July 10, 1923. 1,461,056

W. L. WALKER

SIGNALING APPARATUS

Filed June 22, 1917

Fig. 1.

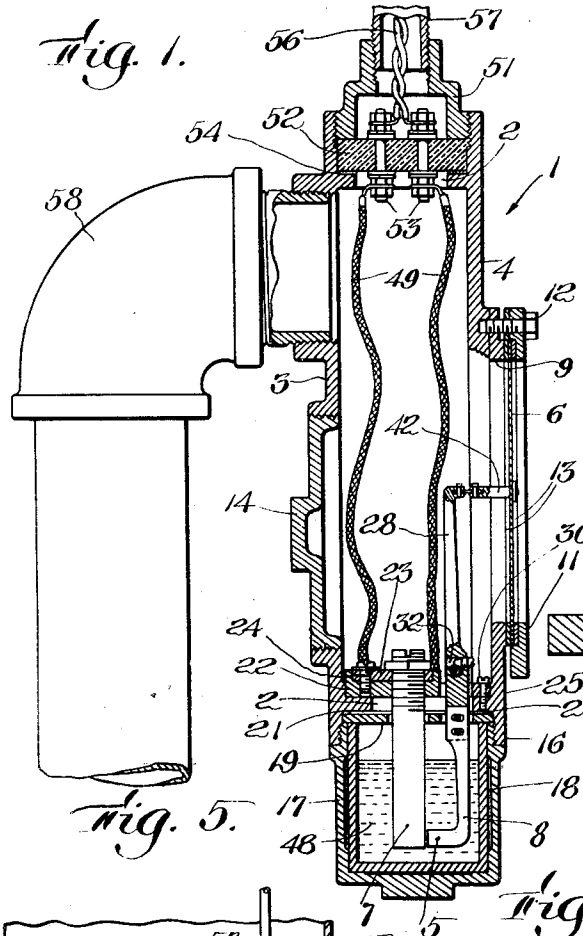


Fig. 2.

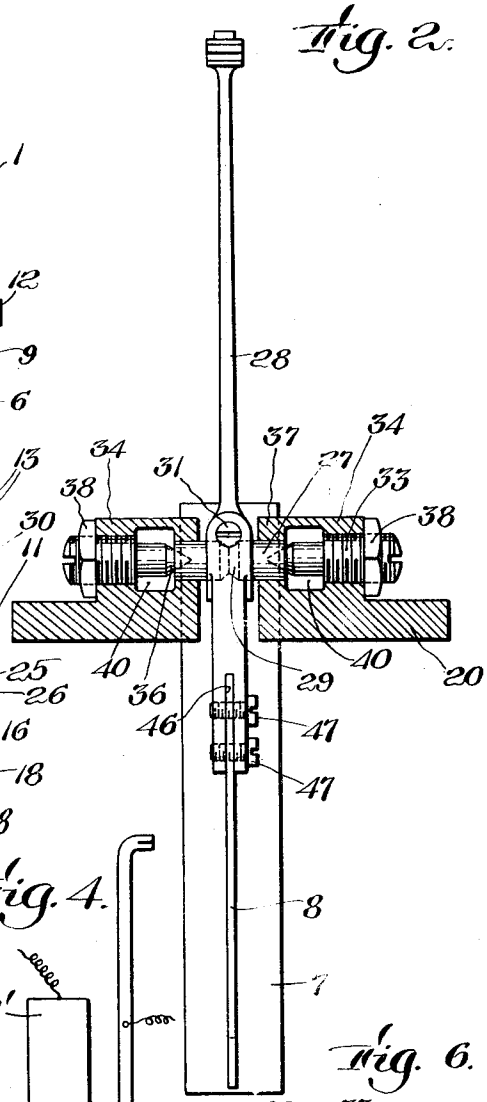


Fig. 5.

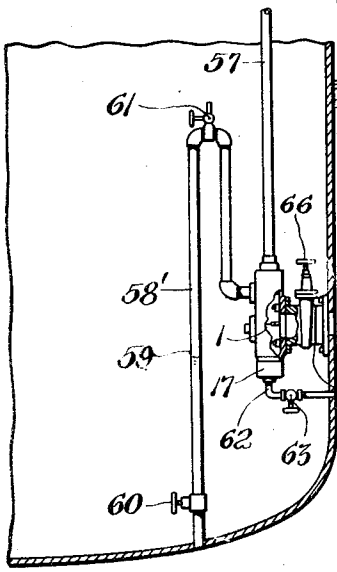


Fig. 4.

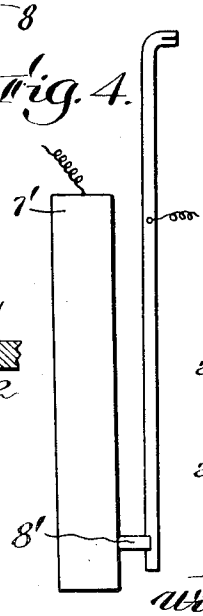


Fig. 3.

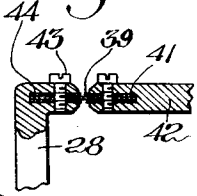
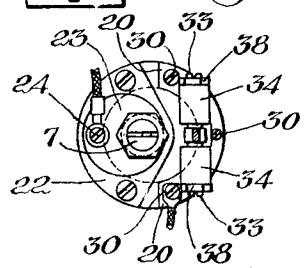


Fig. 6.



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UNITED STATES PATENT OFFICE.

WILLIAM L. WALKER, OF NEW YORK, N. Y., ASSIGNOR TO WALKER SIGNAL AND EQUIPMENT CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

SIGNALING APPARATUS.

Application filed June 22, 1917. Serial No. 176,299.

To all whom it may concern:

Be it known that I, WILLIAM L. WALKER, a citizen of the United States, and resident of New York, in the county of New York and State of New York, have invented new and useful Improvements in Signaling Apparatus, of which the following is a specification.

This invention relates to electrical signaling apparatus for receiving sound disturbances and the like, whether above or below the average audible range and whether in code or otherwise, and more particularly the invention relates to submarine signaling apparatus adapted to detect sound disturbances beneath the surface of a body of water and to transmit the disturbances to a distant point.

Of the many types of apparatus heretofore proposed for submarine signaling, most of them have comprised either a microphonic device or an electromagnetic device for transforming the sound disturbances into electrical disturbances in order to transmit the signals from the receiving device to a distant point. The electromagnetic devices have been more or less heavy and the moving parts have been adapted to respond readily only to wave disturbances throughout a limited range of frequencies. Moreover, the electromagnetic devices have not been sufficiently sensitive to detect the fainter disturbances such as the sound disturbances produced by a distant vessel. The microphonic devices have not been wholly satisfactory for the reason that they are inherently delicate and therefore not adapted to reproduce heavy sound disturbances which produce a large movement of the sound diaphragm or other sound responsive devices. Moreover, the microphonic devices have not been capable of distinguishing between sounds of different characters and of widely different intensities.

It is the principal object of the present invention to overcome the disadvantages inherent in the above and other types of apparatus and to provide means for receiving sound disturbances and the like, of whatever nature, which is exceedingly sensitive, which will respond to disturbances throughout an exceedingly wide range of frequencies and intensities, which will readily distinguish between the various kinds of sound such as the sounds produced by submarines of different types, surface vessels of different types and sizes, code signals of various intensities and frequencies and which is also adapted to receive and reproduce speech. Another object of the invention is to control the pressure within a sound-box so that as the sound-box is submerged in a body of water with the outer surface of the sound diaphragm in contact with the water the pressure of the water on the outside of the diaphragm is counterbalanced by the pressure produced on the inside of the sound-box, the pressure within the sound-box preferably being regulated automatically as the sound-box is raised and lowered in the water either mechanically or due to the rolling of the vessel.

Other objects of the invention are to provide signaling apparatus of the character referred to which has a sound diaphragm unobstructed on the outside, which has an adjustable electrode connecting with the diaphragm on the inside, which has a connection between the electrode and diaphragm such as to permit lateral movement of the electrode, relatively to the path of vibration of the diaphragm, and which has a unique electrolytic cell associated therewith. Sill other objects are to reduce the length of the connection between the diaphragm and movable electrode, in apparatus of this character, to reduce the inertia of the moving parts, to dispose the movable electrode largely in a gaseous medium instead of a liquid medium, thereby to reduce the resistance to movement to increase the size of the diaphragm and yet to minimize the weight of the diaphragm, etc.

In the accompanying drawings,—

Figure 1 is a central vertical section of one embodiment of my invention, parts being shown in elevation;

Figure 2 is an enlarged front elevation (that is, looking from the right of Fig. 1) of the pivoted electrode shown in Fig. 1;

Figure 3 is an enlarged sectional view of the connection between the pivot lever arm and the diaphragm;

Figure 4 is a diagrammatic view of a modified form of electrodes;

Figure 5 is a vertical transverse section through the hull of a ship, showing one manner of applying my improved apparatus to a ship for submarine signaling or detecting purposes; and

Figure 6 is a plan view of the electrodes and mounting means inside the sound-box.

The present invention is in the nature of an improvement on the subject matter of my prior application, Sr. No. 161,179, filed April 11, 1917, and reference is hereby made to the former application for a disclosure of certain aspects of the apparatus which are common to the two inventions.

As in my prior application, the apparatus in general comprises a sound-box 1, which is preferably of cylindrical contour having a cylindrical wall 2 and end walls 3 and 4, a diaphragm 6 and opposed electrodes 7 and 8, one of which is connected to the diaphragm so as to be moved thereby. The diaphragm 6 may be mounted on the sound-box in any suitable manner, but it is preferably mounted in an opening 9 by means of a ring 11 secured to the sound-box around the opening 9 by means of bolts 12, the diaphragm being clamped between the sound-box and the ring and packing washers 13 of rubber or other suitable material being disposed if desired between the diaphragm and the housing and ring respectively. In the rear wall 3 of the housing an opening is preferably provided to give access to the interior of the sound-box from the rear, this opening normally being closed by the cover 14.

At the bottom of the sound-box is provided a circular depending flange 16, and into this flange is threaded a cup 17 which is adapted to contain an electrolytic fluid. In order to prevent the electrolytic fluid from contacting with the cup member 17, which is preferably of metal, a cup of insulation 18 may be fitted into the cup 17. Likewise, a disk of hard rubber 19 is preferably placed over the top of the cups 17 and 18 to prevent the electrolytic fluid from contacting with the metallic parts disposed above the cups 17 and 18. A washer 21 may, if desired, be disposed between the disk 19 and the lower wall of the sound-box in order to insure a tight fit between the cup members and the sound-box.

Mounted in the sound-box on the bottom thereof is an insulation member 22 in which is mounted a metallic contact plate 23, the contact plate being secured to the member 22 by means of a screw 24. Extending through the contact plate 23, insulation member 24, and an opening 26 in the bottom of the sound-box, thence through an opening in the disk 19 into the electrolytic cup, is an electrode 7. This electrode preferably has a surface of revolution, the surface being concentric with the longitudinal axis of the electrode, and in the preferred embodiment of the invention illustrated in the drawings, this electrode is cylindrical in contour. The electrode is mounted in electrical contact with the contact plate 23 and is preferably mounted as illustrated by threading it into the plate 23 and member 22, a lock-nut being provided to hold it in adjusted position.

The electrode 8 is pivotally mounted upon the lower wall of the sound-box so as to be oscillated forwardly and rearwardly by the vibration of the diaphragm 6, the electrode being supported on a semi-circular base 20 secured to the bottom of the sound-box by screws 30. The preferred means for pivotally mounting the electrode 8 comprises a short shaft 27 (Fig. 2) passing through an opening in the lever arm 28, the shaft 27 having a peripheral groove 29 around its central portion and having conical recesses axially disposed in its opposite ends. A screw 31 is threaded into an opening 32 in the lever arm 28 so as to engage the groove 29 of the shaft 27 and hold the lever arm tightly in position on the shaft 27. Bearing screws 33 are threaded through lugs 34 projecting upwardly from member 22 into engagement with the ends of shaft 27, the conical points 36 of the screws fitting into conical recesses in the shaft. The lugs 34 also preferably have portions 37 which surround the ends of the shaft 27 which prevents the lubricant, such as graphite grease, in spaces 40 from coming out. Lock-nuts 38 are provided to hold the pins 33 in the adjusted position. If it is desired to insulate the electrode 7 from the sound-box, a layer of varnish or other suitable insulating material is provided between the member 20 and the sound-box.

Owing to the fact that the lever 28 is pivotally mounted in the sound-box its upper end, which travels in the arc of a circle, will necessarily have some vertical movement. The diaphragm is mounted to vibrate horizontally. Consequently I preferably provide means for connecting the upper end of the lever arm 28 to the diaphragm which is adapted to permit some movement of the upper end of the lever arm transversely of the direction of vibration of the diaphragm. The preferred means for this purpose, which is shown enlarged in Fig. 3, comprises a sheet 39 of flexible material such as steel, which is mounted in slots 41 disposed in alinement in the opposing ends of the lever 28 and the stud 42 mounted on the diaphragm 6. The sheet member 39 may be connected to the members 28 and 42 by means of screws 43, sheets of insulating material 44 being provided between the member 39 and the members 28 and 42 if it is desired to insulate the lever 28 from the sound-box 1.

The electrode 8 is preferably shaped as shown in Fig. 1 so that the major portion of the electrode will be disposed at some distance from the electrode 7 and so that the lower portion of the electrode 8 will extend into proximity with the electrode 7. The electrode 8 is preferably formed as a thin

blade and the edge 5 of the electrode facing the electrode 7 is preferably sharpened so as to present a more or less sharp edge to the electrode 7. Electrode 8 is mounted in a slot 46 in the lower end of the lever 28 by means of screws 47. The openings in the electrode 8 for receiving the screws 47 are preferably elongated horizontally so that the electrode may be adjusted to and from the electrode 7 on the lever arm 28. The electrodes are preferably formed of dissimilar metals, such that when the electrodes are immersed in a suitable electrolytic fluid such as indicated at 48 a galvanic current will be set up between the electrodes as more fully described in my former application. Suitable materials for the electrodes are zinc and platinum, and a suitable electrolytic fluid is sulphuric acid although any other suitable combination of metals and electrolyte may be used. The electrodes are respectively connected to receiving circuits and indicating instruments, as described in the former application, through conductors 49, one conductor being connected to electrode 7 through the medium of contact plate 23 and screw 24, and the other conductor being connected to electrode 8 in any suitable manner, as for example, by one of the holding screws 30.

The top of the sound-box 1 is provided with an opening into which is threaded a reducing nipple 51, a block of insulation material 52 being disposed between the housing 2 and the collar 51. The insulation material, which may be of hard rubber, serves to support the connectors 53 and also to close the opening in the top of the sound-box, one or more washers 54 of soft rubber being inserted between the sound-box and member 52 and between member 52 and reducing nipple 51, if desired in order to insure a hermetic seal. In order to house the conductors 56 extending upwardly from the connectors 53, a pipe 57 is preferably threaded into the collar 51.

In order to balance the pressure of the water on the outside of the diaphragm 6 when the apparatus is submerged, a pipe 58 is preferably arranged to communicate with the upper portion of the sound-box and to extend downwardly into the water below the sound-box, all as more fully described in my prior application.

Certain aspects of the present invention are of utility not only in connection with electrolytic fluids, but also in connection with microphonic electrodes, such as carbon button electrodes or a carbon pile. I have therefore illustrated in Fig. 4 a carbon electrode 7′ and a carbon electrode 8′ in contact with the electrode 7′, these electrodes corresponding to the electrodes 7 and 8 in Fig. 1. When using this type of electrodes an electrolytic fluid would of course not be employed, the electrodes functioning merely microphonically.

However, the preferred type of electrodes is the electrolytic type illustrated in Fig. 1, these electrodes functioning in accordance with the following laws: The smaller the internal resistance of an electrolytic cell the greater the current for a given external circuit. The magnitude of the internal resistance depends upon the size of the electrodes, upon their distance apart and upon the specific resistance of the electrolyte. The internal resistance is diminished by increasing the area of the plates or by decreasing the distance between them. The E. M. F. of a cell gives rise to a current and also to the various potential differences in all parts of the circuit. It may be said that current flows by reason of the potential difference or equally that the potential difference arises by reason of the current flow.

By predetermining the areas of the opposing faces of the electrodes the internal resistance of the electrolytic cell can be predetermined to suit the particular uses for which the apparatus is intended. Moreover, the sensitiveness of the apparatus can be regulated by varying the distance between the electrodes and by suitably determining the character of the electrolyte. When sound waves are impinged upon the diaphragm 6, the lever arm 28 and electrode 8 carried thereby are oscillated back and forth, thereby varying the internal resistance of the electrolytic cell, and ultimately actuating the indicating or recording instrument connected to the conductors 56 either directly or through an audion, as in my prior application. In this connection it is to be noted that better results are obtained by balancing the external and internal resistance of the electrolytic cell. That is, the resistance of the conductors 49 and 56 and other portions of the external circuit should be approximately equal to the internal resistance of the electrolytic cell. By varying the length of the electrode 8, as by substituting electrodes of different lengths, the sensitiveness of the apparatus can be varied. In general the apparatus is more sensitive the greater the ratio of the length of the lever arm below the pivot to the length of the lever arm above the pivot.

In operation the electrodes will become disintegrated more or less rapidly, the disintegration taking place almost exclusively in the region of the opposing surfaces of the electrode. In order to correct for the increased gap between the electrodes produced by disintegration, one of the electrodes, namely, the electrode 7, is given the contour of a cylinder. By rotating the electrode 7 a slight amount a new area may be presented to the edge 5 of the electrode 8. Moreover, the electrode 8 may be adjusted

toward the electrode 7 by means of screws 47 to compensate for such disintegration.

My improved apparatus may be employed either in the manner disclosed in my former application or as illustrated in Fig. 5, for example. When employed as described in the prior application the apparatus is lowered into the water to a suitable depth, say twenty-five feet, and by virtue of the water rising in pipe 58 the pressure within the sound-box can be made equal to the pressure of the water on the outside of the sound-box. In this way the diaphragm 6 can be made very thin, and for the same reason it may be made much greater in diameter for a given thickness inasmuch as it does not have to withstand the pressure of the water. In this way the weight of the vibrating parts can be made much less and the sensitiveness of the apparatus can be materially increased. Owing to the fact that the pivoted electrode is disposed within the sound-box instead of on the outside of the box, the lever arm may be made considerably shorter and therefore considerably lighter. With the lever arm disposed within the sound-box the outer surface of the diaphragm is wholly uncovered to the action of sound waves.

In applying my improved apparatus to a ship it is preferably mounted on the inside of the hull of the vessel with the diaphragm exposed to the water through an opening in the hull as illustrated in Fig. 5, the apparatus being disposed beneath the water level W. The pipe 58′ connecting the upper portion of the sound-box with the outside of the vessel may be extended upwardly above the level of the sound-box in the form of a loop, as shown in Fig. 5, in which event the water may rise in pipe 58′ to a point above the sound-box. A valve 60 is preferably provided to close the pipe 59 for the purpose of making repairs, and an air connection and valve 61 may, if desired, be connected to the loop of pipe in order to force air or other gas into the sound-box under pressure to regulate or supplement the pressure produced by the water rising in pipe 58′. By virtue of the pipe 58 extending above the sound-box in the form of a loop, the pipe may be made of small internal diameter and still contain a sufficient quantity of air or other gas to be compressed by the water rising in the pipe. When the pipe is of relatively small diameter the resistance which it offers to the water will be relatively larger, thereby to prevent a too rapid rise and fall of the water therein due to rolling of the vessel. Furthermore, when using a small pipe water will enter the vessel at a slower rate in the event of the pipe being broken.

When employing the apparatus as illustrated in Fig. 5 the electrolytic cup 17 may be arranged to communicate with the exterior of the vessel, as for example, through a pipe 62 and valve 63. In this way salt water may be admitted to the electrolytic cup and employed instead of sulphuric acid or other electrolyte as the electrolytic solution. By suitably regulating the pressure in the sound-box the liquid may be permitted to rise in cup 17 through connection 62 only to substantially the level of the liquid shown in Fig. 1. When water is permitted to rise in cup 17 through pipe 62 the pressure in the sound-box is so regulated that the water will only rise to the desired height in the cup, the water rising in pipe 58′ to the same height.

In Fig. 5 I have also illustrated means for cutting off the sound-box from the outside of the vessel, this means comprising a valve 66 disposed in the short passage 67. In this way the passage may be closed while the diaphragm is being replaced or repaired. Moreover, the passage 67 affords a pocket adapted to hold a quantity of relatively quiet water while the vessel is being propelled through the water, thereby to reduce the effect on the diaphragm of water rushing past the aperture in the hull of the vessel.

I claim:

1. In apparatus of the character described, the combination of a housing having an opening therein, a diaphragm mounted in the opening, a pair of electrodes disposed in opposed relationship below the level of the diaphragm, and a flexible member having one end connected to one of the electrodes and its other end connected to the inner side of the diaphragm so that movement of the diaphragm produces movement of the one electrode relatively to the other electrode.

2. In apparatus of the character described, the combination of a sound responsive member, a liquid container, current carrying liquid in said container, a pair of electrodes immersed in said liquid in spaced relationship, one of the electrodes being movable with relation to the other electrode, and means for positively connecting the said one of the electrodes to the diaphragm so that it is moved relatively to the other electrode by movement of the diaphragm.

3. Submarine signaling apparatus comprising a housing having an opening in one side thereof, a diaphragm mounted in the opening, current carrying liquid in the lower portion of the housing, a movable electrode disposed at least in part in the housing with its lower end immersed in said liquid, and means for positively connecting the electrode with the inner side of the diaphragm.

4. Submarine signaling apparatus comprising a housing having an opening in one side thereof, a diaphragm mounted in the opening, a liquid container secured to the

lower portion of the housing, current carrying liquid in said container, electrodes extending downwardly into the liquid, one of the electrodes being movable, and means for positively connecting the movable electrode with the diaphragm.

5. In apparatus of the character described, the combination of a housing having an opening in one side thereof, a sound-responsive diaphragm mounted in the opening, a pair of opposed electrodes disposed in the housing, and a lever arm pivotally mounted in the housing and having positive connection to the diaphragm, the lever arm serving to connect the diaphragm and one electrode so that movement of the diaphragm produces movement of the one electrode relatively to the other electrode along a path parallel to the movement of the diaphragm.

6. Signaling apparatus comprising a diaphragm, means for supporting the diaphragm, a lever arm, means for pivotally supporting the lever arm, flexible means for positively connecting the lever arm to the diaphragm so that movement of the diaphragm in either direction produces movement of the lever arm about its pivotal support, the lever arm carrying an electrode thereon, a second electrode mounted in proximity to the first electrode, and means for regulating the distance between the electrodes.

7. Signaling apparatus comprising a housing having an opening in one side, a diaphragm mounted in the opening, an electrolytic cell secured to the bottom of the housing, a pair of electrodes mounted in the housing and extending into the cell in spaced relationship, means for connecting one of the electrodes to the diaphragm so that vibration of the diaphragm in either direction produces corresponding movement of the electrode relatively to the other electrode, and means for insulating the electrodes from the housing and diaphragm.

8. Signaling apparatus comprising a housing having an opening in one side, a diaphragm mounted in the opening, an electrolytic cell secured to the bottom of the housing, a pair of electrodes mounted in the housing and extending into the cell in spaced relationship, means for connecting one of the electrodes to the diaphragm so that vibration of the diaphragm produces movement of the electrode relatively to the other electrode, the housing being hermetically sealed, and means for regulating the fluid pressure within the housing.

9. Submarine signaling apparatus comprising a watertight housing having an opening in one side, a diaphragm mounted in the opening, a pair of electrodes disposed in the lower portion of the housing, means for connecting one of the electrodes to the diaphragm so that movement of the diaphragm produces movement of the electrode relatively to the other electrode, the lower portion of the housing communicating with the outside so that liquid may rise in the housing around the electrodes when the housing is submerged.

10. Submarine signaling apparatus comprising a water-tight housing having an opening in one side, a diaphragm mounted in the opening, a pair of electrodes disposed in the lower portion of the housing, means for connecting one of the electrodes to the diaphragm so that movement of the diaphragm produces movement of the electrode relatively to the other electrode, the lower portion of the housing communicating with the outside so that liquid may rise in the housing around the electrodes when the housing is submerged, and means for controlling the pressure in the housing, thereby to regulate the depth of liquid in the housing.

11. Submarine signaling apparatus comprising a water-tight housing having an opening in one side, a diaphragm mounted in the opening, a pair of electrodes disposed in the lower portion of the housing, means for connecting one of the electrodes to the diaphragm so that movement of the diaphragm produces movement of the electrode relatively to the other electrode, the lower portion of the housing communicating with the outside so that liquid may rise in the housing around the electrodes when the housing is submerged, and means for controlling the pressure in the housing, thereby to regulate the depth of liquid in the housing, the latter means comprising a tubular chamber communicating with the upper portion of the housing and extending below the housing into communication with the exterior so that liquid may rise in the chamber and compress the fluid in the chamber when the apparatus is submerged.

12. Signaling apparatus comprising a vessel adapted to contain an electrolyte, two electrodes in the vessel having opposing surfaces, and signal responsive means for moving the electrodes relatively to each other, the surface of one electrode being relatively broad and the surface of the other electrode being relatively narrow, said first electrode being adjustable whereby to permit presenting fresh surfaces thereof opposite said second electrode.

13. Signaling apparatus comprising a diaphragm, a pair of opposed electrodes, and means including a flexible band rigidly joined at its opposite ends to the diaphragm and one of the electrodes for connecting one of the electrodes to the diaphragm so that the electrode may have some movement transverse to the direction of vibration of the diaphragm.

14. Signaling apparatus comprising a di-

aphragm, a pair of opposed electrodes, and flexible means for connecting one of the electrodes to the diaphragm so that the electrode may have some movement transverse to the direction of vibration of the diaphragm.

15. Signaling apparatus comprising a diaphragm, a lever arm extending along one side of the diaphragm, means for connecting the lever arm to the diaphragm, means for pivotally mounting the lever arm so that it is oscillated by vibration of the diaphragm, and a pair of opposed electrodes one of which is carried by the lever arm so as to be moved relatively to the other electrode by movement of the diaphragm and lever arm, the connection between the diaphragm and lever arm comprising a flexible strip of material arranged to permit lateral movement of the lever arm relatively to the direction of vibration of the diaphragm.

16. Submarine signaling apparatus comprising a sound box having an opening in one side, a sound responsive diaphragm over said opening, an air chamber communicating with the interior of the sound box and opening into the water outside the sound box, the air chamber extending to a substantial distance above the level of the sound box and opening into the water at a point below the sound box, whereby the pressure of the water on the outside of the diaphragm may be counteracted.

17. Submarine signaling apparatus comprising a sound box having an opening in one side, a sound responsive diaphragm over said opening, an elongate conduit of relatively small cross-sectional area extending upwardly to a substantial distance above the sound box and thence downwardly to a point below the sound box so that water may rise in the conduit to or above the level of the sound box thereby to counteract the water pressure on the outside of the diaphragm.

18. Submarine signaling apparatus comprising a sound box having an opening in one side, a sound responsive diaphragm over said opening, an air chamber communicating with the interior of the sound box and opening into the water outside the sound box, the air chamber extending above the level of the sound box and opening into the water at a point below the sound box, whereby the pressure of the water on the outside of the diaphragm may be counteracted, and means to regulate the amount of air trapped in the sound box.

19. In combination in a signaling apparatus comprising a housing having an opening in its side provided with a diaphragm exposed to fluid pressure, a pipe having a loop extending to a point substantially above said housing and having one of its ends in communication with the interior of the housing and its opposite end opening into the pressure fluid, and a valve device arranged substantially at the highest point of said loop for admitting air under pressure into said housing for equalizing the pressure upon opposite sides of the diaphragm.

20. In a signaling system comprising a housing having an opening in its side provided with a diaphragm exposed to fluid pressure, means for equalizing the pressure upon opposite faces of the diaphragm comprising a pipe opening at one end into said housing and opening at its opposite end into fluid under pressure, and means at an intermediate point in said pipe whereby air under pressure may be admitted to or discharged from said housing.

Signed by me at New York, New York, this 12th day of June, 1917.

WILLIAM L. WALKER.