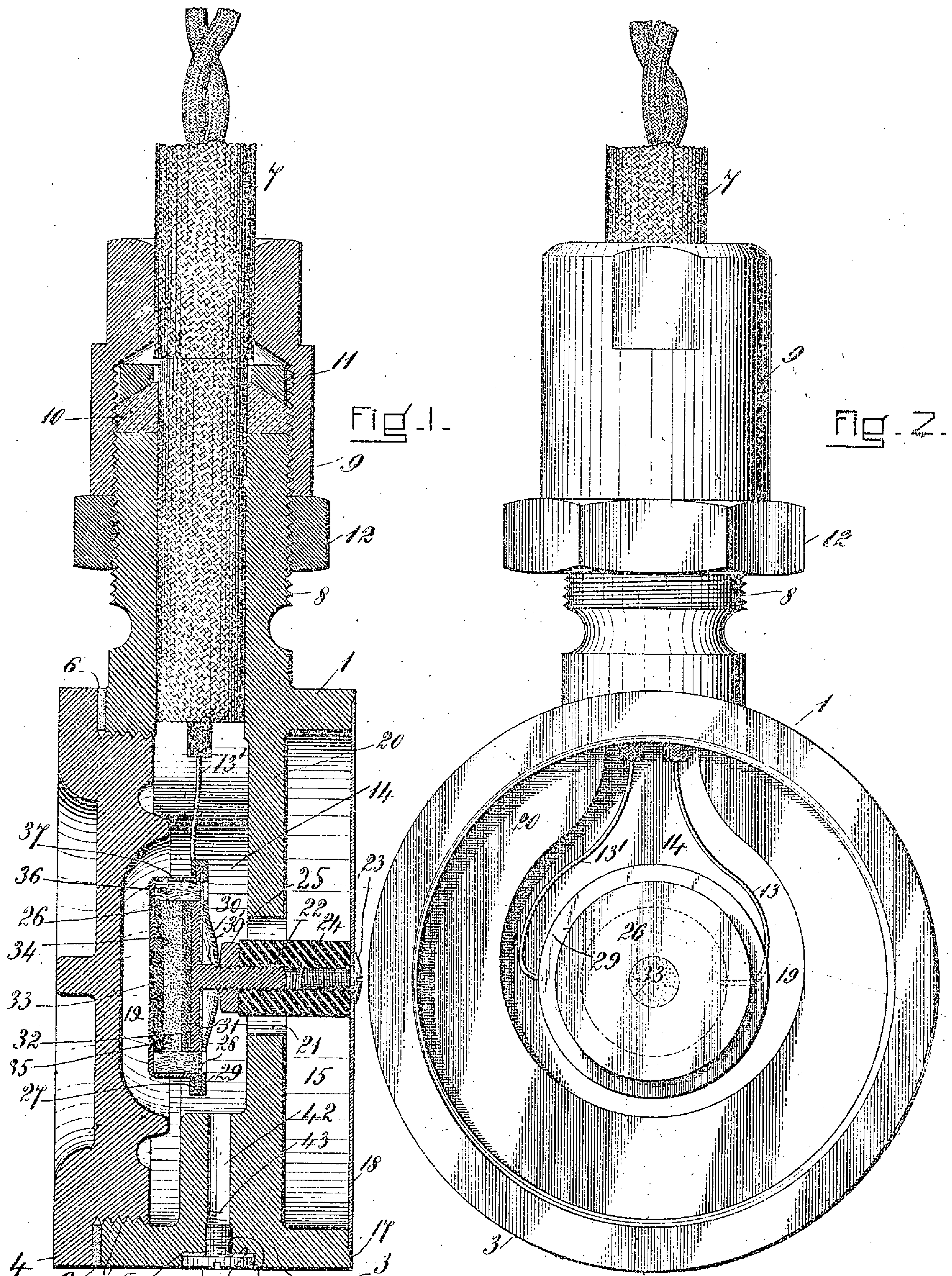
F. M. DURKEE & J. B. MILLET.

SOUND TRANSMITTER.

APPLICATION FILED OCT. 29, 1904.

966,534. Patented Aug. 9, 1910.

2 SHEETS—SHEET 1.



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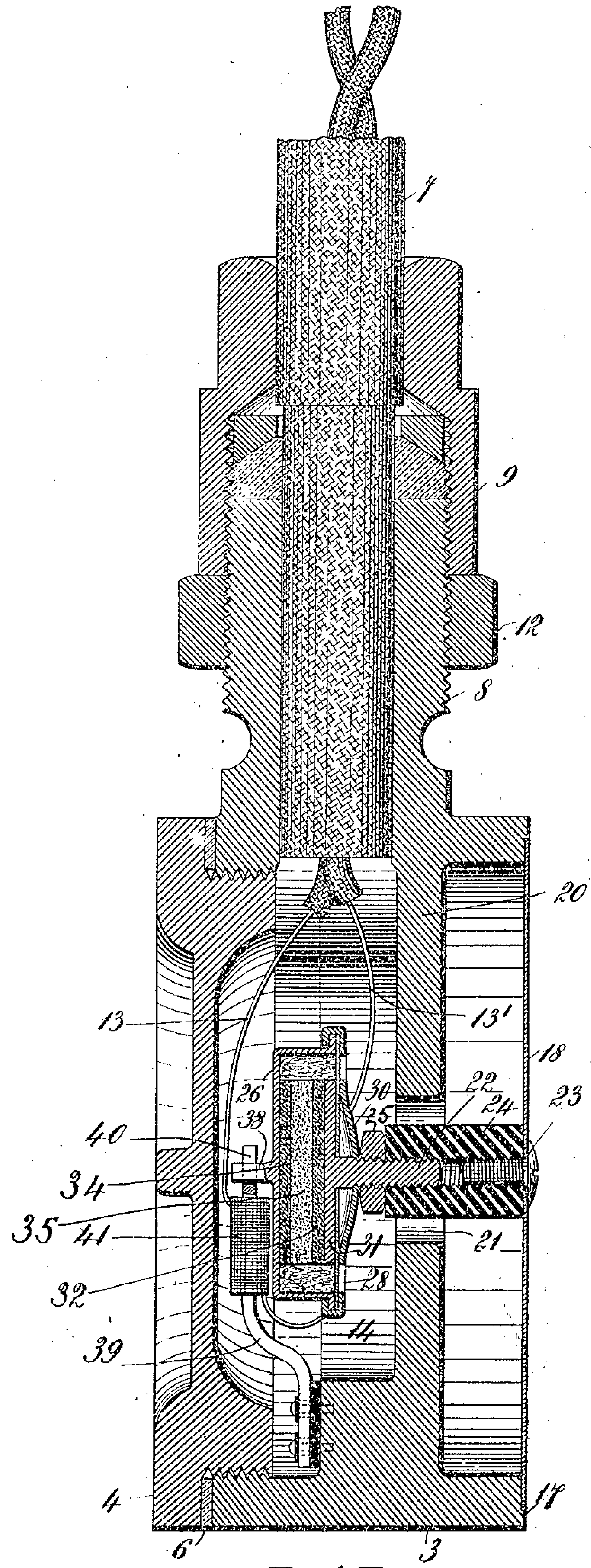

Fig. 3.

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UNITED STATES PATENT OFFICE.

FREDERICK M. DURKEE, OF NEWTON, AND JOSIAH B. MILLET, OF BOSTON, MASSACHUSETTS, ASSIGNORS TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, MAINE, A CORPORATION OF MAINE.

SOUND-TRANSMITTER.

966,534. Specification of Letters Patent. Patented Aug. 9, 1910.

Application filed October 29, 1904. Serial No. 230,510.

To all whom it may concern:

Be it known that we, FREDERICK M. DURKEE, of Newton, in the county of Middlesex and State of Massachusetts, and JOSIAH B. MILLET, of Boston, in the county of Suffolk and State of Massachusetts, both citizens of the United States, have invented certain new and useful Improvements in Sound-Transmitters, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in explaining its nature.

One object of our invention is the construction of a sound transmitter peculiarly sensitive to such sounds as are best adapted for submarine signaling purposes, while insensitive or practically unresponsive to all other sounds.

Another object of our invention is a transmitter within which the action of the sound waves upon the diaphragm is reinforced or amplified to give increased sound effects.

A further object of our invention is a sound transmitter the sensitiveness of which is not impaired by the deadening or dampening effect of variation of water pressure during submersion, although the diaphragm be in direct contact with the sea water.

Another object of our invention is a means of assuring constant and reliable operation of the transmitting microphone by preventing packing of the carbon particles.

Other objects of our invention will hereinafter appear.

The first object of our invention is based upon the principle that sounds in order to have the best carrying quality in water must be of high pitch, experience having demonstrated that sounds of low pitch are distinct at short distances only. Submarine signaling apparatus is accordingly designed to produce sounds of high pitch. On the other hand, those sounds and noises of local origin at the receiving station, such as tend to neutralize and confuse signals, are for the most part of low pitch. We have conceived that by making the receiving diaphragm of the transmitter selective in its action and responsive to sounds of high pitch only, the signals would be much clearer and consequently audible with certainty at greater distance.

Our transmitter diaphragm is rendered selective by mounting the same under considerable tension. A diaphragm so held has substantial vibration in response to notes of high pitch only. Our preferred method of so mounting and maintaining the diaphragm consists in heating the same, and while heated, soldering it at its edges to the transmitter casing. The diaphragm being thus held unyieldingly at its edges becomes extremely taut by virtue of its contraction on cooling.

By restricting the action of the diaphragm to within certain limits, we have accomplished another purpose. We are enabled to reinforce the action of the diaphragm by means of a column of air or other fluid in contact therewith, and of the same pitch. Heretofore where the diaphragm has had wide range of pitch, it has been impossible to reinforce the same by a column of air except perhaps for a single note. This is because such a column has a pitch substantially invariable, and will not respond to sounds of other pitch. A reinforcing means of the character mentioned if used in connection with transmitter diaphragm of usual type, thus responding to certain notes only would be less desirable than none at all because of the sudden variations in quantity of sound that would result therefrom. For these reasons, the ordinary telephone transmitter lacks the reinforcement feature, but even with it, would not be operative to produce improved results.

A common defect of a transmitter when put to submarine use is that its action is deadened or dampened by the pressure of water on the diaphragm, and this trouble naturally increases with the depth at which the instrument is employed. The diaphragm being pressed inward by the water pressure ordinarily tends to force together the disks between which the carbon resistance varying means lies, and, by packing the carbon, to cause the responsiveness of the microphone to be impaired. Attempt has been made to rectify or neutralize the fault by adjusting the resistance varying means to operate efficiently when the diaphragm is thus subjected to pressure. Such adjustment, however, has always been made before submersion of the instrument, and for definite pressures only.

Consequently the result of any variation of the pressure during submersion, such as by raising or lowering the transmitter, has been to impair the efficiency of the instrument. On the contrary, in transmitters of the type hereinafter to be described by us, variation of the pressure of the water against the diaphragm cannot operate to pack the carbon or to otherwise injuriously affect the operation of the microphone. We have provided means whereby there is relative movement of the disks between which the carbon is located, only at the time of receiving signals. At other times the disks are mounted to yield together in response to water pressure, and by so yielding together, to prevent packing or displacement of the carbon.

The manner in which we attain the various objects of our invention will appear upon a more detailed description of the same in connection with the accompanying drawings, in which—

Figure 1 is a view in sectional elevation of our transmitter. Fig. 2 is a rear view in elevation of the same with the cover piece removed. Fig. 3 is a plan in sectional elevation of a modified form of our invention.

Referring to the drawings, we have shown our transmitter case 1 comprised of two sections, 3 and 4, threaded at 5 to engage one another, the joint between the two being rendered water tight by a rubber or other washer 6. The transmitter case is supported upon the suspension cord 7 by means of an extension 8 threaded to engage the sleeve 9 on said cord. The sleeve 9 is provided with a rubber or other plug or packing 10 for tightly holding the suspension cord and providing a water tight connection therewith, and this plug is maintained in position within the sleeve 9 by means of a brass washer or piece 11. The extension 8 of the casing is screwed into the sleeve 9 and into contact with the rubber 10 and is so held in place by means of a lock nut 12 threaded thereon. The suspension cord shown is composed of rubber or other elastic or yielding material whereby it may be pulled and jarred without transferring vibration to the transmitter. Within the cord are the wires 13 and 13′ forming the transmitter circuit. These wires in order that they may not be injured because of the flexibility of the cord, and that they may not impair the flexibility of the cord, are fine, and within the cord are more or less coiled or sinuous, so as to have sufficient length to prevent their rupture, though the cord be somewhat strained or stretched. From the cord 7 the wires are led into the chamber 14 within the transmitter casing. This chamber is for the most part formed within the piece 3 of the casing as shown in the drawing and is closed to the water by means of the piece 4. Within the body or section 3 of the casing is also provided a second chamber 15.

At the outer end of the flange 17 of the casing, and closing the mouth of the chamber 15, is a sound receiving diaphragm 18. This diaphragm is soldered while expanded under heat into its position on the casing, and upon contraction is tautly stretched across the mouth of the chamber 15. At the center of the diaphragm 18 is supported the microphone or resistance varying means 19. The resistance varying means itself is within the chamber 14, which is just of sufficient size to snugly contain the same. The chambers 14 and 15 form within the casing a partition 20. An opening 21 is provided at the center of this partition through which the support for the resistance varying means extends to the diaphragm. We have shown this support as consisting of a threaded extension 22 on the microphone and a screw 23 fitting within a hole in the center of the diaphragm, the two being engaged by a threaded sleeve 24 of insulated material such as hard rubber or ivory, to prevent grounding of the current through the case. A lock nut 25 prevents the microphone turning or becoming loose in the sleeve 24.

The microphone is shown as comprising a cup-shaped member 26, having an outwardly turned flange 27. Lying against the flange 27 and closing the member 26 is a disk 28 of mica or similar material. The disk 28 is retained in place against the flange 27 by a clamping ring 29. Supporting the disk 28 is the button or member 30. This member 30 is perforated as at 30′ to provide for the support 22. Integral with the support 22 within the microphone casing is the plate 31. Secured to the plate 31 is a carbon disk 32. Secured to the member 26 as at 33 is a carbon disk 34. Between the disks 32 and 34 is the resistance varying means or granular carbon 35. The disks 32 and 34 together with the carbon between them are closely embraced by a layer 36 of fibrous material such as cotton or glass wool which occupies the space between the resistance varying elements and the circumference or wall 37 of the cup 26. Conducting wires 13 as shown are attached to the cup member 26 which is of brass or other suitable material, while the wire 13′ is attached to the member 30 of similar material.

It is important that the transmitter casing in the structure shown by us be perfectly water tight. Otherwise the efficiency of the resonance chamber will be destroyed by the admission of water, and the microphone injured, grounded or short circuited from the same cause. Accordingly as already stated, the rubber washer or packing 6 is to prevent any access of the outer water to the chamber 14 through the casing, and the rubber

washer or plug 10 to prevent any water reaching the chamber through the extension 8 along the suspension cord. In order, however, to positively insure a perfectly water tight casing we have made provision for testing the joints of the same. In Fig. 1 the member 3 of the casing is shown as having a passage or inlet 42 threaded at its outer end 43. Threaded to engage and close this passage is shown a screw plug 44 the head 45 of which lies in a countersink 46 in the member 3. Beneath the head 45 of the plug is a rubber or other washer 47 to hermetically close the passage 42 when the plug is in place. After the transmitter has been assembled and before the instrument is used the plug 44 is removed and the interior of the transmitter placed in communication through the passage 42 with a suitable source of fluid under compression. By this means not only is any leak in the casing exposed, but, what is more important, the column of air or other fluid within the casing and in contact with the diaphragm may be so adjusted in density or pressure, as to act in harmony with the diaphragm when vibrating having regard to the depth at which the instrument is to be used. When the proper relation has been established between the fluid within the casing and the diaphragm the plug 44 is screwed into place. Any other insulating fluid may be substituted for air if desired.

The structure shown in Fig. 3 is identical to that shown in Fig. 1 with the exception of the manner in which the microphone is mounted within the chamber 14. Whereas in Fig. 1 the resistance varying means is of the inertia type and is mounted entirely upon the diaphragm 18, in Fig. 2 the resistance means, although shown supported by the diaphragm 18 as before, is also provided with a so-called solid back of peculiar construction. In this modification the member 26 of the microphone casing has mounted thereon an iron rod or stud 38. Upon the casing member 3 is rigidly mounted the rod 39 forked or in the form of a yoke 40 at its upper end. This rod is of such a shape that it extends upward directly behind the member 26 of the microphone casing, the yoke 40 loosely embracing the stud 38 on the casing. Upon the rod 39 is mounted the electromagnet 41. In this structure the conducting wire 13 passes through the electromagnet 41 and thence to the casing 26, while the wire 13′ is attached to the casing member 30 as before.

The operation of our invention and the function of the various elements thereof are as follows. The transmitter is lowered or suspended in the water by means of the rubber insulated suspension cord 7. Although designed to be submerged directly in the water, the transmitter is of course equally adapted to be immersed in a submerged tank of any liquid and to receive vibration from the water through the medium of the liquid within the tank, as described in U. S. Patents Nos. 768,568 and 768,570. The transmitter being lowered in the water the pressure upon the diaphragm 18 gradually becomes greater, but, where in the ordinary transmitter this pressure would tend to force the carbon disks 32 and 34 together thereby packing the carbon 35 between them, in the case of our invention the two disks yield inwardly together because they are both supported upon the diaphragm in the manner hereinbefore described. The inertia of the microphone, however, is such that the sharp action of the sound waves upon the diaphragm causes the two disks to have relative movement, and the resistance varying means to be thereby operated, causing pulsations of current in the receiving circuit. This circuit is traced from the wire 13, through the casing 26, carbon disk 34, carbon 35, carbon disk 32, plate 31, extension 22, plate 30, and wire 13′. The ivory or rubber insulating sleeve 24, as hereinbefore stated, prevents grounding of the current by the diaphragm 18. The effect of the cotton fiber or glass wool 36 is to provide an elastic support or retaining means for the granulated carbon. The cotton has sufficient elasticity to yield to any undue pressure or tendency there may be to pack the granular carbon, and in this way the carbon is maintained in a free and sensitive condition. The casing 37 closely fitting around the carbon prevents the same from suffering deterioration by virtue of absorbing moisture or exposure to the air. The casing 37 has the further effect of maintaining the fiber truly and unyieldingly in place whereby its proper action is further insured. The disk of mica 28 lying between the cup 26 and plate 30 prevents access of air and moisture to the fiber and carbon, between the edge of disk 30 and ring 29.

As hereinbefore mentioned, the diaphragm 18 is tautly mounted over the casing and its tension is such as to make it especially responsive to sounds of high pitch. The pitch provided for is that at which effective submarine signal apparatus is sounded. The diaphragm is but little if at all responsive to the noises or sounds of local origin such as originate within the ship or receiving station itself, or to any other sounds except those of the signal bell. The chamber 15 is of such size that the fluid column therein vibrates at the pitch to which the diaphragm is designed to vibrate. The vibrations of the diaphragm and fluid being thus in synchrony reinforce each other and increase the

action of the diaphragm upon the resistance varying means.

It has been stated that the chamber 14 is as small as possible to hold the microphone and permit of the proper action of the same. One reason for having the chamber of such restricted size is to render the instrument compact. Another reason, however, is that the chambers 14 and 15 are in communication as at 21, and as the chamber 15 is especially designed to vibrate with the diaphragm, it is desirable not to have its pitch affected by communication with a large column of fluid such as might be contained in a large chamber 14.

The structure shown in Fig. 3 is in all respects similar in operation to that shown in Fig. 1, except in the provision of the temporary solid back hereinbefore described. As in the structure shown in Fig. 1 the microphone casing and its connections are all mounted upon the diaphragm 18 by the means described. In this figure the receiving circuit may be traced as follows:—wire 13, electromagnet 41, casing 26, disk 34, granular carbon 35, disk 32, plate 31, extension 22, plate 30, wire 13'. The plate 26 is, however, of modified form, being provided with a stud or rod of metal such as iron. So long as no signal is being received by the operator, there is no current in the local circuit and the microphone yields with the diaphragm to the pressure of the outer water, the stud 38 slipping freely between the prongs of the yoke or fork 40 on the rod 41. Upon the establishment of a current in the line by the operator for the transmission of signals, however, the magnet 41 in said circuit is energized, and acting magnetically upon the stud 38 operates to maintain the casing 26 and carbon disk 34 immovable. The movement of the carbon disks 34 and 32 toward each other in response to sound waves is then no longer relative or differential as in the structure of Fig. 1, but is positive, with the result that the sound effects in the local circuit are perhaps more sharp.

Although the above is a description of the most satisfactory embodiment of our invention now known to us, it is apparent that in detail the structure shown may be modified without departing from the spirit thereof.

We are aware of the patent to Daniel Drawbaugh, No. 540,961, dated June 11, 1895, and disclaim the invention therein described.

Having thus fully described our invention, what we claim and desire to secure by Letters Patent of the United States is:

1. In a device for receiving submarine signals, a water-tight case adapted to be submerged, a high pitch diaphragm closing one side of the same, a microphone behind said diaphragm in operative connection therewith, and a resonance chamber, whereby the apparatus is made to transmit submarine signals of a definite pitch in preference to other sounds.

2. A transmitter having a diaphragm secured thereon while expanded under heat and held tautly stretched by virtue of its contraction on cooling.

3. A transmitter having a diaphragm arranged to vibrate at high pitch, a chamber closed by said diaphragm, said chamber of a size to have the column of fluid therein vibrate at high pitch in unison with diaphragm to reinforce the latter.

4. A transmitter having a diaphragm of definite pitch inclosing a column of fluid of substantially the same pitch whereby the two vibrate in unison to reinforce each other and enlarge the sound effects on the microphone.

5. In a transmitter, two disks, resistance varying means between the same, a diaphragm in connection with one of said disks, said disks being mounted to yield together with said diaphragm under normal conditions, and means for rendering one of said disks stationary for the reception of signals.

6. In a transmitter, two disks, resistance varying means between the same, a diaphragm in connection with one of said disks, said disks being mounted to yield together with said diaphragm under normal conditions, means controlled by the operator's receiving circuit for rendering one of said disks unyielding for the reception of signals.

7. In a transmitter, resistance varying means, a chamber in which said means is closely contained, a sound receiving diaphragm, a resonating chamber closed by said diaphragm, a partition between said chambers, said diaphragm communicating through the two chambers and said partition with said resistance means.

8. In a transmitter, resistance varying means, a chamber in which said means has movement as a whole and vibrates in response to sound, said chamber being closely fitted to said means, a sound receiving diaphragm, a resonating chamber closed by said diaphragm, a partition between said chambers, said diaphragm communicating through the two chambers and said partition with said resistance means.

9. In a device for receiving submarine signals, a water tight case adapted to be submerged, a high pitch diaphragm closing one side of the same, a microphone behind said diaphragm in operative connection therewith, and a resonance chamber, and means for connecting the resonance chamber with a fluid supply whereby the fluid pressure in said chamber may be adjusted, comprising an opening in said case leading into

said chamber, and a closure for said opening, as described.

10. A transmitter comprising a casing and a diaphragm of definite pitch and inclosing a column of fluid of substantially the same pitch with said diaphragm, and means for regulating the pitch of said fluid column whereby it and the diaphragm may vibrate in unison to reinforce each other and enlarge the sound effects on the microphone, said means comprising an opening in said casing adapted to be connected to a source of fluid under pressure, and a closure therefor, as described.

FREDERICK M. DURKEE.
JOSIAH B. MILLET.

In presence of—
HORACE B. GALE,
ANNIE J. CONVERSE.