June 10, 1947. R. VERMEULEN 2,421,820

MICROPHONE

Filed March 23, 1943

Fig. 1.

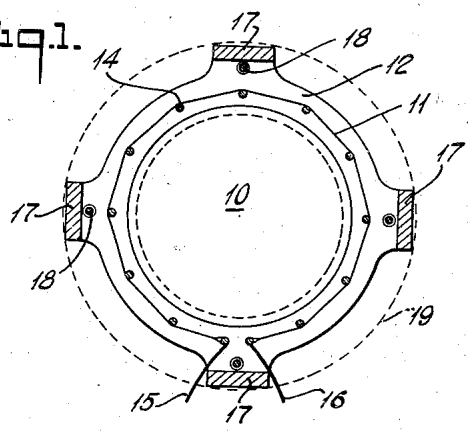


Fig. 2.

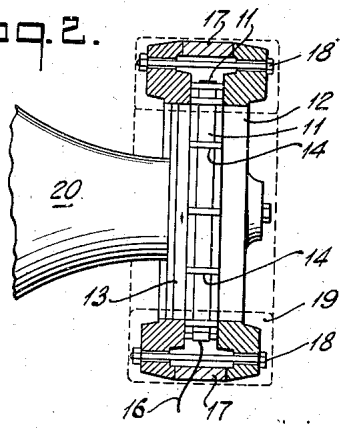


Fig. 3.

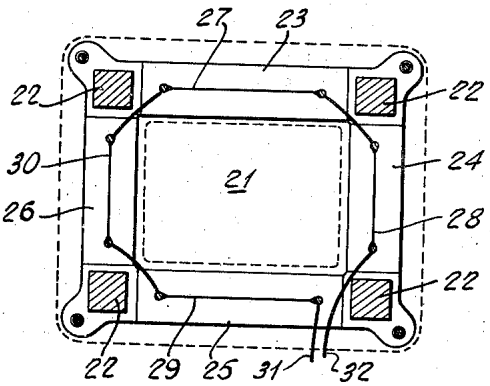


Fig. 4

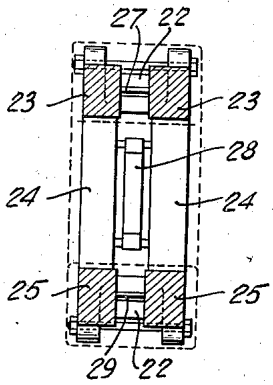


Fig. 5.

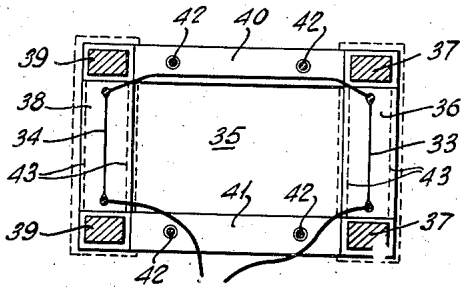
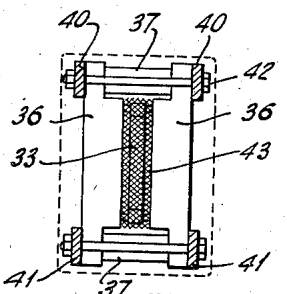


Fig. 6.



INVENTOR
ROELOF VERMEULEN.
BY H. S. Grover
ATTORNEY

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UNITED STATES PATENT OFFICE

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MICROPHONE

Roelof Vermeulen, Eindhoven, Netherlands, assignor to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

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9 Claims. (Cl. 179—139)

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This invention relates to microphones and, more particularly, to microphones for use in the case of a high noise level. These microphones consist of a plurality of electrically interconnected elements for converting air vibrations into electric voltage variations.

Known microphones which are utilized in spaces having a high noise level and which have for their purpose to transmit the useful sound and to pick up as little parasitic noise as possible, consist of two sound-responsive elements, each having a unidirectional characteristic, whose irresponsive sides are placed against one another and which are electrically connected to one another in opposite senses. The parasitic noise is picked up by the two elements in the same measure but, owing to the electrically opposite connection, it is not further amplified. The sound to be transmitted can substantially reach only one of the microphones and is further amplified. The drawback of such installations is that the screening of the other microphones against reflecting sound waves must be rather complete since else the useful sound would be transmitted only feebly. Moreover, the output energy of these microphones is only half the energy which can be transmitted with the use of two microphones since one of the two microphones does not transmit useful sound.

The invention has for its object to provide a microphone which consists of one or more elements which transmit all of the useful sound and which jointly suppress parasitic noises.

According to the invention, the microphone consists of a space surrounded by an element or by a plurality of elements provided around said space, which are capable of converting pressure gradients into electrical oscillations and which are so arranged and interconnected that the acoustic oscillations coming from outside the space and acting on these elements generate therein electric voltages which substantially neutralize one another whereas the acoustic oscillations coming from within the space and acting on these elements generate therein voltages which amplify or add to each other.

As is well-known, pressure gradient or velocity microphones are responsive to sound waves which have a velocity component perpendicular to the plane of the microphone. Such microphones consequently have their maximum responsiveness in two opposite directions. With the microphone according to the invention, one of these directions is turned towards the enclosed space.

Since the various elements are connected to

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each other, the alternating voltages generated either amplify or counteract each other. For sound waves coming from a source of sound outside the space enclosed by the microphone, the pressure gradients of all the elements or of all parts of the element are equal. With a proper connection of the elements, the voltages set up thereby neutralize each other. If, however, the sound comes from a point located within the enclosed space, the alternating voltages generated add to each other in the case of the same circuit-arrangement.

The microphone may consist of a single ribbon microphone having the shape of a closed ring. It is also possible to arrange a plurality of ribbon microphones symmetrically around a space, said microphones being connected in series in this case. In both cases, means are provided for bringing the sound to be transmitted into the enclosed space. They may consist, for example, of a sound-conducting funnel. It is also possible to leave the space enclosed by the microphone open on both sides so that the mouth of the speaker may be put into this space.

The invention will be explained more fully with reference to a few embodiments thereof shown by way of example.

The figures of the accompanying drawing represent three embodiments in longitudinal and in transverse section.

Figs. 1 and 2 show an annular microphone which encloses a space 10. A circular conducting ribbon 11 is stretched between two likewise annular pole shoes 12 and 13 in a magnetic field. With the aid of a plurality of insulated pins 14, the ribbon is supported in the annular space. The two ends of the ribbon are provided with connecting cords 15 and 16. For the purpose of generating a magnetic field there are present four magnets 17 which are clamped between the two pole shoes 12 and 13. By means of four bolts 18 the pole shoes are kept assembled and, in addition, the magnets are clamped. The whole of it is surrounded by an annular housing 19 of large-meshed copper gauze in order to protect the microphone against mechanical damage. The meshes are chosen of such width that there is no question of any sound-screening effect. With the aid of a funnel 20, the sound is led into the space 10.

Parasitic noises originating from the surrounding space may reach the microphones on all sides since the open housing 19 allows the sound to pass without any impediment. These parasitic noises may reach all parts of the ribbon 11 and

impart thereto an amplitude whose phases are equal in the absolute sense for all parts. In two parts of the ribbon 11, which are located opposite one another, the one part consequently moves inwards at a given instant and the opposite part moves outwards. The voltages thus set up in these parts have opposite directions and compensate each other to such an extent that no voltage occurs at the connected cords 15 and 16. The microphone is consequently irresponsive to sounds coming from the outside surroundings. If, however, the sound waves are brought into the space 10 and if they move radially outward from this space to the ribbon 11, the amplitudes of these oscillations will be of the same phase, reckoned from the middle of the space. The absolute phases of the oscillations of the ribbon consequently have opposite directions; the voltages set up are added. These acoustic oscillations consequently afford electric voltages at the connected cords 15 and 16.

Figs. 3 and 4 represent one form of construction which consists of four separate ribbon microphones which symmetrically surround a space 21. With the aid of four permanent magnets 22 which are all magnetized in the same direction, a magnetic field is generated between four sets of pole pieces 23, 24, 25 and 26. Between each of these pole pieces, is located a conducting ribbon 27, 28, 29, 30. These four ribbons are electrically connected in series; the voltage is led away by the cords 31 and 32. The operation completely corresponds to that described with reference to Figs. 1 and 2. The ribbons 27 and 29 generate for sounds originating from the surroundings electrically oppositely connected voltages as do the ribbons 28 and 30 which are located opposite one another. For acoustic oscillations originating from the sound space 21, the voltages are, however, connected in series successively behind one another. The sum of these voltages may be taken from the wires 31 and 32.

The area of the aperture 21 has such dimensions that the mouth opening of the speaker may just be introduced into the said space so that the sound in the space 21 itself is transmitted to the air. In this form, the microphone is suitable for pilots, guides, and the like. The frequency characteristics of two ribbons located opposite one another are equal, i. e., the dimensions and the compositions of and the voltages in two oppositely located ribbons are the same so that with the same absolute phase also throughout the whole range of frequencies, the alternating voltages neutralize each other. A suitable direct current voltage is applied to the ribbon circuit so as to stretch the ribbons, the natural frequency of each ribbon is then such that the range of frequencies below a predetermined limit is substantially not reproduced, the reproduction of excessive low tones by which speech is rendered unintelligible, being thus avoided. This natural frequency is about 800 cycles per second.

Figs. 5 and 6 represent a very simple form of construction of the microphone. The sound-responsive elements consist of two separate ribbons 33 and 34 which are provided on either side of the space 35. This space 35 has such dimensions that the mouth of the speaker may be brought between the two microphone elements and brings the sound into the space 35. The ribbons 33 and 34 are connected in series. Each ribbon is located in a separate magnetic field, viz., the ribbon 33 between the pairs of pole shoes 36 with the magnets 37 and the ribbon 34 between the pairs

of pole shoes 38 and the magnets 39. The two elements are mechanically kept assembled by two sets of copper strips 40 and 41, respectively which are clamped together with the aid of four bolts 42.

Since the mouth of the speaker is in front of the space 35, that is to say, in the immediate vicinity of the ribbons 33 and 34, it has been found necessary to provide the ribbons with suitable damping in order to damp excessively large amplitudes and, in addition, to prevent blowing against the ribbons due to the respiration. For this purpose, the air gap is covered on both sides at the points where the two ribbons are present, with a thin piece of fine-meshed cloth 43.

What is claimed is:

1. A microphone for use where high noise levels occur, comprising sound responsive elements for converting air vibrations into variations of electrical voltages, said sound responsive elements being arranged to form a nearly complete enclosed space, a connection lead joined to the ends of said sound responsive elements, a plurality of magnetic poles adjacent said sound responsive elements, means for leading desired sound waves within said space, whereby the acoustic oscillations originating from the outside of said space act upon the sound responsive elements to set up electrical voltages which substantially neutralize each other whereas the acoustic oscillations coming from within said space act upon said elements to set up voltages which add to each other.

2. A microphone comprising a plurality of sound responsive elements for converting air vibrations into variations of electrical voltages, said sound responsive elements being arranged to form a nearly complete enclosed space, a connection lead joined to the ends of said sound responsive elements, a plurality of magnetic poles adjacent said sound responsive elements, means including a funnel shaped member for leading desired sound waves within said space, whereby the acoustic oscillations originating from the outside of said space act upon said elements to set up electrical voltages which substantially neutralize each other whereas the acoustic oscillations coming from within said space act on the elements to set up voltages which add to each other.

3. A microphone comprising a plurality of sound responsive elements for converting air vibrations in variations of electrical voltages, said sound responsive elements being connected in series and arranged to form a nearly complete annular space, a plurality of magnetic poles surrounding said sound responsive elements, a connection lead joined to the ends of said sound responsive elements, means for leading desired sound waves within said space, whereby the acoustic oscillations originating from the outside of said space act upon said elements to set up electric voltages which substantially neutralize each other whereas the acoustic oscillations coming from within said space act on the elements to set up voltages which add to each other.

4. A microphone comprising two similar sound responsive elements which are responsive to pressure gradients, two ring-shaped pole shoes, each one of said sound responsive elements being arranged on each side of said pole shoes to form a nearly complete ring-shaped enclosed space, a plurality of magnetic poles adjacent said responsive elements, a connection lead joined to the ends of said sound responsive elements, means for leading desired sound waves within said space, whereby the acoustic oscillations originating from the outside of said space act upon said elements

to set up electric voltages which substantially neutralize each other whereas the acoustic oscillations coming from within said space act on the elements to set up voltages which add to each other.

5. A microphone comprising a plurality of sound responsive elements for converting air vibrations into variations of electrical voltages, said sound responsive elements being connected in series and arranged to form a nearly complete annular space, a plurality of magnetic poles adjacent said responsive elements, means including a funnel shaped member having an aperture which is located adjacent to said enclosed annular space, said aperture having substantially the same dimensions as the human voice opening for leading desired sound waves within said space, whereby the acoustic oscillations originating from the outside of said space act upon said elements to set up electrical voltages which substantially neutralize each other whereas the acoustic oscillations coming from within said space act on the elements set up voltages which add to each other.

6. A microphone comprising two similar sound responsive elements which are responsive to pressure gradients, two annular pole shoes, each one of said sound responsive elements being arranged on each side of said pole shoes to form a nearly complete annular enclosed space, a plurality of magnetic poles adjacent said responsive elements means for leading desired sound waves within said space, whereby the acoustic oscillations located symmetrically opposite one another and arranged whereby the responsiveness of said element is below the range of frequencies required for the intelligibility of human voice to the leading desired sound waves within said space and whereby the acoustic oscillations originating from the outside of said space act upon said elements to set up electric voltages which substantially neutralize each other, whereas the acoustic oscillations coming from within said space act on the elements to set up voltages which add to each other.

7. A microphone comprising a plurality of ribbon sound responsive elements for converting air vibrations in variations and electrical voltages, said sound responsive elements having a natural frequency of 800 cycles per second and being connected in series and arranged to form a nearly complete annular space, a plurality of magnetic poles adjacent said sound responsive elements, means for leading desired sound waves within said space, whereby the acoustic oscillations originating from the outside of said space act upon said elements to set up electric voltages which substantially neutralize each other, whereas, the acoustic oscillations coming from within said space act on the elements to set up voltages which add to each other.

8. A microphone comprising a plurality of sound responsive elements for converting air vibrations in variations and electrical voltage, said sound responsive elements being in the form of a nearly complete prismatic space, a plurality of magnetic poles adjacent said sound responsive elements, means for leading desired sound waves within said space, whereby the acoustic oscillations originating from the outside of said space act upon said elements to set up electric voltages which substantially neutralize each other, whereas the acoustic oscillations coming from within said space act on the elements to set up voltages which add to each other.

9. A microphone comprising a plurality of ribbon sound responsive elements for converting air vibrations into variations of electrical voltages, two ring-shaped open pole pieces, said ribbon being interposed between said open pole pieces and arranged to form a nearly complete annular space, a plurality of insulated pins for retaining said ribbon secured to said ring-shaped pole pieces, a plurality of magnetic poles adjacent said sound responsive elements, a connection lead joined to the ends of said sound responsive elements, means including a funnel-shaped member for leading desired sound waves within said space whereby the acoustic oscillations originated from the outside of said space act upon said elements to set up electrical voltages which substantially neutralize each other whereas the acoustic oscillations from within said space, act to set up elements on the voltages which add to each other.

ROELOF VERMEULEN.

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