UNDERWATER TRANSPONDER ASSEMBLY INCLUDING FLOTATION UNIT

Filed July 30, 1965

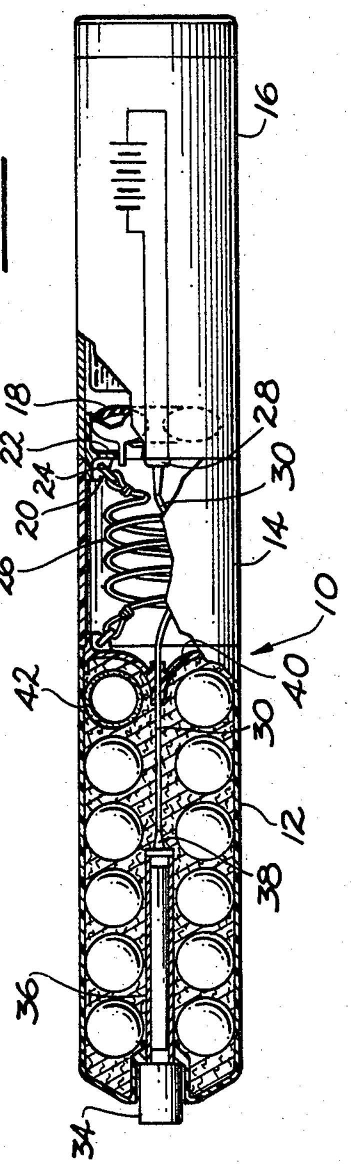


FIG. 1

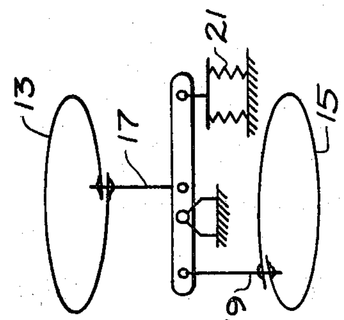


FIG. 3

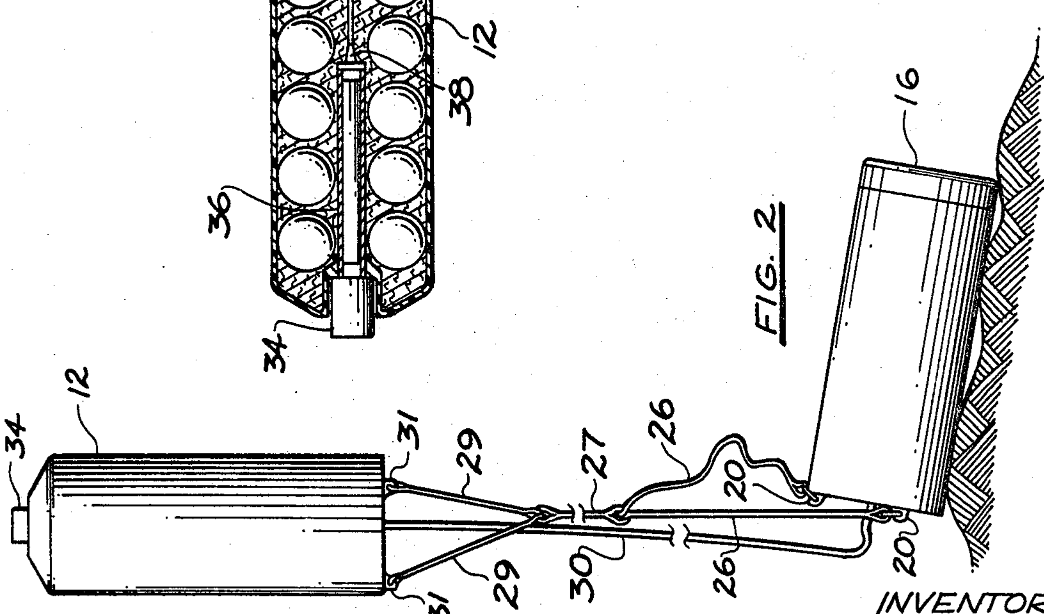


FIG. 2

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3,384,867

Patented May 21, 1968

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3,384,867

# UNDERWATER TRANSPONDER ASSEMBLY INCLUDING FLOTATION UNIT

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Filed July 30, 1965, Ser. No. 476,086
4 Claims. (Cl. 340—2)

## ABSTRACT OF THE DISCLOSURE

An underwater transponder assembly including a cylindrical anchor housing containing a battery; a transducer and electrical means connected to the transducer; a cylindrical lightweight housing providing a free-flooding flotation assembly for supporting the transducer essentially vertically in the water, the flotation being supplied essentially by hollow glass spheres arranged in tiers in the assembly; electrical and tethering cables connecting the anchor housing to the flotation assembly; a third cylindrical housing containing the electrical and tethering cables connected between the anchor assembly and the flotation housing to maintain the entire transponder assembly in the form of a single cylindrical unit, and a pressure-responsive release for separating the third housing from the other housings after launching.

This invention relates to buoys and more particularly to an underwater buoy for vertical looking transducers mounted on the ocean floor.

Recent developments in navigational equipment for ships have included locating a number of underwater transmitters, called transponders, at known locations on the ocean floor. These transponders, which contain their own power sources, may be interrogated by means of sonar equipment on a ship. When the underwater transponder receives an acoustic signal of the proper frequency, it responds with a sonar signal of unique frequency. The shipboard receiving equipment then receives this signal along with those from other underwater transponders and, by means of triangulation techniques, computes the location of the ship in relation to the known location of the underwater transponders.

The matter of designing such transponders and placing them into service involves some significant problems. Since the transponders may be located at great depths, the provision of structure and seals which will withstand extreme pressures over long periods of time has been a problem. The transducer head itself must always be oriented to look upwardly, and therefore flotation means is required to assure the proper attitude. Yet the location on the ocean floor must be preserved, and this obviously requires a heavy anchoring means. Some of the earlier designs met this requirement by attaching the transponder, which includes a transducer head and an electronic package, to a tightly sealed tank of kerosene or other liquid which is lighter than sea water. Such a tank resists great pressures successfully because of the relative incompressibility of the contained liquid. This structure is connected by cabling means to a large and very heavy anchor structure containing the batteries for powering the electronic equipment. Launching such equipment at sea has proved to be hazardous, however, both to the personnel working with it and to the equipment itself. The housing containing the batteries is very heavy since it must anchor the entire assembly to the ocean floor despite the flotation afforded by the kerosene-filled tank and the possible existence of cross currents. The kerosene-filled tank is, itself, very heavy in air, and the handling of two such heavy containers linked together by means of cabling is obviously inconvenient. It is, therefore, an object of the present invention to provide a transponder design which is inherently much safer and more convenient to store and to launch than those presently in use.

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It is another object of the present invention to provide a flotation structure for the transducer head and electronic package which has greater buoyancy in relation to its projected area than those now in use, so that cross-current effects are minimized.

It is another object of the present invention to provide a flotation structure for the transducer head and electronic package in which some of the more serious sealing problems are eliminated or minimized.

It is a further object of the present invention to provide a flotation package meeting the above objectives having substantially greater resistance to corrosion from sea water than do flotation units presently in use and, therefore, greater reliability.

It is a still further object of the present invention to provide a flotation package meeting the above objectives in which the amount of buoyancy may be easily varied as required by varying conditions.

Other objects and advantages will become apparent from consideration of the following specification taken in connection with the accompanying drawings, in which:

FIGURE 1 is a plan view, partly in section, of a complete transponder assembly as pacakged prior to launch.

FIGURE 2 is a view of the transponder assembly in operating position on the floor of the ocean.

FIGURE 3 is a schematic diagram of a pressure-sensitive arrangement for releasing part of said assembly at a desired depth.

Referring now to FIGURE 1, the transponder assembly is generally shown at numeral **10** and consists of a first housing element **12** which may be of glass resin and which contains the flotation members; a second housing **14**, which may also be of glass resin and which contains the cabling interconnecting housing **12** and a third housing **16** which may be of a corrosion-resistant alloy or galvanized steel and which contains battery cells, cushioining material such as a plastic foam and transformer oil. Also contained in housing **16** is a pressure-compensation bladder **18** which may be made of synthetic rubber and which operates in a manner to be described for equalizing pressures on opposite sides of the housing **16**. Housing **16** also contains a plurality of anchoring loops **20** which are shown as molded into the end section **22** and through which are formed links **24** anchoring the end loops of the cable sections **26**. Also attached to end plate **22** and effectively sealed therethrough by means of a sealing construction **28** is an electrical conductor **30** which supplies power from the battery pack in housing **16** to the transducer assembly.

Housing **12**, which is generally cylindrical in shape, also includes at the outboard end a cylindrical interior portion which receives a transducer head **34** which is sealed to a small diameter cylindrical housing member **36** which contains the electronic circuitry for driving the transducer **34**. The battery cable **30** is connected to the housing **36** by means of a sealing connector **38**. At the inboard end of housing **12** is an internal supporting structure **40** which also includes a center passage for supporting cable **30**. The required flotation is actually supplied by a plurality of glas spheres **42** which are clustered in tiers of four around the centrally mounted electronic housing **36**. These glass spheres are retained in position in tiers by means of open cellular polyurethane foam to provide an interlocking action as well as shock insulation. Alternatively, the packing material between these spheres might be rubberized hair. With the arrangement shown, additional buoyancy may be added simply by adding extra tiers to the assembly, within the limits imposed by the length of housing **12**, of course. Since the housing **12** is free-flooding, it is not necessary for the glass resin wall to withstand a substantial pressure differential. The glass spheres are of comparatively light weight, have the capability of resisting extremely high external pressures, are corrosion-resistant and simple in construction. These spheres provide substantially all of the required buoyancy, and the function of the housing and packing materials is primarily to retain the vertical orientation of the transducer head and the mechanical configuration of the flotation package.

The center housing **14**, which is removable, may also be formed of fiberglass resin and is also free-flooding. Its primary function is to retain the mechanical orientation of housings **12** and **16** during storage and launch and to prevent tangling of the tethering cables. Any of several well known means may be employed for removing housing **14** subsequent to launch. Typically, housing **14** may be formed of two interlocking half cylinders of material which are held together by means of a pair of flexible rings **13** and **15** held closed by release pins **17** and **19**, which are released at a desired depth by a pressure-sensitive release device **21** (FIG. 3). Such devices are well known in the art, having been used on sonobuoys for anti-submarine warfare since before 1950, and need not be discussed at length herein. There is an advantage in having the release pressure on such devices adjustable to some significant depth below the surface of the water, since a premature release of housing **14** would not be desirable.

FIGURE 2 shows the transponder assembly in operative condition on the ocean floor. Housing **16**, which contains the batteries and which is very heavy, lies on its side on the ocean floor, thereby serving as an anchor. It will be observed that there are three mounting lugs **20** attached to the inboard end of housing **16**, and to these mounting lugs are attached a tether consisting of three cables **26**. The mounting lugs **20** would normally be located at 120° apart around the periphery of the housing **16**, and only two have been shown in FIGURE 2 since one would normally tend to be directly behind the one shown in extended condition. The cable members **26** are shown attached to a loop forming one of the ends of a cable **27**, which may be of any desired length and which has a similar loop at its opposite end for receiving the loop ends of three cables **29** (of which only two are shown) attached to mounting lugs **31** formed on the inboard end of housing **12**. The electrical connecting cable **30** is shown extending between the housings **12** and **16**, and it must be of sufficient length that none of the buoyant force exerted by the flotation unit **12** is exerted against it.

Prior to launch, the transponder assembly is shown in the configuration of FIGURE 1. Since it consists essentially in one elongated cylindrical piece, it is relatively fairly straightforward to handle. After launch, the assembly will sink in the water with the housing **16** normally seeking the lower position because of its weight. When the pressure of the sea water reaches a value sufficient to actuate pressure-responsive member **21** and release the intermediate housing **14**, this member opens up and drops away from the assembly, thereby permitting the cabling structure **26**, **27**, **29** to be extended. When the housing **16** reaches the bottom of the body of water, it normally will lie on its side as shown in FIGURE 2, and the housing **12** will continue to remain in a vertical or substantially vertical position, as shown. It is highly desirable that the transponder head **34** remain oriented such that it faces straight upwardly, or substantially so. The existence of underwater cross-currents will tend to cause the flotation member **12** to assume a position somewhat displaced from a true vertical, and this tendency is counteracted in part by keeping the projected area of the buoy assembly as small as possible when viewed from the side. Here again, the flexibility of this



arrangement which permits the adding of additional spheres in layers or tiers affords a way of increasing the relative vertical component with respect to the horizontal component of force applied to the housing **12**. As previously indicated, after a launch the surrounding water immediately floods the chambers within housings **12** and **14**, and the pressure is therefore equalized on each side of the walls of these chambers. With respect to chamber **16**, however, the structure is made to withstand the external pressure applied by the sea water, even at extreme depths. The bladder **18** is so arranged that the sea water may flow into its interior, and as the housing **16** seeks greater and greater depths, the pressure exerted on the inside of bladder **18** correspondingly increases. This pressure is exerted against that of the transformer oil on the inside of housing **16**, and by this means the fluid pressure acting on opposite sides of the walls of housing **16** is substantially equalized.

While only a single embodiment is shown and described herein, it is recognized that numerous modifications may be made within the scope of the present invention. While the transponder structure is generally shown as an elongated cylinder, and this is a very convenient configuration, many others are possible since the principal requirement is that the flotation member be capable of supporting the transducer in an essentially upward facing direction and that the battery structure be capable of serving as a sufficiently adequate anchor such that the transponder will retain its position on the ocean floor. It will also be apparent that any of many tethering arrangements are possible, the one shown being chosen because it is simple, adequate and appropriate to the specific configuration of transponder assembly. Other modifications will occur to those skilled in the art.

I claim:

1. An underwater transponder assembly comprising a first housing of corrosion-resistant metal containing a battery, transformer oil and a flexible bladder having its outer surface in communication with said oil;
   - a second housing of lightweight material including an electrical assembly with an underwater transducer, a plurality of glass spheres arranged in tiers and separated from each other by packing material, said spheres serving to cause said second housing to exert a substantial buoyant force such that said underwater transducer is supported in said water;
   - an electrical cable connecting said electrical assembly with said first housing;
   - flexible teethering means connecting said first housing to said second housing; and
   - a third housing fastened to said first housing and said second housing and positioned therebetween and enclosing said electrical cable and said tethering means, said third housing including means for separating itself from said first and second housings subsequent to launching of said transponder assembly into the water.

2. An underwater transponder assembly comprising a first housing containing at least a battery and pressure compensation means for substantially equalizing the pressure on opposite sides of said housing,
   - a flotation structure and tethering means for attaching said flotation structure to said first housing,
   - a second housing including an electronic assembly connected to said first housing and a transducer attached to said second housing and connected to said assembly, said second housing being fastened to said flotation structure;
   - characterized in that said flotation structure includes a free-flooding housing of lightweight material, a chamber formed in said free-flooding housing for receiving said second housing such that said transducer is maintained in an upward-facing attitude, a plurality of glass spheres arranged in said free-flooding housing,

and packing material for maintaining said spheres in position;

and a third housing is provided including fastening means for fastening said third housing to said first housing and to said flotation structure to form a unitary assembly containing said tethering means, and pressure-responsive means for releasing said fastening means at a desired depth.

**3.** For use with an underwater transponder assembly including a transducer electrical means connected to said transducer, a container for said electrical means to which said transducer is attached and an anchor structure containing a battery connected to said electrical means:

a flotation structure for supporting said transducer in a desired attitude comprising an elongated cylindrical free-flooding housing of light weight, corrosion-resistant material including a centrally located aperture for receiving said container, a plurality of sealed, thin-walled hollow glass spheres in said housing, each of said spheres being of such diameter as to constitute a sizable proportion of the diameter of said housing and at least some of said spheres being arranged to surround said centrally located aperture, a packing including a plurality of tiers of open cellular plastic foam material for receiving said spheres and for protecting said spheres from shock;

and means for tethering said flotation structure to said anchor structure.

**4.** In an underwater transponder assembly comprising an anchor structure including a housing with a battery located in said housing, an underwater transducer and



electronic circuit means including a second housing connected to said transducer, a flotation structure fastened to said second housing for maintaining a desired orientation of said transducer, means for mechanically tethering said flotation structure to said anchor structure, and electrical cable means connected between said battery and said electronic means;

the improvements that said flotation structure includes a free-flooding housing of lightweight material, a plurality of glass spheres in said free-flooding housing, and packing material for holding said spheres in position;

that a third housing is provided for fastening said anchor structure and said flotation structure to itself to form a unitary assembly, said third housing containing said tethering means and said cable means;

and that said assembly includes pressure-responsive means for releasing said third housing from said anchor structure and said flotation structure.


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