C. R. MOORE.

ACOUSTIC DEVICE.

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1,426,757.

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Fig. 1.

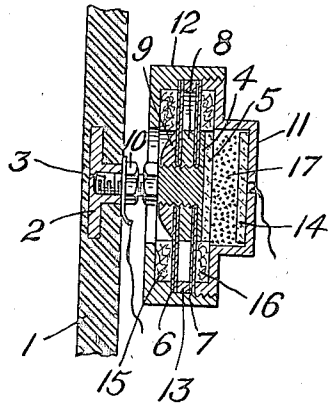


Fig. 2.

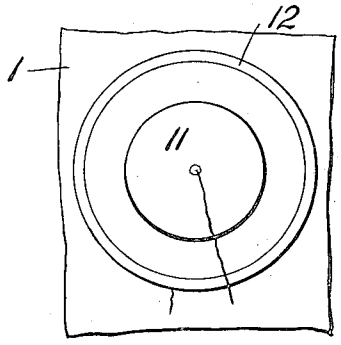
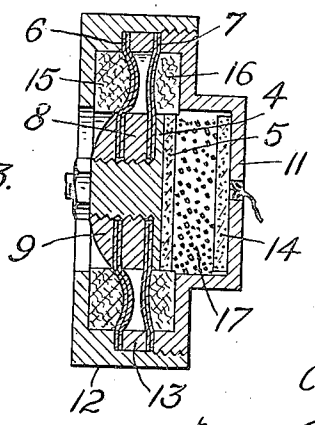


Fig. 3.



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UNITED STATES PATENT OFFICE.

CHARLES R. MOORE, OF WYOMING, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

ACOUSTIC DEVICE.

1,426,757. Specification of Letters Patent. Patented Aug. 22, 1922.

Application filed June 24, 1919. Serial No. 306,494.

To all whom it may concern:

Be it known that I, CHARLES R. MOORE, a citizen of the United States, residing at Wyoming, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Acoustic Devices, of which the following is a full, clear, concise, and exact description.

The invention relates to an acoustic device, and more particularly to a device of this character which serves to translate acoustic vibrations into variations in an electrical circuit. Devices of this character are well known in the art and in general consist of a sound-responsive body which often takes the form of a diaphragm with which is associated a current-varying device adapted to be included in an electrical circuit. In general, the current-varying device consists of two relatively movable members, one of which moves with the sound-responsive device, and the movement between these two members is utilized to vary the resistance, inductance or capacity of an electrical circuit.

The present invention has to do more particularly, however, with the construction and arrangement of the current-varying device and the mounting and arrangement of the movable member of such current-varying device.

The acoustic device of the invention is particularly designed to operate as a means for detecting the presence of sound vibrations propagated from a distant point through water. It finds its widest application as a detector for enemy submarine vessels. Devices of this character are generally used in connection with various forms of floats, buoys and other devices adapted to be towed or floated upon or under the surface of the water. Consequently they have imposed upon them by the conditions under which they are used certain requirements which are not met by the ordinary current-varying devices such as commonly used in a telephone transmitter. For example, they are subjected to disturbing variations due to wave motion when used on a float, due to the turbulency of the water when they are towed through the water, and to violent concussion in the water, due to the explosion of depth bombs in the vicinity. A rugged construction is therefore essential and in addition, the device must be rendered extremely sensitive.

In accordance with a feature of the present invention the movable part of the current-varying device is supported so as to permit motion between it and a relatively fixed member in one direction without permitting relative movement in a direction perpendicular thereto. In accordance with this feature of the invention, the movable member of the current-varying device is supported upon a pair of resilient spaced discs, and relative movement between the movable and fixed members is permitted by flexure of these discs. In accordance with a further feature of the invention means are provided to damp the movement of the movable member, which means consists of pads or cushions of energy-absorbing material acting upon either or both of the supporting discs.

In accordance with still another feature of the invention, in order to provide a very sensitive current-varying device and one which may be easily attached to a sound-responsive body regardless of the particular form of such sound-responsive body, the entire current-varying device is supported from the sound-responsive body, and the movable member thereof is supported by means of the plurality of resilient discs, as above referred to, which are so arranged relative to the movable member that the center of gravity of the entire current-varying device falls between the two flexible discs. In accordance with this feature of the invention the flexible discs are secured in spaced relation on a stem which in turn is secured to the sound-receiving body. The fixed member of the current-varying device is also secured to this stem. The movable member of the current-varying device is supported in a cup which in turn is supported by the flexible discs. The cup is so formed that the portion which carries the movable member of the current-varying device on one side of the flexible discs is counterbalanced by a similar cup member which

extends on the other side of the flexible discs. More specifically stated, in the embodiment of the invention shown, the cup which supports the movable member of the current-varying device also serves as a carbon chamber, and a resistance material is included in this carbon chamber between the fixed and movable members of the current-varying device which take the form of carbon electrodes.

In accordance with another feature of the invention which is particularly applicable to a current-varying device of the carbon-granule type, the diaphragms or diaphragm supporting the movable electrode is placed under an initial stress which is so applied that upon the heating produced by the passage of electric current between the electrodes, the expansion of the granule chamber causes a slight movement between the electrodes which loosens up the carbon granules and prevents packing.

In the drawings Fig. 1 is a sectional view of an acoustic device constructed in accordance with the invention, and Fig. 2 is an end elevation of the same, and Fig. 3 is an enlarged sectional view.

Referring to the drawings, 1 indicates a sound-responsive device which, as shown, is a diaphragm of resilient material such as rubber or gutta-percha which has been found suitable for under water work. However, this sound-responsive body may, and often does, take the form of the wall of a mine casing or buoy, or even the side of a ship. Suitably embedded in the sound-responsive body is a bushing 2 which is threaded to receive the screw-threaded stem 3. The stem 3 is provided with an enlarged portion 4 and a disc portion to which is secured the electrode 5. This electrode is provided with the usual polished carbon face. Supported on the stem 3 is a plurality of flexible discs 6 and 7. Each of these discs is preferably composed of two discs of mica or other similar material and the resulting compound discs are separated from each other by a spacing member 8, also supported on the stem 3. While only two of these discs are shown it is obvious that three or more may be used. The disc 7 is placed on the stem 3 in contact with the inner face of the electrode 5 and is held between the inner face of the electrode 5 and the spacer 8 by means of the nut or threaded member 9 which also serves to clamp the disc 6 between it and the spacing member 8. Suitable lock nuts, indicated at 10, are provided to lock the stem in the bushing 2 and to lock the threaded member 9 in position. Supported solely by the periphery of the discs 6 and 7 is a cup member which comprises two portions 11 and 12, one of which is threaded exteriorly and the other of which is threaded interiorly. The member 12 is provided with an internal annular shoulder against which the periphery of the disc 6 rests. An annular spacing member 13 rests upon the periphery of the disc 6 within the portion 12. The periphery of the disc 7 is clamped between the spacing member 13 and the edge of the portion 11 of the cup. The arrangement is such that when the portions 11 and 12 of the cup are threaded together, the peripheries of the two discs are securely clamped between the cup members, being spaced by the spacing member 13. Thus the discs form the sole mechanical connection between the stem 3 and the cup. This arrangement provides a mounting for the movable electrode 14 which is secured in the cup 11 and which will readily yield in a direction perpendicular to the plane of the sound-responsive body and yet is rigid and unyielding in a direction transverse thereto. The plural disc construction also provides a yielding mounting which is very rugged and not easily damaged by violent vibrations of the sound-responsive body, due to external shocks and concussions. Included between the cup members 11 and 12 and the peripheries of the flexible discs 6 and 7 are damping rings 15 and 16 of felt or similar material. Inasmuch as the cup member 12 and the cup member 11 are so mounted from the flexible discs 6 and 7 that the cup member extends on either side of the discs, the center of gravity of the disc supported parts, taken as a whole, falls on the button axis at a point somewhere between the two discs and approximately at the midpoint. This is important, since if the center of gravity of the supported parts coincides with the center of support, there will be no tendency on the part of the supported body to rotate when the apparatus as a whole is subjected to disturbances due to wave motions and vibrations of the ship. As a result of this construction the two carbon electrodes 5 and 14 are maintained at all times in parallel relation.

The damping rings 15 and 16 are also designed to perform an important function in addition to damping the moving system of the device. These rings are carefully selected and tested so that the thickness thereof under a definite weight bears a fixed relation to the distance between the diaphragm and adjacent parallel wall of the cup and cover. As a result, as indicated in exaggerated form in Fig. 3, there is a slight bowing of the diaphragm when the cover is screwed home on the cup. The washers 15 and 16 are chosen so that the resulting bowing of the diaphragm 6 is greater than that of the diaphragm 7. The result on the compound diaphragm is the same as though a single diaphragm were slightly bowed toward the back electrode 14. As a result when the cup 11 heats up, due to the passage

of a steady current between the electrodes, the consequent peripheral expansion of the rim of the cup permits the bowed diaphragm construction to straighten out, causing a slight movement tending to separate the electrodes, thus loosening up the carbon granules included between the electrodes. Experiments and careful tests have shown that devices constructed as above described, when included after a period of inactivity in circuit with a source of potential, present a low resistance due to packing of the granules, which resistance gradually increases and becomes constant as the device heats up. It is particularly advantageous in underwater devices of this character to avoid the effects of packing of the granules, since the usual method of giving the carbon chamber a sharp blow cannot be utilized, owing to the inaccessibility of the device.

The operation of the device may be explained as follows. Sound vibrations or other vibrations which it is desired to detect cause the vibration of the sound-responsive body 1. The electrode 5 and the parts which are fixedly secured to the stem 3 partake of this vibration. The cup members 11 and 12, however, due to the fact that they are flexibly supported from the stem 3 by means of the discs 6 and 7, partake of this motion, yet due to the inertia of the cup members and the stiffness of discs 6 and 7, the phase of the motion of the cup members differs from that of the sound-responsive body. This produces relative movement between the cup member and the sound-responsive body, and consequently between the electrodes 5 and 14, which serves to vary the resistance of an electrical circuit including the electrodes 5 and 14 and the carbon granules 17. The damping rings 15 and 16 are for the purpose of preventing sustained vibration of the moving system of the current-varying device when subjected to vibrations at or near the natural frequency of such moving system. Such damping means are a very important element of the device of the character disclosed because resonant effects introduce distortion and materially affect the quality of the reproduction.

What is claimed is:

1. In an acoustic device, the combination with a sound-responsive body, of a current-varying device mounted thereon comprising a part fixed to said sound-responsive body, a plurality of spaced resilient diaphragms carried by said fixed part, and a second part solely supported by said diaphragms for relative movement to said sound responsive body.

2. An acoustic device comprising a sound-responsive body, a member having considerable inertia, means comprising a plurality of spaced flexible diaphragms for supporting said inertia member from the center of said sound-responsive body, and current-varying means controlled by relative movement between said body and member.

3. A microphone comprising a cup, an electrode fixed in said cup, a second electrode, means comprising a plurality of spaced parallel resilient diaphragms solely supporting said cup on said second electrode, and a resistance-varying material included in said cup between said electrodes.

4. An acoustic device, comprising a sound-responsive body, an inertia member, means for supporting said inertia member on said body for movement relative to said body with the point of support substantially coinciding with the center of gravity of said inertia member.

5. In an acoustic device, the combination of a sound-responsive body with a current-varying device supported thereon with its center of gravity substantially coinciding with the point of support.

6. An acoustic device comprising a sound-responsive body, an electrode mounted thereon, a yielding support on said electrode, a cup supported on said yielding support with a portion on either side of said support, a second electrode mounted in said cup, and a variable resistance material included between said electrodes.

7. A microphone comprising a cup containing electrodes and a variable resistance material, a cover for said cup having an aperture of less extent than the opening of the cup, a diaphragm clamped at its periphery between said cup and cover, and energy-absorbing material included between the inner surface of said cover and said diaphragm.

8. A microphone comprising a cup having an enlarged portion, a cover for said cup having a central aperture, a diaphragm clamped between said cup and cover, energy-absorbing material included between the enlarged portion of the cup and the diaphragm and between the inner surface of the cover and the diaphragm, and a pair of electrodes within said cup and variable resistance material included between said electrodes.

9. A microphone comprising a pair of electrodes, granular material included between said electrodes, and means responsive to the passage of current therebetween for imparting a slight relative movement to said electrodes to compensate for any expansion of the granular material.

10. A microphone comprising a pair of electrodes, a resilient mounting for one of said electrodes, means exerting a pressure on said mounting normally displacing the electrode supported thereby towards the other electrode, and means responsive to the heating effect of current between said elec-

trodes to render said pressure means inactive to permit a slight separation of the electrodes.

11. A microphone comprising a pair of electrodes, a resilient mounting for one of said electrodes including a diaphragm, means for normally bowing said diaphragm, and means responsive to the heating effect of current passing between said electrodes to render said bowing means ineffective.

In witness whereof, I hereunto subscribe my name this 16th day of June A. D., 1919.

CHARLES R. MOORE.