Sept. 24, 1929. I. C. CLEMENT 1,729,161

SOUND RECEIVER AND TRANSMITTER

Filed March 22, 1927

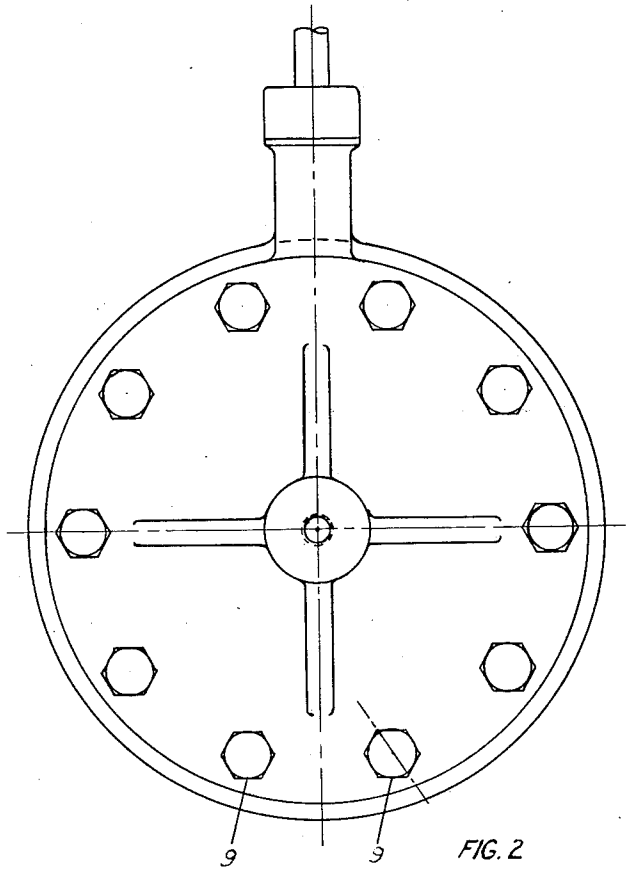


FIG. 2

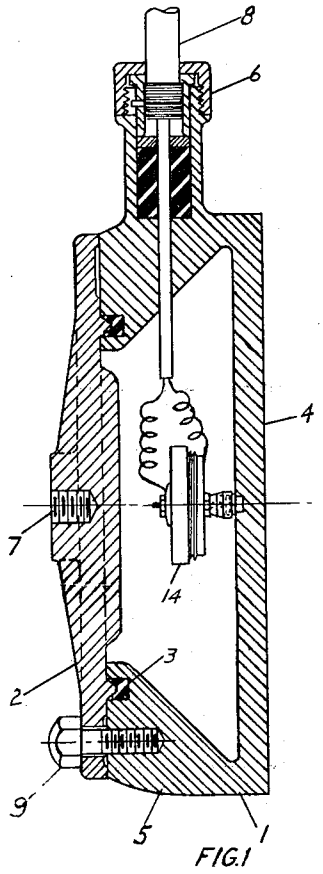


FIG. 1

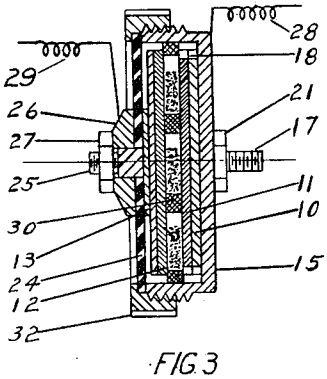


FIG. 3

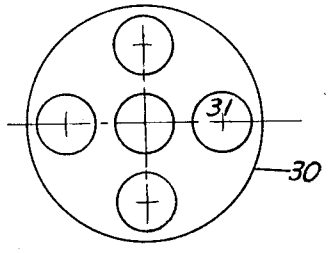


FIG. 4

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UNITED STATES PATENT OFFICE

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SOUND RECEIVER AND TRANSMITTER

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The present invention relates to sound receivers and transmitters and in particular to microphones in which sound waves are translated into electrical vibrations. The invention has further application in submarine signaling in which a microphone is mounted upon a tuned or untuned diaphragm as the case may be depending upon under what conditions and for what purposes the hydrophone as it is called is to be used.

The present invention resides not only in the particular method and means used in the construction of the microphone to be described later but also in the combination of the microphone and what is known as a tuned case whereby a remarkably rugged, efficient, constant and at the same time sensitive hydrophone results.

The advantages in the microphone of the present construction are amongst other things its ruggedness in service and the comparative ease with which one can obtain a number of microphones exactly alike. This last feature is particularly advantageous not only in submarine signaling but in the art of sound reception in general where for eliminating undesirable noises and for intensifying the sound which is to be received a number of microphones are used together. In such cases it is only rarely that microphones of the same kind and ostensibly made exactly alike are so much alike that they will operate together in all particulars. It is well known, for instance, that a large number of microphones operating together ordinarily produce no more powerful response than two or three operating together. This is due to the fact that the individual microphones do not all respond exactly alike to produce a multiplication equivalent to their number but some are slower in their response than others or do not respond with the same degree of intensity or amplitude. This has been so true in the art of microphone construction that of a dozen microphones made alike, all of the same material, usually only three can be found which may be said to be similar. These three may be alike in amplitude phase but then again after a long or sometimes even only after a short period in service, it is usually found that they have varied so much that they can no longer be called similar.

In the present invention I have built a microphone button which can easily be matched. Among twelve microphones of the present construction there are always six or more which are alike and more closely alike than microphones previously constructed. In addition these six buttons will remain approximately alike substantially for their service life. Besides these advantages the hydrophones using these buttons are approximately two or three times as sensitive as hydrophones of the same sort now in standard use, which, of course is a considerable advance in the art.

While I have certain theories concerning the remarkable qualities of the present button and of the hydrophones and sound receivers wherein it is used, particularly with regard to the remarkable qualities and advantages gained over anything prior in the art, nevertheless I cannot definitely state wherein all these advantages are gained beyond the fact that the particular manner of construction and material involved in the various parts associated with the choice of proper mass and dimensions produce the desired results.

It is known in the art that if the total elastic force in a microphone button is large in comparison with the elastic force produced by the compression and expansion of the carbon granules that the microphone button will possess a certain constancy with regard to damping resistance and tuning which is otherwise difficult to obtain. Attempts have been made to accomplish this result but have lead to large microphones, excessively large, in fact, on account of employing metallic diaphragms. In order to increase the elastic force of the diaphragm its thickness had to be increased, but then its pitch is also increased to reduce which within the desired range the diameter of the diaphragm of the button had to be increased. Metal diaphragms were used for the most part in these large microphones since mica, which is used in small buttons, did not run uniform nor

could its diameter be advantageously increased.

I have found that phenolic condensation materials such as the material known by the trade name of bakelite are suitable for use in the diaphragm of the button and believe that one of the main features of my button by which the above mentioned advantages are gained is due to the use of this material, as the material for the diaphragm. While I mention this material, I do not mean to limit myself to the substance known as this material alone but mean to include substances similar in composition made by various chemical combinations, but not, however, any natural substances such as rubber or fibre which is not suitable in the present purposes.

Phenolic condensation products and other similar substances have some internal friction damping but this damping appears to be uniform throughout the material and of desirable character in the structure of microphone buttons. Furthermore, it has a high elasticity as compared with rubber for instance, but fairly low as compared with steel or other similar metals. Again it appears to be unaffected by ordinary heat or moisture and is not likely to warp or change in character. Furthermore, it is very uniform in character.

As the density is approximately 1.5 and as its elasticity is considerably lower than metals, a diaphragm having the desired resonance pitch is of substantial mass. The mass of the diaphragm in this type now used in submarine signaling is approximately sixteen times as heavy as the mass of a corresponding metal diaphragm having the same point of resonance. In addition the resonance curve is much broader than that of a metal diaphragm so that the method now employed in sound receivers is to use a diaphragm whose resonant pitch is above the range of signals to be received, so that within the range of signal no distortion will appear. In addition, having a high pitched diaphragm demands greater thickness, therefore greater mass and a greater ratio of the total elastic force to that of the carbon granules.

Having discussed in detail the advantages of the present diaphragm employed, I shall now describe the microphone button and its combination with a so called tuned case in the description of the combination and the details of the individual structures of which further features of the invention will readily be noted.

The description will refer to the drawing, in which—

Figure 1 shows a hydrophone receiver in section.

Figure 2 shows the hydrophone viewed from the back.

Figure 3 shows a cross section through the center of the microphone.

Figure 4 shows a detail of the microphone.

Figure 1 shows a hydrophone receiver which is capable of being used in a tank or otherwise immersed in water. The hydrophone receiver consists of a case 1 which is closed by a back plate or cover 2 which covers the open end of the case and prevents, by means of a watertight bushing 3, any water from entering within the case. The cover is held securely to the case by means of machine bolts 9, which, as shown in Figure 2, are placed around the outer part of the cover. It will be noted that the case itself is integral with the diaphragm 4. The usual practice has been to have the diaphragm a separate element, secured to the case. The diaphragm is also rather large and is tuned to the signal which it is designed to receive. The rim 5 of the casing is heavy with respect to the diaphragm and furnishes, together with the cover, a heavy mass, thus allowing the diaphragm to execute a maximum amplitude without imparting much energy to the heavy case. This type of rim is known as an inertia rim. The leads entering the casing, as shown in Figure 1, come in through a cable head 6 at the top of the hydrophone. This joint is made watertight after the usual manner, as will be readily seen from the figure. While the hydrophone may be mounted by means of the tapped thread 7 in the rear of the cover, it is usual to suspend it, by means of the cable 8 from some supporting means above. At the center of the diaphragm is mounted in any suitable manner the microphone 14, which microphone is shown in section in Figure 3. Here there is a metallic casing 15, cylindrical in shape and closed at one end but for a hole in the center through which the stud 17 passes, which stud carries the electrode 18. The casing is composed of brass or other suitable material. The electrode is composed of two discs, the back disc 10 being of brass while the front part 11 is made of carbon and soldered to the brass. The electrode 18 fits snugly against the end of the casing and is clamped thereto by means of the nut 21 threading the stud 17. The other electrode 12, opposite the electrode 18, is similar in all respects with the exception that there is a turned boss 13 for the purpose of setting the electrode away from the diaphragm of the button. The diaphragm 24, as has been stated above, is composed of phenolic condensation material or some similar material. It has a hole through the center through which the stud 25 of the front electrode passes for the purpose of clamping the diaphragm and the electrode firmly together. This is done by means of a clamping washer 26 and a nut 27 which

firmly clamp the center portion of the diaphragm to the boss of the front electrode. It will be noted that the back electrode makes electrical contact with the casing and furnishes in this manner one point of connection for the wire 28. The front electrode is so adjusted that it does not touch the walls of the casing 15 and is supported only by the diaphragm 24, which, at the same time, acts as an insulator in insulating it from the casing. A wire 29, soldered to the washer 26, furnishes the other electrical contact for the microphone button. Between the two electrodes 18 and 12 there is a felt washer 30 which just fits into the casing. This washer, as shown in Figure 4 has five holes 31 placed symmetrical about the axes perpendicular to the washer at its center. These holes are partially filled with carbon granules which serve to change the resistance between the two electrical contacts mentioned above when the microphone button is vibrated. The diaphragm 24 rests against the outer rim of the casing 15 and is clamped thereto by means of the clamping ring 32, which is screwed on to the open end of the casing.

While, as has been stated, the hydrophone case is tuned to the signal to be received, nevertheless, this tuning is rather broad, not only on account of the mass but on account of the size of the diaphragm. The button is also so designed that it is broadly tuned, but much higher pitched than the diaphragm. In one instance of construction, which has been found suitable in submarine reception, the case, so called, is tuned to a resonant pitch of 1200 cycles per second, while the button is tuned to 1800 cycles. Further, the mass of the casing and diaphragm of the case is so great in comparison with the weight of the button that no appreciable change in the tuning of the case is brought about by the coupling of the case and the button, with the result, therefore, that the resonant curve of the resulting hydrophone is substantially like that of the tuned case. However, due to the fact that the button is higher pitched and broad in resonance bordering upon being aperiodic, it cannot easily be agitated by impact excitation but needs more or less a continued vibration to produce a response in the electrical circuit which it operates. And, what is fully as important, due to the fact that the case is highly damped, impact excitation will not easily excite it and therefore it will have very little energy to force the button, which is substantially aperiodic at the frequency at which the case will vibrate from impact excitation. It will be remembered that impact excitation is excitation from shocks, heterogeneous sounds, etc., which in effect give a blow to the diaphragm and cause it to vibrate at its own natural frequency.

The result of the combination of the tuned case and the particular button produces, therefore, a surprisingly useful hydrophone, far more reliable than the hydrophone having a tuned diaphragm and a rubber aperiodic button, far easier to match, and considerably more sensitive.

Having now described my invention, I claim:

1. A hydrophone including in combination a tuned case and a microphone button mounted thereon, said case being tuned and broadly damped for the signal range desired to be received, and said button being likewise tuned and broadly damped, but for a range considerably higher than the signal range to be received.

2. A hydrophone including in combination a tuned case and a microphone button mounted thereon, said case being tuned and broadly damped for the signal range desired to be received and said button being likewise tuned and broadly damped, but for a range considerably higher than the signal range to be deceived, said case having a large mass, as compared to said button, whereby the hydrophone resonant curve is substantially like that of the hydrophone case alone.

3. In a sound receiver and transmitter a microphone button having a diaphragm made of phenolic condensation material.

In testimony whereof I affix my signature.

IVAN C. CLEMENT.