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H. F. OLSON

2,301,638

SOUND TRANSLATING APPARATUS

Filed Jan. 2, 1940

Fig. 1.

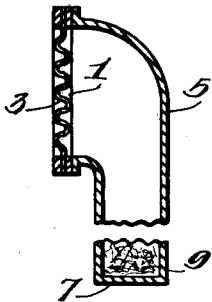


Fig. 2.

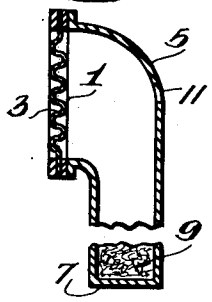


Fig. 3.

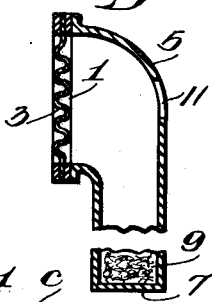


Fig. 4.

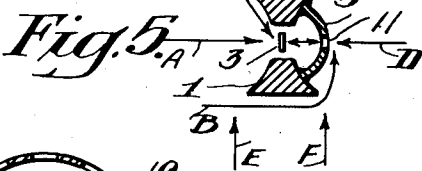
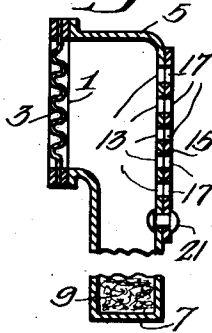


Fig. 6.

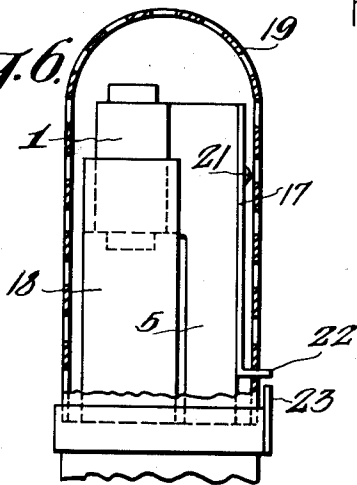


Fig. 7.

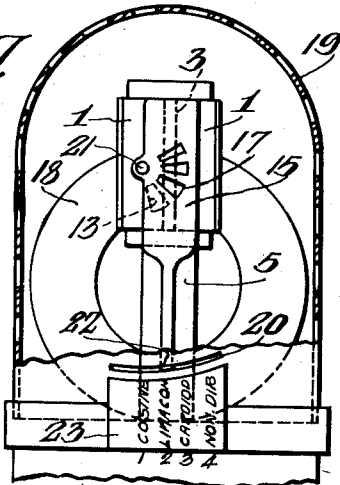


Fig. 8.

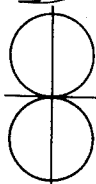


Fig. 9.

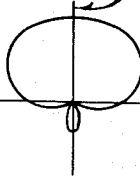


Fig. 10.

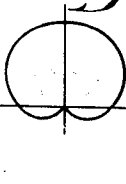
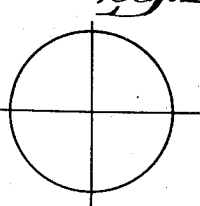


Fig. 11.



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UNITED STATES PATENT OFFICE

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SOUND TRANSLATING APPARATUS

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Application January 2, 1940, Serial No. 312,053

6 Claims. (Cl. 179-138)

This invention relates to sound translating apparatus, and more particularly to a microphone of the type employing a movable conductor in a magnetic field, the present invention being an improvement over that disclosed and claimed in Reissue Patent No. 19,115, granted to H. F. Olson and J. Weinberger.

In the aforesaid patent, there is disclosed a ribbon microphone employing two serially connected ribbon conductors mounted for movement in a magnetic field, one of said conductors being responsive to the pressure component of a sound wave and having a non-directional characteristic, and the other of said conductors being responsive to the pressure gradient component of the sound wave and having a bidirectional characteristic. The combination of these two conductors provides a microphone which has a unidirectional characteristic, as represented by a cardioid of revolution, when the sensitivity of each of the conductors or units is equal.

Now, I have discovered that it is not necessary to employ two separate conductors as aforesaid in order to provide a microphone having a unidirectional characteristic, but that a microphone having such a characteristic can be made with but a single conductor, and the primary object of my present invention is to provide a microphone of this sort.

More particularly, it is an object of my present invention to provide an improved microphone of the type set forth which is extremely simple in construction and yet highly efficient in use.

Another object of my present invention is to provide an improved microphone of the type set forth, the directional pattern of which is superior to that of previously known unidirectional microphones.

A further object of my present invention is to provide an improved microphone as aforesaid which can readily be changed from a microphone having a unidirectional characteristic to one having either a bidirectional characteristic or a non-directional characteristic at will.

In accordance with my present invention, I employ but a single conductor or ribbon and place behind it a pipe terminating in a labyrinth filled with tufts of felt or the like and constituting an acoustic resistance, just as in the case of the pressure responsive section of the conventional microphone shown, for example, in the above noted reissue patent. However, I provide in the pipe immediately behind the ribbon one or more openings which can be closed off more or less. When the openings are entirely

closed, the microphone acts as a non-directional pickup device. When the openings are entirely open, the microphone acts as a bi-directional microphone, since the sound wave energy can reach both surfaces of the conductor freely. By closing off the openings only partially, the resulting microphone will have either a unidirectional pattern or one which closely approximates the unidirectional pattern, depending upon the extent to which the openings are closed. A microphone of this sort affords the advantages of simplifying the magnet structure which provides the magnetic field for the ribbon or conductor with a resultant increase in efficiency, simplifies the ribbon mounting problems, permits reduction in the length of the ribbon, reduces the response to wind, and results in a more uniform directional characteristic with respect to frequency.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description of several embodiments thereof, when read in connection with the accompanying drawing, in which

Figure 1 is a fragmentary sectional view of a ribbon microphone which is responsive solely to the pressure component of the sound wave and has a non-directional characteristic.

Figure 2 is a similar view of a microphone according to one feature of my present invention and wherein the directional characteristic is a cardioid of revolution,

Figure 3 is a similar view of a microphone according to another feature of my present invention and wherein the ribbon is responsive to the pressure gradient component of the sound wave with the result that it has a bidirectional characteristic,

Figure 4 is a similar view of a microphone incorporating the features of the microphones of Figs. 2 and 3,

Figure 5 is a central sectional view of a microphone according to my invention and illustrating the principle of operation thereof,

Figure 6 is a side elevation of a complete microphone formed according to my present invention,

Figure 7 is a rear elevation thereof, and Figures 8 to 11, inclusive, are curves showing the directional characteristics of the various pickup devices to which my improved microphone may be adjusted.

Referring more particularly to Figs. 1 to 5 of the drawing, I have shown a pair of pole pieces 1 of a suitable magnetic structure spaced apart to provide an air gap within which is vibratably mounted a conductive ribbon or the like 3 of well known form. Behind the ribbon 1, there is mounted a closed pipe 5 (Fig. 1) which terminates in a suitable labyrinth structure or the like 7 filled with tufts of felt or similar damping material 9, the pipe and labyrinth structure acting as an acoustic resistance terminating the ribbon 3. The ribbon 3 substantially closes the mouth of the pipe 5 as shown in the drawing and as more fully disclosed in the above identified Reissue Patent No. 19,115, for example. If the pipe 5 is closed at the rear of the ribbon 3, as shown in Fig. 1, sound waves will strike the ribbon 3 only at the front surface thereof, as represented by the arrow A (Fig. 5), and the ribbon 3 will be responsive only to the pressure component of the sound wave. The microphone will then have a non-directional characteristic, as shown by the curve in Fig. 11.

If an opening 11 is formed in the pipe 5 behind the ribbon 3, the response characteristic of the microphone will be altered, depending upon the size of the opening. If the opening 11 is small, as shown in Fig. 2, then sound coming from the front of the microphone will reach the ribbon 3 along the paths represented by the arrows A, B in Fig. 5. Obviously, the sound traveling along the path B will reach the back of the ribbon 3 considerably later than that traveling along the path A because the sound wave traveling along the path B must not only pass around the pipe 5, but must encounter the inrtance provided by the small opening 11 as it passes there-through. Sound coming from the back of the microphone will take the path C around to the front of the ribbon and the path D to the back of the ribbon. If the delay afforded by the small opening 11 to the sound wave traveling along the path D is substantially equal to the delay encountered by the sound traveling along the path C as it passes around the pole pieces 1 to the front of the ribbon (which can easily be the case by properly choosing the size of the opening 11), then sound waves traveling along the paths C and D will reach the front and rear surfaces of the ribbon 3 simultaneously and in phase. For sound waves traveling at right angles to the axis of the microphone, as represented by the arrows E and F, those traveling along the path E around to the front of the ribbon 3 will reach the ribbon slightly in advance of those traveling along the path F to the rear of the ribbon since the latter must pass through the opening 11. The result is that the microphone has the cardioid characteristic of a unidirectional microphone, as shown by the curve in Fig. 10.

Now, if the opening 11 is made quite large, there will be practically no acoustical inrtance offered by the opening 11. However, the sound traveling along the path B will reach the back of the ribbon somewhat later than that traveling directly to the front of the ribbon along the path A because the former must pass around the pole pieces 1 and a small portion of the pipe 5. Similarly, sound traveling along the path C will reach the front of the ribbon slightly later than that traveling along the path D, while sound traveling along the paths E and F will reach the ribbon simultaneously and will cancel out. The result is that the microphone is responsive to the pressure gradient or velocity component of

the sound wave and it has the bidirectional characteristic shown in Fig. 8.

If the opening 11 is made intermediate in size (i. e., larger than in the case represented by Fig. 2, but smaller than in the case represented by Fig. 3), the directional characteristic will be altered gradually from that shown in Fig. 10 to that shown in Fig. 8. At some point, the size of the opening 11 may be so chosen that the characteristic will be a limacon, for example, as represented by Fig. 9.

In Fig. 4, I have shown a structure wherein the size of the opening behind the ribbon 3 may be adjusted to give the desired characteristic. Instead of forming but a single opening in the pipe 5, I form a plurality of small openings 13 therein and pivotally mount on the back of the pipe 5 a shutter 15 which is provided with an equal number of openings 17. The shutter 15 is so arranged that it may be moved to any one or more of a number of predetermined positions to cover one or more of the openings 13, or to the position illustrated in Fig. 4, wherein the openings 13 are all uncovered by aligning the openings 17 therewith. This is, in effect, the same as providing a large opening in the pipe 5, such as that illustrated in Fig. 3.

In Figs. 6 and 7, I have shown a complete microphone embodying the principles of my present invention. The magnetic field is supplied by a magnet 18 in engagement with the pole pieces 1, and the entire structure is housed within a suitable, perforated casing or cover 19 having an arcuate slot 20 formed in the back thereof. The shutter 15 is pivotally mounted on a pin 21 on the back of the pipe 5 and is formed with an operating handle 22 extending out through the slot 20. An index plate 23 is mounted on the back of the casing 19 as a reference index for the various positions of the shutter 17. Thus, when the handle 22 is moved to position 1 (the extreme left as viewed in Fig. 7), all of the openings 13 in the pipe 5 are exposed and the microphone becomes a velocity microphone having the bi-directional characteristic shown in Fig. 8. When the handle 22 is moved to position 2, one of the openings 13 becomes covered (as shown by the dotted opening 13 in Fig. 7) to provide a somewhat smaller overall opening in the pipe 5, and the microphone has the limacon characteristic of Fig. 9. By moving the handle 22 to position 3, three of the openings 13 in the pipe 5 will become closed and only one open, in which case the microphone becomes uni-directional and has the cardioid characteristic of Fig. 10. Finally, by moving the handle 22 to position 4, all of the openings in the pipe 5 become closed and the microphone acts as a non-directional pressure responsive microphone having the characteristic shown in Fig. 11.

From the foregoing description, it will be apparent to those skilled in the art that I have provided a novel and efficient microphone employing but a single ribbon, with its inherent advantages, and adjustable to any preselected one of a plurality of predetermined directional characteristics at will, since the inrtance provided by the opening 11 may be adjusted until the desired characteristic is obtained. Although I have shown and described but one embodiment of my invention, it will be apparent to those skilled in the art that many other modifications thereof are possible. I therefore desire that my invention shall not be limited except insofar

as is made necessary by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a sound translating device, the combination of means for producing a magnetic field, an elongated conductor mounted in said field for vibration therein in response to sound wave energy, a pipe mounted behind said conductor in close proximity thereto and including means constituting a terminating acoustic resistance for said conductor, said conductor substantially closing the mouth of said pipe and said pipe having an opening therein behind said conductor, and means for more or less closing off said opening.

2. In a sound translating device, the combination of means for producing a magnetic field, an elongated conductor mounted in said field for vibration therein in response to sound wave energy, and a pipe mounted behind said conductor in close proximity thereto and including means constituting a terminating acoustic resistance for said conductor, said conductor substantially closing the mouth of said pipe and said pipe having a large opening therein behind said conductor whereby sound waves may reach said conductor both from the back and from the front substantially freely.

3. In a sound translating device, the combination of means for producing a magnetic field, an elongated conductor mounted in said field for vibration therein in response to sound wave energy, and a pipe mounted behind said conductor in close proximity thereto and including means constituting a terminating acoustic resistance for said conductor, said conductor substantially closing the mouth of said pipe and said pipe having an opening therein behind said conductor of a size sufficient to impart to said

device a directional characteristic which is a cardioid of revolution.

4. In a sound translating device, the combination of means for producing a magnetic field, an elongated conductor mounted in said field for vibration therein in response to sound wave energy, and a pipe mounted behind said conductor in close proximity thereto and including means constituting a terminating acoustic resistance for said conductor, said conductor substantially closing the mouth of said pipe and said pipe having an opening therein behind said conductor of a size sufficient to impart to said device a directional characteristic which is a limacon.

5. In a sound translating device, the combination of means for producing a magnetic field, an elongated conductor mounted in said field for vibration therein in response to sound wave energy, and a pipe mounted behind said conductor in close proximity thereto and including means constituting a terminating acoustic resistance for said conductor, said conductor substantially closing the mouth of said pipe and said pipe having an opening therein behind said conductor of a size sufficient to impart to said device a cosine characteristic whereby said device is bi-directional in response.

6. In a microphone, the combination of means for producing a magnetic field, a single elongated conductor mounted in said field for vibration therein in response to sound wave energy, and a pipe mounted behind said conductor providing an acoustic resistance to said conductor, said conductor substantially closing the mouth of said pipe and said pipe having an opening therein behind said conductor constituting an acoustic inductance.

HARRY F. OLSON.