

UNITED STATES PATENT OFFICE.

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SOUND-DETECTING DEVICE.

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To all whom it may concern:

Be it known that I, IRVING LANGMUIR, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Sound-Detecting Devices, of which the following is a specification.

My invention relates to devices for detecting sounds or similar vibrations transmitted through a fluid medium such as water or the like, in which the sounds are rendered perceptible through the instrumentality of a telephone receiver connected to a sound detecting device comprising a microphone, or similar electric device, located in a closed chamber, and attached to a sound transmitting diaphragm.

Microphones of one type to which I refer comprise a tight casing which contains carbon granules located between carbon terminals or plates. Electric current connections are made to these terminals of the microphone through conducting wires. Now I have found that the mechanical reaction of the conducting wires against movement of the microphone due to changes in pressure on the diaphragm carrying the microphone or similar device markedly affect the resistance of the microphone and thereby become perceptible in the telephone receiver. These pressure effects are peculiarly noticeable when the sound detecting device is submerged in water the surface of which is more or less agitated by waves, as the rhythmic changes in hydrostatic pressure on the sound detecting device, due to the rise and fall of the waves, produce in the microphone pressure variations on the carbon particles, and corresponding changes in the sensitiveness of the microphone. As a result there is a rhythmic increase and decrease in the loudness of the sounds heard. In order to contribute to the elimination of these wave sounds I provide the microphone with current conducting wires so associated with the microphone as to be free from such mechanical reaction against movement of the microphone as would result in producing any audible sounds. In other words, any pressure against the diaphragm carrying the microphone caused by the action of waves will not produce any change in the pressure upon the carbon granules of the microphone.

In carrying out my invention in practice,

I may utilize a microphone of the inertia type so arranged as to receive the vibrations from the fluid medium through the vibrations of an interposed body of a material, such as soft rubber, having non-resonant, aperiodic characteristics.

The scope of my invention will be particularly pointed out in the appended claims, while the invention itself will be better understood by reference to the following description and the accompanying drawings, in which:

The figure shown is an enlarged longitudinal sectional view of a device embodying my invention.

The sound receiving device embodying my invention, though not necessarily limited to use under water is nevertheless primarily adapted for that purpose, and to this end it is constructed so that its interior working parts shall be maintained free from water or moisture. In the particular form indicated in the drawings a cup-shaped member 1, best constructed of pure soft Pará rubber, contains the microphone element, which is carried on a perforated metallic disk 2 embedded in the rubber and having a perforated shank 3 projecting centrally into the interior or inner side of the cup. The rubber, which is molded about this perforated disk at the time the cup 1 is being formed, penetrates the openings or perforations in the disk 2 from side to side and thus firmly secures or sews it in place.

The microphone element is supported on the shank 3, which is centrally drilled and tapped to hold it. This microphone element, shown partly in section and in the main of usual construction, comprises a brass casing or cup 4 containing carbon granules 5 in contact with one carbon plate or terminal 6 resting on the bottom of the cup and also with a second carbon plate or terminal 7, electro-plated on one side, and soldered on that side to a disk 8 of brass provided with a threaded projection 9. The carbon terminals are separated from the sides of the cup by a ring of felt 10, and the cup is closed by a perforated mica diaphragm 11 clamped between the disk 8 and a disk 12 of brass or other suitable material threaded on the projection 9 of the brass disk 8, and screwed down against the mica diaphragm. The brass casing or cup 4 has a threaded supporting stud 13 integral with or riveted to it

to screw into the shank 3 and support the microphone in place.

To assist in making electrical connections to the microphone in such a manner that
 5 movement of the microphone does not cause variations of pressure on the carbon granules I provided a bail 14, of brass or other conducting material, fastened to a metal ring spun about the flaring tip of the cup 4 and
 10 in electrical contact through the cup with the carbon terminal 6. A flexible terminal wire 15 leading to the microphone is mechanically and electrically connected to the bail 14 while the other flexible terminal wire
 15 16 is mechanically connected to but insulated from the bail by an insulated terminal 17, which is connected through a very flexible wire 18 to the threaded projection 9 and thence to the carbon plate or terminal 7.

To enclose the microphone in a water tight chamber I close the open end of the rubber cup 1 with some suitable water tight closure. I prefer a thimble or short tube 19 having external circumferential grooves and
 25 fitted tightly into the rubber cup 1. This thimble is counterbored at the outer end to receive various members which cooperate to produce a water tight closure, while the open inner end of the thimble leaves the
 30 bottom of cup free to act as a diaphragm. A brass disk 20 fitting snugly in the counterbore of the thimble 19 has on its edge a groove for holding a drying agent, preferably metallic calcium in the form of a number of turns of wire 21. The slow diffusion
 35 of the air contained in the interior of the thimble and cup 1 through openings 22 into the groove 21 and over the calcium wire keeps the air perfectly dry.

Electrical connections with the microphone are made through the terminal wires 15 and 16 by leading-in wires 23 and 24 heavily coated with rubber 25 and 26 and fitting tightly into holes in the brass disk
 45 20 and also into holes in a solid block 27 of soft rubber which presses against the grooved brass disk 20. To compress the rubber 27 firmly about the wires and against the disk I provide a follower disk 28, preferably of brass, and having holes for the wires.
 50 The follower disk is driven against the rubber block 27, expanding it outwardly against the thimble 19 and inwardly against the leading-in wires to form an absolutely
 55 water-tight joint, by means of a follower ring 29 screw-threaded into the outer end of the thimble 19. A lock-washer 30 of phosphor bronze or similar spring metal between the follower disk and the ring keeps
 60 the parts under constant compression in case they should have a tendency to give through the action of time or other influences.

In many cases it is advisable to clamp the rubber cup 1 to the thimble 19 by a clamp
 65 31, locked by a screw-fastener 32 in place

around the cup so as strongly to compress it against the thimble.

To protect the leading-in conductors 23 and 24 and the other portions of the device projecting from the cup 1 a soft rubber cover 33, through which the leading-in conductors pass, is applied over the projecting
 70 portion of the thimble 19. A reentrant portion 34 of this cover fits into the interior of the follower ring 29.

When the device above described is immersed in a sound conducting liquid medium the sound waves act upon the bottom of the cup 1, which forms a rubber diaphragm for supporting the microphone, and cause vibrations to be transmitted to the carbon granules and carbon terminals by reason of the inertia of the parts of the microphone. As already explained, the variations in resistance of the microphone circuit due to these sound vibrations may be disturbed, in case the device is used in the open sea, by variations in the hydrostatic head of water above the device due to the rise and fall of the waves. The pressures due to water waves are applied and released very slowly, as compared with the rapid varying pressures produced by a sound wave, and cause a slow oscillation of the diaphragm, so that the microphone is moved bodily back and forth.
 80 Any effect upon the microphone of this slow movement of the rubber diaphragm is prevented by eliminating any factor which would make the microphone button sensitive to slowly applied pressure. To this end the terminal wires 15 and 16 leading to the microphone from the leads 23 and 24 are very flexible and are fastened mechanically to the bail 14 so that as the microphone is moved back and forth by the slow oscillation
 85 of the diaphragm these wires cause no variation in the pressure on the carbon granules of the microphone.

Changes in air pressure in the closed chamber produced by the oscillations of the rubber bottom of the cup 1 also vary the pressure on the carbon granules if the casing 4 of the microphone is tight. To prevent these pressure variations the brass casing 4 may be ventilated by perforations 35
 90 which equalize the pressure in the closed chamber and in the casing 4.

I do not lay claim to the ventilated construction for the microphone as heretofore described nor to the use of rubber as a supporting diaphragm for the microphone, as these features are described and claimed in companion applications of Chester W. Rice Serial No. 302,247 and Albert W. Hull Serial No. 302,232.

Sound detecting devices such as herein described may be used singly if desired, but are especially useful in pairs or in triplets, for determining the direction from which a sound comes by means of the bin-

aural sense possessed by the human ears. When sound is transmitted to the human ears from a point which is not equally distant from the two ears of the observer, the sound arrives at one ear later than at the other because of the different distances which the sound has to travel to reach the two ears. The same sound impulses are therefore not received simultaneously at the two ears of the observer and in some way due to this effect the brain receives the impression that the source of sound is either at the one side or the other of the observer. This effect is less pronounced the purer the quality of the sound received. In the case, for example, of a pure tone, such as that of a tuning fork, or a telephone fed with sine wave alternating current, the binaural sense can only with great difficulty determine the direction of the sound. Where, however, the sound includes sharp peaks or other salient and recognizable variations or characteristics the binaural effect is much more acute. The use of a soft rubber diaphragm to support the microphone as heretofore described is of especial value where devices of this general character are to be used binaurally, as it avoids any resonance effects such as might occur if diaphragms of metal, wood or the like were employed, which resonance effects would, by magnifying sound vibrations forming no essential portion of the sounds to be listened to, have a tendency to produce a false quality in the sound perceived through the microphone. As the binaural sense seems to depend upon some kind of comparison of some salient characteristics of the sound to be listened to, this sense is interfered with seriously where a false reproduction of the received sounds is produced by resonant effects produced in the receiving apparatus itself.

I have disclosed herein a microphone of the granule type for producing a varying current. It is evident, however, that the attachment of the leads in the manner herein disclosed will be similarly useful if other means for producing a variable current are used, as for example a microphone not of the granule type or a magnetophone, if such other means operates upon the inertia principle and employs a floating or relatively movable member or members having one or more leads connected thereto. While other material having the desired characteristics of soft rubber may be employed in place thereof, as the material of the cup,

soft rubber gives the best results for the purposes in hand of any material with which I am acquainted.

It is observed that in the device which I have disclosed the rubber diaphragm supporting or carrying the microphone is in an unstrained and unstretched condition and I consider this a valuable quality. The fact that rubber is of approximately the same density of water, in which it is immersed, contributes to the non-resonant quality of the diaphragm under the conditions of use.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. A sound detecting device comprising a rubber diaphragm, means of the inertia type for producing a varying electrical current, said means having two members, one attached to said diaphragm, and the other movable with respect to said first member, a lead for conducting electrical current extending to said relatively movable member, means for preventing the application of stress to the relatively movable member by the lead which extends thereto.

2. A sound detecting device comprising a rubber diaphragm, a microphone of the inertia type mounted on and movable with said diaphragm, current conducting leads for said microphone stressed by movement of said diaphragm, and means for preserving the resistance varying element of said microphone from variations due to mechanical stress exerted on said leads by a movement of said diaphragm.

3. A sound detecting device comprising a flexible diaphragm, a microphone of the inertia type carried thereby and bodily movable therewith, said microphone having one element thereof fastened to said diaphragm, current conducting leads for said microphone, and means for mechanically fastening the ends of both of said leads to that element of the microphone carried directly by the said diaphragm.

4. In a sound detecting device, the combination of a rubber diaphragm forming one wall of a closed chamber, a microphone attached to said diaphragm and located within said chamber, a groove located within said chamber and a wire of drying material fitted within said groove for maintaining dryness of the air in said chamber.

In witness whereof, I have hereunto set my hand this 5th day of June 1919.

IRVING LANGMUIR.