July 30, 1946. W. R. HARRY ET AL 2,404,798

ELECTROMECHANICAL DEVICE

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FIG. 1

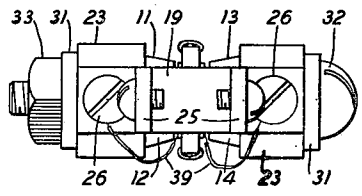


FIG. 4

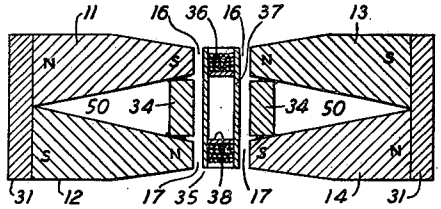


FIG. 2

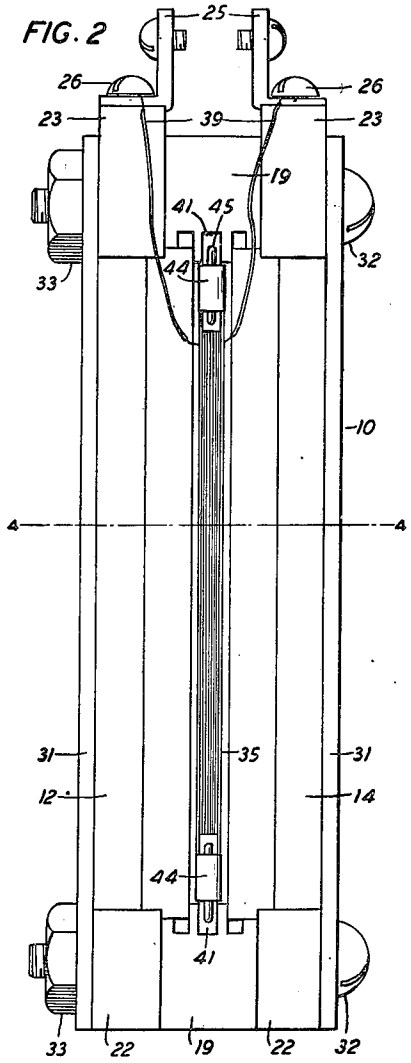
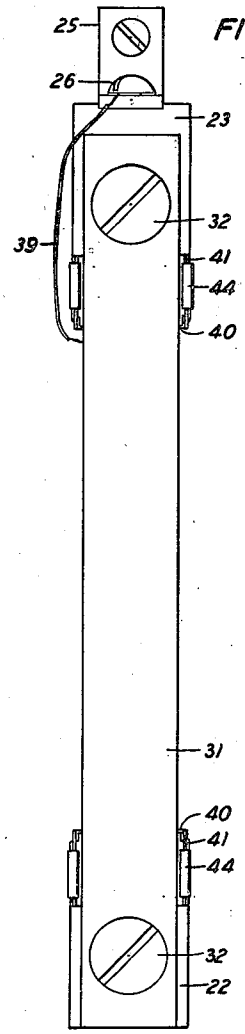


FIG. 3



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FIG. 5

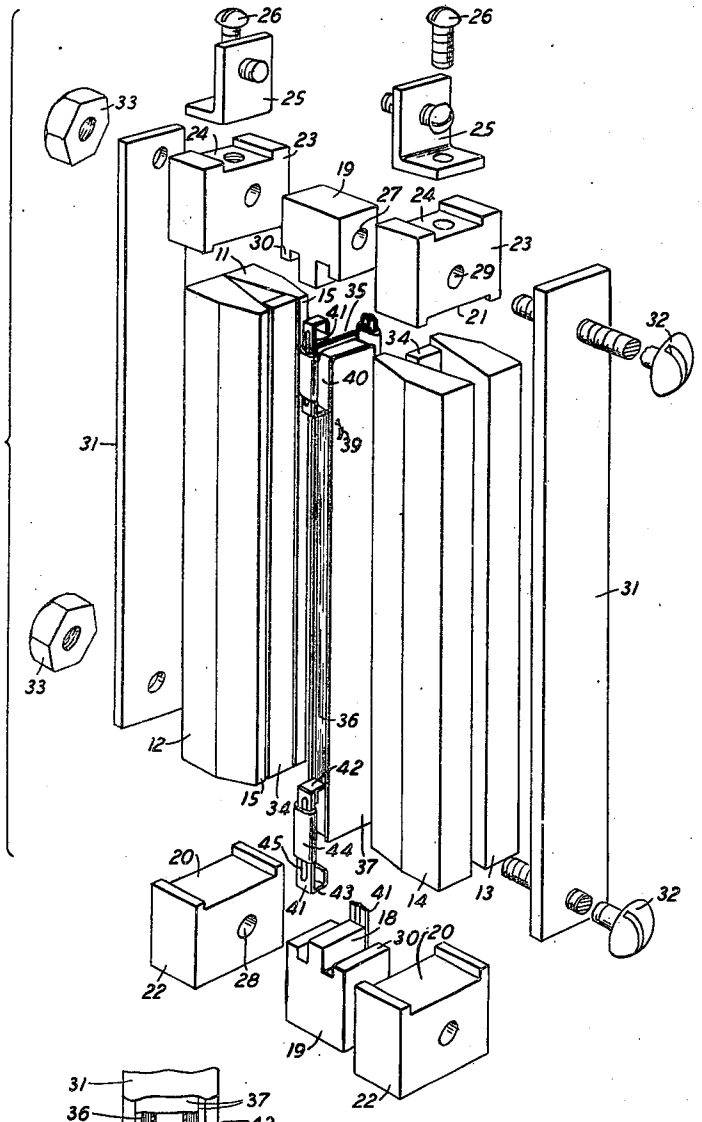
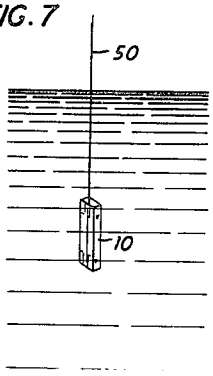


FIG. 7



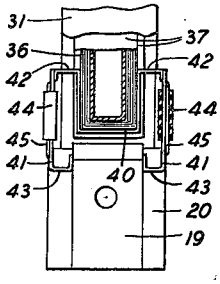


FIG. 6

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ELECTROMECHANICAL DEVICE

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Application October 15, 1941, Serial No. 415,032

2 Claims. (Cl. 177—386)

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The invention relates to electromechanical devices and more particularly to a signal pressure variation or wave detector or microphone for use in a liquid wave transmission medium, for example, water.

An object of the invention is to enable the detection with a single device of submarine signals or disturbances in both the audio and super-audio portions of the frequency range.

A further object is to improve the structure and performance of submarine signal detectors or microphones.

A feature of the invention comprises a submarine signal detector or microphone of the pressure gradient type.

A further feature comprises a submarine signal detector or microphone in which the signal responsive element is a coil disposed in a magnetic field and adapted to move therein in response to the pressure gradient established between different portions of the coil by the signal pressure variations.

Still another feature comprises a submarine signal detector or microphone in which the signal responsive element is a coil exposed to the liquid medium.

A submarine signal detector or microphone in accordance with this invention comprises a coil of many turns of fine wire, supported for movement in a magnetic field, and adapted to be exposed to the water in which the microphone is submerged or immersed. The coil may have a pair of elongated portions each of which is exposed to the water on opposite sides or surfaces of the microphone structure which may be a somewhat flat, elongated rectangular structure. Signal pressure variations or signal waves in the water originating on either side of the microphone are effective on each of the elongated coil portions, the coil movement being determined by the difference in the phases of the signal pressure variation or wave acting on the two portions. With each elongated coil portion positioned in a separate magnetic field and with the magnet elements producing the magnetic field properly poled, the currents generated in the coil portions by movement thereof in the magnetic fields will be cumulative.

A more complete understanding of this invention will be obtained from the detailed description that follows taken in conjunction with the showings of the appended drawings wherein:

Fig. 1 is a top plan view of a microphone embodying this invention;

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Figs. 2 and 3 are a front and a side elevational view, respectively, of the microphone of Fig. 1;

Fig. 4 is an enlarged cross-sectional view of the microphone of Fig. 1 taken along the line 4—4 of Fig. 2;

Fig. 5 is an exploded perspective showing of the microphone of Figs. 1 to 4 to evidence structural details more clearly;

Fig. 6 is a view, partly broken away and partly in section, of one end of the microphone of Figs. 1–5 to show more clearly the manner in which the coil is supported; and

Fig. 7 illustrates how the microphone may be suspended or immersed in a liquid medium.

With reference to the drawings, there is shown a microphone 10, embodying the invention. It comprises a plurality of elongated magnets 11, 12, 13, 14 that may be of any suitable magnetic material, magnetized so that their poles are at the larger and smaller bases of each as indicated in Fig. 4. The magnets are arranged in two oppositely disposed pairs with their narrower or tapered bases providing spaced planar pole faces 15, defining two air-gaps 16, 17. The pole faces are maintained at a preassigned separation by the projections 18 on metallic spacer or separator members 19 of non-magnetic material at the upper and lower ends of the microphone. The ends of each pair of magnets fit into grooves or slots 20, 21 in the upper and lower surfaces of non-magnetic blocks or members 22, 23, respectively. The upper surface of each member 23 contains a groove or slot 24 adapted to receive the horizontal portion of an L-shaped terminal 25 which is fastened to the block by a suitable member 26. The members 19, 22, 23 contain passages 27, 28, 29 between their lateral vertical surfaces which are in alignment when the magnet ends are in the slots 20, 21 and the shoulder portions 30 of the member 19 rest on the ends of the magnet with projection 18 extending into the air-gap. The magnet and the members 19, 22, 23 are clamped between two elongated strips or plates 31 of magnetic material by fastening members 32, 33, the stem of each member 32 extending through the apertures in the strips 31 and the passages 27, 28, 29 and being engaged on its threaded end by member 33. The substantially V-shaped space or chamber 50 formed by each pair of magnets is closed by an elongated strip or insert 34 of non-magnetic material, whose outer surface is substantially in the same plane as that of the pole faces. The upper and lower extremes of these spaces are closed by the adjacent surfaces of the members 22, 23 and by the

shoulders 30 of the member 19. Hence, when the device is immersed in water, the water does not enter these spaces, or, if it does, it can have no effect on movement of the coil 35 now to be described. If desired, the magnets, the inserts 34, the spacers 19 and the strips 31 may be soldered together where adjacent, to constitute a unitary structure.

The coil 35 comprises a spool or channel member of insulating or of non-magnetic material on which is wound many turns of fine insulated wire 36. The spool comprises a pair of elongated planar rectangular portions 37 spaced apart by a frame portion 38 to form a peripheral channel or recess in which the wire 36 is located. The spool material may be Bakelite; after the wire has been wound in the channel, it may be vacuum impregnated in a Bakelite varnish medium. Instead of Bakelite, the spool material may be aluminum. The ends 39 of the winding may be brought out to the terminals 25. The coil is supported in the air-gaps 16, 17 by U-shaped spring metal members or yokes 40 slipped over and fastened to each end of the coil and flexible spring members 41. Each of the latter is soldered at one end to an outwardly projecting tab or extension 42 of a member 40, and at its other end 43 is soldered to a spacer member 19. Each member 41 has a longitudinal boss or ridge 45 to stiffen it, and is surrounded by a cover or sleeve 44 of damping material, such as rubber. The members 41 permit movement of the coil in two directions 180 degrees removed, that is, to and fro in the air-gaps with the planar portions 37 of the spool moving substantially parallel to the pole faces; constrain the coil against movement in other directions; and aid in minimizing undesirable or parasitic vibrations in the coil.

The spaces or passages existing between the side walls or surfaces of the spool and the magnet structure, that is, the spaces between the spool portions 37 and the pole faces and the insert 34 are such that a very high impedance is presented to signal pressure variations or waves of frequencies within the band of frequencies to which the microphone is intended to be responsive. When the device is immersed in water, the water may flow between the front and the back of the microphone through these spaces, that is, between the two large surfaces of the microphone, but signal pressure variations or waves must travel around the microphone in order to be effective on each vertical or air-gap portion of the coil. The mass of the coil is proportioned so as to be equal approximately to the radiation mass of water.

The microphone may be supported under water as shown in Fig. 7 by a suitable cable 50 which may include the conductors for connecting the microphone at the terminals 25 with suitable electrical equipment at an observer or recording station, for analysis or indication of the response of the microphone to signal or other under-water disturbances of a frequency or frequencies within the range to which the microphone is responsive.

In a microphone constructed in accordance with the invention, the actual dimensions were approximately one-half those of Figs. 1, 2 and 3. The magnet members 11—14 were of an aluminum-nickel-cobalt-steel alloy (Al—10%; Ni—17%; Cu—6%; Co—12%; Fe and C balance); the air-gaps were approximately .125 inch wide and approximately 2.5 inches long; the clamping strips 31 were of Swedish steel. The flux density at the pole faces was of the order of 1800 gauss. The spool for the coil was of Bakelite; the conductor for the spool was of No. 33 B. and S. enamel-coated aluminum wire, and comprised approximately 62 turns. The coil supports were of phosphor bronze, the thickness of the strip from which they were formed being approximately .002 inch. A microphone in accordance with this invention will respond under water to sonic or supersonic signal waves or disturbances over a wide frequency range, for example, up to 60,000 C. P. S. or greater.

The microphone described hereinabove may be used as a standard microphone for calibrating microphones of similar or different construction intended for use in a liquid medium, and, specifically, under water for detecting marine or submarine signals or disturbances. Such signals or disturbances might be those created with a suitable source under water for communications or sounding purposes, or might comprise the underwater sonic or supersonic waves developed by particular marine craft or equipment, such as, ships, submarines, ship engines, etc.

The microphone described is of the pressure gradient type, i. e., its wave-responsive element or coil is movable in response to the pressure gradient or difference in pressure established between different portions thereof by the signal wave or disturbance. The coil is exposed at the front and back of the microphone, i. e, the large-area portions through which the elongated winding portions are observable. The signal wave or disturbance has access, therefore, to each of the elongated coil portions. If the wave is incident on each elongated coil portion in the same phase, the coil does not move, but if the incoming wave or disturbance is incident out of phase on the coil portions, the coil will be caused to move to an extent dependent on the intensity of the wave and the magnitude of the phase difference. The microphone has a directional response characteristic, and may be arranged to be maintained stationary, or adapted for adjustment in position dependent on the advantage desired to be taken of such characteristic.

Although this invention has been disclosed with reference to what is believed at this time to be a preferred embodiment, it is apparent that it is not limited thereto, its scope being evidenced by the appended claims.

What is claimed is:

1. A device for detecting signal pressure variations in a liquid medium, said device comprising a coil, means to support said coil to expose the coil directly to the liquid medium, means providing a magnetic field having an air-gap, said supporting means disposing said coil in said air-gap for translational movement in said magnetic field in response to pressure gradient set up between different portions of said coil by the signal pressure variations, said air-gap allowing a mechanical clearance between the coil and magnetic pole-pieces sufficient to allow the liquid medium to flow therebetween but small enough to present high impedance to the signal pressure variations.

2. A device according to claim 1 in which said coil is rectangular in shape with one dimension many times longer than the other and said supporting means comprises a fixed frame surrounding the coil and U-shaped spring members slipped over the ends of the coil and having their extremities resiliently supported from the ends of said frame.

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