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2,758,203

SONOBUOY

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FIG. 1.

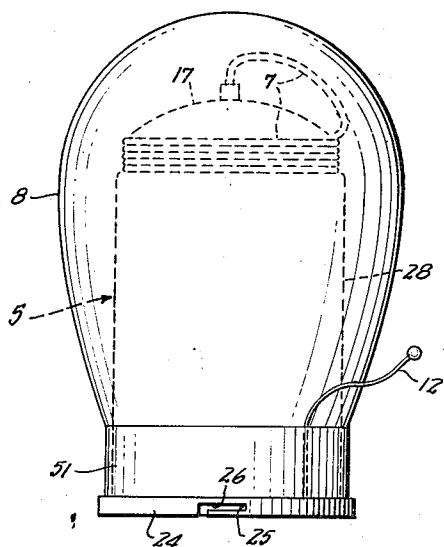


FIG. 2.

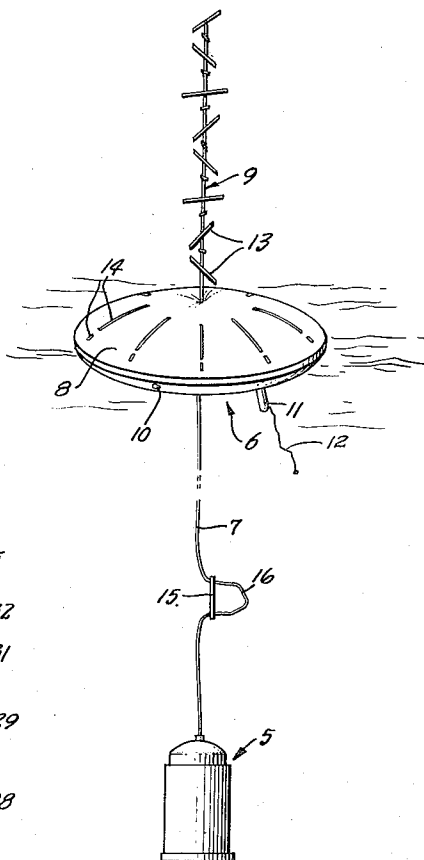
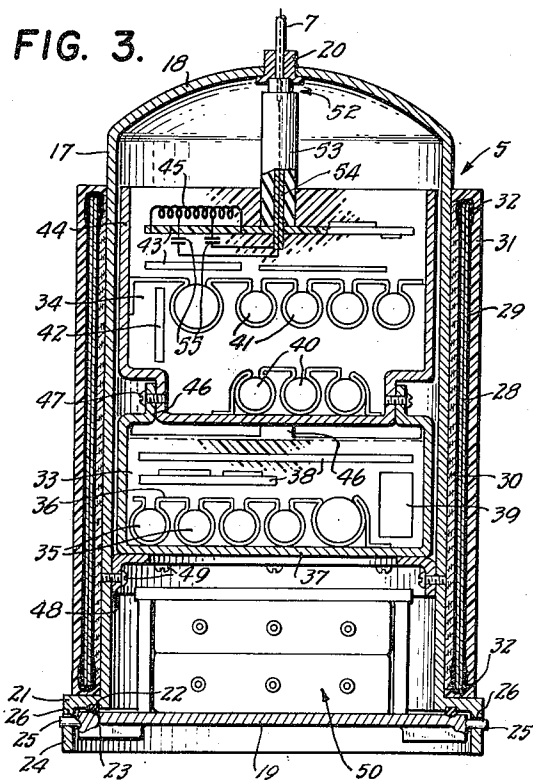


FIG. 3.



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SONOBUOY

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16 Claims. (Cl. 250—17)

My invention relates to electro-acoustic devices and, in particular, to such devices as applied to radio sonobuoys.

It is an object of the invention to provide an improved electro-acoustic transducer construction of the character indicated.

It is another object to provide an improved radio-sonobuoy configuration.

It is a further object to provide means whereby superior electrical performance may be obtained in a radio sonobuoy.

It is a general object to meet the above objects with a construction which offers advantages in compactness, simplicity, performance, and ruggedness over prior constructions.

Other objects and various further features of novelty and invention will be pointed out or will occur to those skilled in the art from a reading of the following specification, in conjunction with the accompanying drawings. In said drawings, which show, for illustrative purposes only, a preferred form of the invention;

Fig. 1 is a simplified view in elevation of an assembled radio sonobuoy incorporating features of the invention, and shown packaged, ready for launching;

Fig. 2 is a view of the device of Fig. 1, after launching, and as it appears when in use; and

Fig. 3 is an enlarged vertical sectional view of the transducer unit of the buoy of Fig. 1, certain electronic parts being shown in abbreviated form and schematically.

Briefly stated, my invention contemplates an improved transducer construction, particularly adaptable for use in a novel radio-sonobuoy configuration. The transducer may be formed as a single unitary package with the electronic components such as amplifier means, and including a radio transmitter; and these electronic components may be suspended with the transducer by a free cable attached to a float-mounted antenna. By having all electronic components mounted with the transducer and well beneath the water surface, one is able to obtain optimum performance from the transducer and relative immunity to surface noise. Further insulation against noise may be obtained by means of novel shock-absorber means incorporated in the cable suspension. If desired, half-wavelength reflectors may be carried by the float, or by the antenna, or both, to facilitate radar location of the buoy.

Referring to the drawings, my invention is shown in application to a radio sonobuoy comprising essentially a transducer assembly 5 and a float-antenna assembly 6, connected to each other by flexible means such as an insulated cable 7. The antenna-float assembly may comprise an inflatable gas bag 8, preferably of thin, circular waferlike proportions as shown, so as to provide maximum stability for erection of antenna means 9. Bag 8 may be of Nylon or other suitable plastic or rubber construction, and may include a soluble plug 10 on the underside so as to permit sinking a predetermined time after launching. A gas bottle 11, carrying pressurized

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gas, such as carbon dioxide, may also be affixed to the underside of the bag 8 and is preferably connected for actuation by rip-cord means 12, as suggested in Fig. 2 and as will be made more clear. Safety-valve means (not shown) may assure limiting inflation to a preselected pressure.

The antenna means 9 may be of silver-plated, spring-wire construction, so as to permit coiling around the transducer assembly 5 when stowed, ready for use. In order to permit the antenna means to serve the additional function of providing a radar beacon, I have illustrated a plurality of half-wavelength reflectors 13 secured in spaced relation along the length of the antenna. The reflectors 13 may be of alternate lengths appropriate to each of a plurality of radar bands and may be in angularly indexed orientation about the axis of the antenna, so as to provide good reflection no matter what the radar aspect. If desired, further radar reflectors may be carried by, or formed as a part of the float bag 8, and I have shown a plurality of radially extending reflecting strips 14, which may be flexible ribbons of conducting material bonded to insulating portions of the top surface of the float 8.

As indicated generally above, I have substantially reduced the noise to which my buoy is subjected by employment of a novel shock-absorbing means in the transducer-suspension cable 7. Such means may simply comprise resilient means such as a strip of rubber or rubber-like material 15, resiliently connecting two spaced points along the cable means 7. Such connection will necessarily define a stress-free loop 16 in the cable 7, so that upon undulation of the float 8 the relatively heavy and deeply submerged transducer unit 5 may tend to stay at the same undisturbed depth.

Referring to Fig. 3, my transducer unit 5 is seen to comprise a container 17 which may be generally cylindrical and with an integrally formed closure 18 at one end, and with a removable closure 19 at the other end. The integral closure 18 is preferably that from which the device is suspended, and the cable 7 means may, therefore, enter through a central bushing 20 carried by closure 18. The other end of the container 17 may be formed with an outwardly extending circumferential flange 21, to which the closure 19 may be removably secured. In the form shown, the flange 21 is grooved, as at 22, to accommodate a circular seal ring or gasket 23, against which the closure 19 is squeezed when the container 17 is closed. The flange 21 may include an axially extending portion 24, within which the closure member 19 may be received, and I have illustrated the attachment of the closure member 19 by bayonet means including pins 25 carried by member 19 and engaged in bayonet slots 26 in the flange extension 24.

The transducer itself may be of cylindrical configuration, employing an elongated radially stricture cylinder with means electrically responsive to radial deformation thereof. In the form shown, the transducer comprises a cylinder 28 of magneto-strictive material, such as that known to the trade as Permendur, and the electrically responsive means may include a toroidal winding of an insulated conductor 29. Omni-directional external response may be assured by application of a layer 30 of pressure-release material around the container 17 and within the transducer means 28—29. The transducer may be made integral with the container 17, as by vacuum casting a potting of sound-transmitting material 31 completely around the transducer and adjacent parts of the container 17. I prefer that the cast dimensions of the transducer proper, that is, including the protective layer 13, shall not exceed the radial dimensions of the flange 21, thus assuring mechanical protection against handling abuse prior to launching, as well as pro-

tection against damage to the transducer should the transducer unit 5 strike solid matter upon water entry.

By way of illustration, highly satisfactory results may be obtained by employing a transducer wall 23 consisting of two 0.010-inch thicknesses of Type Z-V Permen-dur, which may be spirally wound or concentrically fitted. The cylinder may have dimensions of about 4.5 inches diameter by six inches long. The pressure-re-release layer 30 may be a $\frac{1}{16}$ -inch thickness of Corprene, and the container 17 may be of drawn aluminum.

To fabricate the transducer, the laminations are first given a thin, hard plastic coat. In the concentric-cylinder arrangement, only one cylinder need be given such a coating; it may then be fitted inside the other cylinder, and edge insulators 32 may be applied. The transducer is then wound and assembled over the Corprene before vacuum-casting with the plastic. Vacuum casting may be accomplished with a bell jar, and a removable vinyl sleeve (not shown) may be used to confine the liquid plastic in place. Alternatively, a permanent rubber sleeve may be used, or a permanent thin aluminum outer wall may be employed, as long as its stiffness does not impair acoustic response.

Also in accordance with the invention, I provide for the containment of electronic circuitry within the transducer unit 5. Such circuitry may, broadly speaking, be termed amplifying means, all of which may be potted into a single unitary structure for reception and mounting in the container 17 in a simple operation. In the form shown, however, I have provided two such assemblies 33—34. The unit 33 may contain pre-amplifier components, including a plurality of sub-miniature amplifying stages 35, all carried by a single mounting member 36. Member 26 is shown to include separate spring loops for reception of each of the successive amplifying stages 35, and if the clip 36 is of conductive material, it may serve as a means of heat dissipation so as to assure better performance. The clip 36 is shown secured to the bottom of a mounting cup 37, and the remainder of the pre-amplifier may comprise a plurality of printed circuits 38 and other components, as at 39, all potted within the cup 37. (It will be understood that, in the drawing, cross-hatching for the potting material is only fragmentary, for purposes of more clearly suggesting the contents of cup 37.)

The other potted electronic assembly may be of similar construction, but containing radio-transmitter components as, for example, a cluster of local-oscillator amplifying devices 40, and a cluster of radio-frequency amplifier devices 41. Again, printed-circuit components 42—43 may be mounted within the cup 44, in which they are potted, and even the output coil 45 may be potted in the assembly 34. Coupling to the cable 7 may be accomplished by plug-in fittings 52 carried, respectively, by the bushing 20 and by a resilient pedestal 53 projecting out of assembly 34. A shielded cable 54 within pedestal 53 may connect fittings 52 to output coil 45, as through capacitances 55, and the shield of cable 54 may be grounded to container 17 through bushing 20, as will be understood.

To facilitate assembly of the two units 33—34, which may be electrically connected to each other by plug-in fittings (not shown), I have shown the lower cup 37 formed with angularly spaced projections 46 engaging a recessed part of the upper cup 44, so that the two cups may be secured together, as by screws 47. The lower cup 37 may be secured to the container 17 by means of a down-turned flange 48 carried by the cup 47 and offering structure to which securing bolts 49 may be applied.

The power supply for the buoy may comprise a battery pack 50 which is shown carried by the closure member 19, so that batteries may be replaced readily without disturbing the electronic assembly. Connections from the transducer to the amplifying means are not shown,

but it will be understood that they may pass through an opening in the wall of container 17 for readily accessible attachment to leads (also not shown) to the pre-amplifier; battery leads (not shown) will be understood to pass to the pre-amplifier in a similar manner.

When stowed in readiness for use, my radio sonobuoy has the appearance shown in Fig. 1. The bag 8 is not inflated, but is collapsed and folded over the permanently closed end of the container 17. The cable 7 may be wrapped around that part of the container 17 which projects beyond the transducer means 23, as suggested by circumferential coils in dotted lines in Fig. 1. The antenna means 9 may also be circumferentially wrapped around the transducer unit, and the free ends of the bag 8 may be secured to the transducer unit by frangible means, such as a circumferential wrap of tape 51 near the base of the assembly. Rip-cord means 12 may be sealed by the tape 51, so that the tape is broken when the cord 12 is pulled.

In air-launching applications, the only operation necessary is to pull the rip-cord 12. This frees the bag 8 for inflation and may actuate the gas bottle 11 so as to commence inflation. Inflation may proceed while the device is falling, and the more the bag 8 becomes inflated, the greater the aero-dynamic drag it offers. By the time the buoy is ready to hit the water, the cable 7 is fully extended and the transducer unit 5 properly oriented for water entry. The antenna means 9 will have been erected through the inherent resiliency of the spring-wire construction. The power supply for the electronic components may be turned on, either manually prior to launching, or by means of a switch (not shown) controlled by the rip-cord 12, or by a water-actuated switch (also not shown). The shock-absorbing means 15 will protect the assembly for the initial impact which occurs when the float becomes water-borne, as well as for transient impacts due to wave motion.

It will be appreciated that I have described improved transducer and sonobuoy constructions characterized by simplicity of components and of use, while at the same time offering superior performance. While I have described my buoy particularly in application to aircraft launching, it will be appreciated that the same basic structure has useful application to surface launching or to sub-surface launching; in the latter cases, particularly in a submarine launching, activation by means of the rip-cord 12 may not be desirable, but satisfactory operation may be commenced by employing soluble elements, such as a soluble tape 51, to release bag 8 for automatic inflation. In certain cases, the transducer 28 may be used solely as a hydrophone, but in other applications it may serve equally well as a projector, in which case the components within the chassis 34 may be radio-receiving components, and the components 33 may amplify the received signals for driving the transducer 28 as an underwater-sound projector.

Although I have described my invention in detail for the preferred form shown, it will be understood that modifications may be made without departing from the scope of the invention as defined in the claims which follow.

I claim:

1. A radio sonobuoy, comprising a float, antenna means carried by said float, and an integral unit-handling transducer and transmitter connected to said antenna means by an elongated cable, said unit-handling transducer and transmitter being negatively buoyant in water, whereby microphonics and wave-slap noise may be minimized.
2. A radio sonobuoy according to claim 1, in which said cable includes a loop, and means resiliently connecting two spaced parts of said loop.
3. In a radio sonobuoy, an inflatable flexible bag, antenna means carried by said bag, an elongated cable connected to said antenna means, and a transducer unit connected to said cable, said transducer unit comprising a unit-handling assembly of an electro-acoustic transducer

and amplifying means for said transducer, and said transducer unit being negatively buoyant, whereby said amplifying means may be supported in a relatively quiescent subsurface zone so that wave-slap noise effects may be minimized.

4. A buoy according to claim 3, in which said transducer unit includes a radio transmitter.

5. A buoy according to claim 3, and including a water-soluble plug in the envelope of said bag, on the side thereof from which said transducer unit is suspended.

6. A buoy according to claim 3, and including a high-pressure gas bottle attached to said bag for automatic inflation thereof.

7. A radio-sonobuoy package, comprising a cylindrical container, amplifying means within said container, cylindrical electro-acoustic transducer means carried by said container and circumferentially surrounding the same, a collapsed inflatable flexible bag and pressurizing means for inflating the same, antenna means attached to said bag, and an elongated cable connecting said container to said antenna, said cable being doubled up within said bag, and said bag being folded around said container, and frangible securing means securing the folded bag to said container, whereby upon breakage of said frangible means said container may fall free of said bag so that said bag in an air launching may provide aero-dynamic drag to assure water entry of said container in a desired orientation.

8. A buoy according to claim 7, in which said frangible member is a tape extending circumferentially of said bag and container, and rip-cord means for said tape.

9. A buoy according to claim 7, in which said frangible member includes a rip-cord with an actuating connection to said pressurizing means, whereby upon pulling the rip-cord the bag may be inflated, as during an air trajectory following aircraft launching.

10. In a radio sonobuoy, a flexible bag inflatable to a relatively thin waferlike circular shape, antenna means secured generally centrally of one side of said bag, cable means connected to said antenna means and passing through the other side of said bag, and an integral unitary

negatively buoyant structure comprising an electro-acoustic transducer and amplifier means therefor connected to the other end of said cable means.

11. A sonobuoy according to claim 10, in which said bag is of electrically non-conductive material, and including a plurality of half-wavelength reflectors carried by the antenna-supporting side of said bag.

12. A sonobuoy according to claim 11, in which said half-wavelength reflectors are flexible ribbons of conductive material bonded to the surface of said bag.

13. In a device of the character indicated, a generally cylindrical cup-shaped container having a radially outwardly-extending flange at the open end and closed at the other end, amplifying means within said container and including a cable outlet through said closed end, a cylindrical transducer surrounding said container and of outer dimensions within the radial limits of said flange, and means permanently securing said transducer to said container.

14. A device according to claim 13, in which said cable outlet passes through the center of said closed end.

15. A device according to claim 13, in which said last-defined means is a sound-transmitting plastic securing said transducer to said container and sheathing the outer surface of said transducer with sound-transmitting material.

16. A device according to claim 13, and including a layer of sound-absorbing material radially between said container and said transducer.

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