in at the ambient pressure at the desired depth at which erection of the array is to take place, no more work need be done by the first spring **16**, at great depths, than would be required if operation were just below the surface of the body of water. The device therefore is as efficient at very considerable depths as it is near the surface.

While only one embodiment of the invention has been described in detail herein and shown in the accompanying drawing, it will be evident that various modifications are possible in the arrangement and construction of its components without departing from the scope of the invention.

I claim:

1. A pump comprising:
- a wall forming a cylinder with an open end and a closed end;
- an inlet port and an outlet port in the wall in the region of the cylinder closed end;
- a check valve, movably mounted relative to the wall, permitting fluid flow into and preventing fluid flow out of the cylinder through the inlet port;
- a fixed stop in the cylinder spaced from the cylinder closed end;
- a coil spring mounted in the cylinder and having a first end engaging the stop and a second, free end extending toward the cylinder closed end, the spring free end being movable axially of the cylinder to a given position in which the spring is compressed;
- latch means releasably holding the spring in said given position and comprising an element movable for releasing the spring;
- and a piston slidably mounted in the cylinder between the spring free end and the cylinder closed end and movable to a position in which it strikes and moves the latch means element, whereby the spring is released, the piston is moved toward the cylinder closed end by expansion of the spring, and fluid is forced from the outlet port by the piston.

2. The pump recited in claim **1** and further comprising means for moving the piston to the position in which it strikes the latch means element.

3. The pump recited in claim **1** and further comprising:
- a second spring mounted between the piston and cylinder closed end and expansible for moving the piston into contact with the latch means element;
- and means releasably holding the piston in a position spaced from the latch means element.

4. The pump recited in claim **1** and further comprising a second stop fixed in relation to the cylinder and limiting travel of the piston toward the cylinder closed end.

5. In combination:
- a cylinder with a closed end and an open end;
- a fixed stop located in the cylinder and spaced from the cylinder closed end;
- a first coil spring mounted in the cylinder and having a free end extending toward the cylinder closed end and an oppositely extending end engaging the stop, the free end being movable to a given position for compressing the spring;
- a latch comprising a member movable between a first position in which it engages and holds the first spring in said given position and a second position in which the spring is released for expansion toward the cylinder closed end;
- a piston slidably mounted in the cylinder between the first spring and cylinder closed end;
- a second coil spring weaker than the first spring and mounted between the piston and cylinder closed end, the piston being movable between a first position in which it compresses the second spring against the cylinder closed end and a second position in which it has struck the latch member and moved the latter from its first to its second position, the second spring being of sufficient length and strength to move the piston from its first to its second position;
- means releasably holding the piston in its first position;
- an inlet port and an outlet port in the cylinder in the region of the cylinder closed end;
- a check valve so related to the inlet port as to permit inflow and prevent outflow therethrough;
- and a distensible body having an interior communicating with the cylinder interior through the outlet port.

6. The combination recited in claim **5** and further including:
- an inner cylinder mounted on the piston and having an open end extending away from said cylinder closed end;
- and a cable housed in the inner cylinder.

7. In combination:
- a cylinder with a closed end and an open end;
- an inlet port and an outlet port in the cylinder in the region of the cylinder closed end;
- a distensible member having an interior connected to the cylinder interior through the outlet port;
- a piston slidably mounted in the cylinder and movable between a first position in the region of the cylinder closed end and a second position more removed from the cylinder closed end;
- means holding the piston in its first position when fluid pressure ambient to the cylinder is below a given level and releasing the piston when fluid pressure ambient to the cylinder is above said given level;
- means for moving the piston from its first to its second position upon release of the piston;
- and means for moving the piston from its second position toward the cylinder closed end.

8. In combination:
- a cylinder with an open end and a closed end;

an outlet and an inlet in the region of the cylinder closed end;

means permitting inflow and preventing outflow through the inlet;

a piston slidably mounted in the cylinder;

interconnected, hollow, collapsed, flexible members distensible to form a framework of predetermined configuration;

means connecting the interior of the hollow members with the cylinder interior through the outlet;

a plurality of transducers mounted on the members and so positioned as to form an array of predetermined configuration upon distension of the members;

a cable containing a plurality of electrical conductors and withdrawably stowed in the cylinder between the piston and cylinder open end, the cable having a free end withdrawable from the cylinder and also having another end;

a fixed attachment between the cable and cylinder in the region of the cable other end, whereby withdrawal of the free end from the cylinder permits lowering of the cylinder and hollow members to a desired working depth in a body of water;

electrical connection at the cable other end between the transducers and electrical conductors;

means for moving the piston away from the cylinder free end to draw water into the cylinder through the inlet at the desired working depth;

and means for moving the piston toward the cylinder closed end to force water through the outlet into the hollow members to distend the same and erect the array of transducers.

9. The combination recited in claim **8** and further comprising a housing releasably attached to the cylinder closed end and containing the hollow members; and means for release of the housing.

10. In combination:

a housing;

a distensible body enclosed in the housing;

means for releasing the body from the housing at a predetermined depth beneath the surface of a body of water;

and means for taking water from said body of water at said predetermined depth and injecting said water into the distensible body.

11. In combination:

a distensible body;

transducers mounted in a given arrangement on the distensible body;

submersible means actuatable for distension of the body;

and pressure-sensitive means responsive to a predetermined fluid pressure exteriorly of said means for distension of said body for actuation of the latter means.

12. For erecting a structure having interconnected, hollow, collapsed, flexible members distensible to form a framework of predetermined configuration and having transducers mounted in predetermined locations on said framework, the method comprising:

submerging the structure to a desired operating depth in a body of water;

and pumping water from the body of water at the operating depth into the hollow members at a pressure sufficient to distend the structure.

13. In an arrangement comprising resilient means, first and second relatively movable bodies at least one of which is connected to the resilient means and which are locatable in a given position relative to each other in which they are spaced by a given interval and urged by the resilient means to move in a direction increasing said interval, in combination with said first and second bodies, a device for holding said bodies in said given position against urging of the resilient means, said device comprising:

a third body which is a diaphragm and disposed between the first and second bodies;

a frangible rod disposed between the first and third bodies;

means connecting two axially spaced locations on the rod with one of said first and third bodies;

means connecting a location on the rod intermediate said axially spaced locations with the other of said first and third bodies;

a rigid body connected to the second body between the first and second bodies and having a cavity with an opening;

and means mounting the third body on the rigid body in a position in which it faces the first body and hermetically seals the cavity opening.

14. A holding device sensitive and responsive to ambient fluid pressures, said device comprising:

a rigid body with a cavity having an opening;

a diaphragm;

means mounting the diaphragm on the body in a position wherein it hermetically seals the opening;

at least one rigid member rigidly attached to the body, the member having an end outwardly spaced from the body;

a frangible member disposed outwardly of the body intermediate the body and the rigid end;

means connecting the frangible member with the rigid member end;

and means connecting the frangible member with the diaphragm,

whereby increase of fluid pressure exteriorly of the rigid body imposes a force tending to force the diaphragm inwardly of the cavity and places a load on the frangible member resulting in breakage of the latter when fluid pressure has risen to a given level.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,444,511 May 13, 1969

James A. Morrow

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 66, "conncted" should read -- connected --.
Column 3, line 73, "31" should read -- 15 --.

Signed and sealed this 17th day of March 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents