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NOISE-CANCELING MICROPHONE

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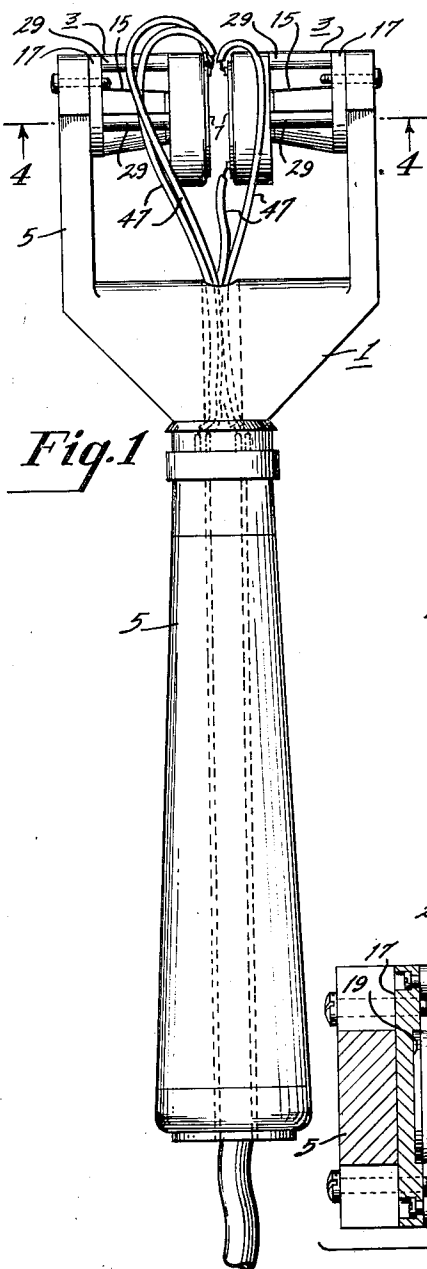


Fig. 1

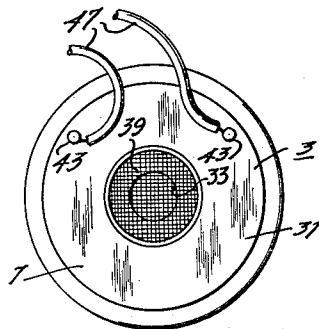


Fig. 3

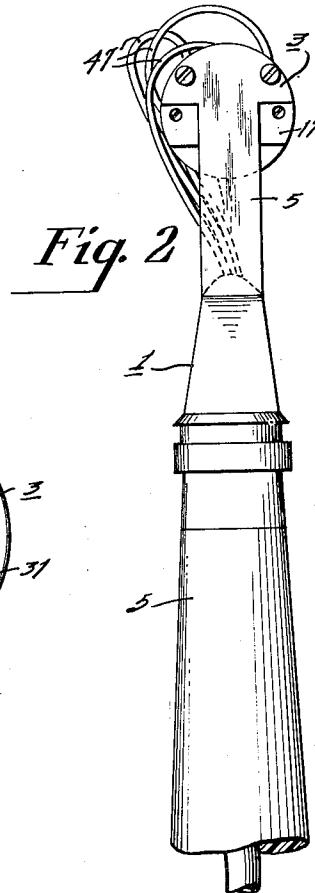


Fig. 2

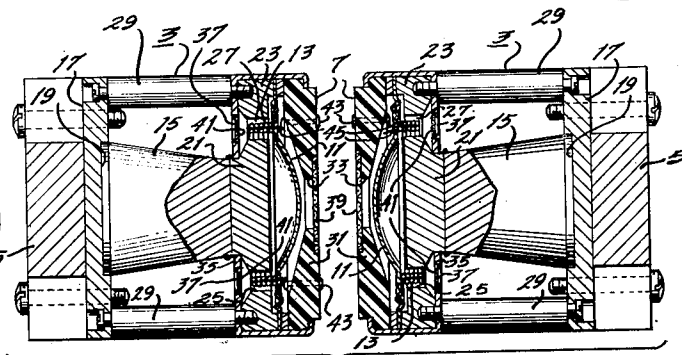


Fig. 4

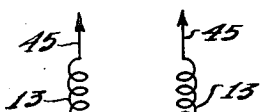


Fig. 5

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NOISE-CANCELING MICROPHONE

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5 Claims. (Cl. 179-1)

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This invention relates to electro-acoustical apparatus, and more particularly to an improved, noise-cancelling, close-talking microphone.

The close-talking microphone referred to herein is one which is useful in locations where there is considerable noise, such as in many military operations. Such a microphone is so constructed mechanically and acoustically that it provides a high speech-to-noise ratio, depending for its operation on an extremely small "talking distance" as between the lips of the user and the microphone diagram or sound receptive orifice.

My present invention relates to the second order pressure gradient responsive close-talking microphone, the conventional structure of which includes two first order, pressure gradient responsive microphone units arranged one above the other and having their diaphragms located as close together as would be possible without the one interfering with the other in respect to sound waves impinging directly on both of them. Electrically the units are connected so that their output voltages oppose each other and when equal sounds are picked up by each unit their outputs will cancel. In use, a person talks more directly into one of the units than the other unit so that the microphone will produce an output from the useful sound wave energy. Structures of this type are found to possess certain disadvantages in the respect that the unit to which the useful sound wave energy is not directed acts as an electrical load on the other unit with the result that the microphone suffers a loss in useful output. In addition, the cancellation of extraneous high frequency sounds is not as effective due to the limitation of spacing of the two diaphragms. A further disadvantage results from the fact that with the conventional microphone arrangement, it is possible to position the sound source less than one half inch from the directly driven diaphragm resulting in poor response from exceedingly pronounced "blast effect" from such sounds as "B," "P," etc., and from accumulation of moisture on the diaphragm from the breath of the person using the microphone.

The primary object of my present invention is to provide an improved noise-cancelling, close-talking microphone which will overcome the above as well as other disadvantages of prior art close-talking microphones.

It is also an object of my present invention to provide a close-talking microphone which will be more effective in the cancellation of extraneous sound in the high frequency range.

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Another object of my present invention is to provide a close-talking microphone which will provide improved response to useful sound waves, effect cancellation of extraneous sound waves over a wider range of frequencies, and which will have a larger output.

A further object of my present invention is to provide an improved close-talking microphone which is simple and easy to construct as well as highly efficient in operation.

In accordance with my present invention, I provide a noise-cancelling, close-talking microphone comprising two first order, pressure gradient responsive transducer units disposed facing each other in spaced apart relation along a common axis so that the planes of their vibratile elements are substantially parallel. The vibratile elements are mounted for movement in opposite directions in response to sound waves impinging thereon from a closely disposed sound source directed between them. The units have their signal outputs electrically connected in series so that the voltages developed respectively by said units will be additive when the vibratile elements move in opposite directions and will oppose each other when the vibratile elements move in the same direction.

The novel features characteristic of my present invention, as well as additional objects and advantages thereof, will be better understood from the following detailed description when read in connection with the accompanying drawing in which:

Figure 1 is a front elevation of a noise-cancelling, close-talking microphone in accordance with my present invention,

Figure 2 is a side elevation of the microphone shown in Figure 1,

Figure 3 is a front view of one of the transducer units shown in Figure 1,

Figure 4 is a sectional view of the microphone transducer units, taken along the line 4-4 of Figure 1, and

Figure 5 is a diagram of the electrical circuit connecting the outputs of the two transducer units.

Referring more particularly to the drawings, wherein similar reference characters designate corresponding parts throughout, there is shown a noise-cancelling, close-talking microphone 1, in accordance with a preferred embodiment of my present invention, comprising, generally, a pair of conventional first order, pressure gradient responsive transducer units 3 and a hand support member 5.

The transducer units 3 are mounted on the support member 5 along a common axis with their front faces or ends 7, that is, the ends into which sound waves are normally directed, disposed in closely spaced apart relation. Each of the transducer units 3 is of the electrodynamic type and comprises a vibratile element or diaphragm 11 mounted for movement in response to the pressure gradient component of sound waves impinging on opposite sides thereof. Attached to the diaphragm 11 is a coil 13 which is disposed in a magnetic field provided by a suitable magnetic structure and operative in a manner well known in the art.

The magnetic structure of each of the transducer units 3 illustrated and described herein comprises a frustro-conical permanent magnet 15 having the base thereof mounted on a base plate 17 within a recess 19 provided therein. A central or inner circular pole member 21 is mounted on the apex end of the magnet 15. An outer pole plate member 23 has a circular aperture 25 within which the inner pole member 21 is concentrically disposed in spaced relation to the outer pole plate 23 to provide an annular air gap 27. The outer pole plate 23 is supported by a plurality of rod-like members 29 which support it from and connect it with the base plate 17. The rod-like members 29 may be connected to the outer pole plate 23 and the base plate 17 in any suitable manner which will provide a good magnetic flux conducting path between the plates.

The diaphragm 11 is supported at its periphery by the outer pole plate 23 in a manner to permit it to freely vibrate in response to sound waves impinging thereon and to dispose the coil 13 within the air gap 27 for freedom of movement therein. Thus, the diaphragm 11 together with the coil 13 comprise a movable conductor disposed within a magnetic field provided by the magnetic structure. A protecting cover 31 of non-magnetic material, which is provided with a central opening 33, is mounted in front of the diaphragm 11 in spaced relation thereto. Another protecting cover 35 is mounted in back of the air gap 27 and is provided with a plurality of apertures 37 disposed opposite to the air gap 27. Screens 39, 41 are disposed, respectively, within the central opening 33 and the apertures 37 to prevent dust and magnetic dirt particles from interfering with the movement of the diaphragm 11 and the coil 13. Suitable terminals 43 are provided on the front protecting cover 31 to which one end of leads 45 from the coil 13 are connected, and to the other end of which wires 47 are connected for connection with an external electrical circuit.

The distance of separation between the transducer units 3 should be rather small to be effective, preferably of the order not to exceed $\frac{1}{4}$ wavelength at the highest frequency in the range to which the units are to be responsive.

The units 3 have their respective outputs connected in series so that the voltages developed are additive when the diaphragms 11 move in opposite directions, and oppose each other when the diaphragms move in the same direction. Thus, it will be recognized by those persons skilled in the art, that since both units are first order, pressure gradient responsive units, their diaphragms 11 will be moved in opposite directions only when they respond to sound waves originating from a source closely disposed to the units and directed between them. If the sound source is an appreciable distance away from the

units in a plane passing between them, there will be no output from the units for, in that case, the sound source will be disposed substantially in the null plane of each of the diaphragms.

If, however, the sound source is disposed on either side of the plane passing between the units 3, their diaphragms 11 will be caused to move in the same directions, in which case, their outputs will oppose each other and effectively cancel.

It will also be recognized that when the diaphragms 11 are driven in opposite directions, the combined outputs of the units is almost twice that obtained from the conventional second order, pressure gradient responsive microphone wherein the one unit acts as an electrical load on the other directly driven unit.

Thus, the arrangement provided by my present invention will be found to overcome the disadvantage resulting from placing the sound source too close to the diaphragms, as in the case with the conventional type. Because of the physical size and arrangement of the units, it is practically impossible to dispose the sound source closer than approximately $\frac{1}{2}$ inch and thereby reduce the blast effect mentioned above. In addition thereto, since the voice of the user is directed between the units, there will be less tendency for moisture to accumulate on the diaphragms which otherwise would interfere with efficiency of operation.

While I have shown and described but a single embodiment of my present invention, it will also be recognized that various changes and modifications are possible within the spirit of my invention. Therefore, I desire that the particular form of my present invention described herein shall be considered as illustrative and not as limiting.

What is claimed is:

1. A sound translating device comprising a pair of dynamic microphone units, each of said units having a vibratile member mounted for movement in response to the first order gradient of the sound pressure, said vibratile members being mounted in spaced apart relation facing each other for movement in opposite directions in response to sound waves impinging thereon from a closely disposed sound source and directed between said members, and means for effectively connecting the signal outputs of said units whereby the voltages developed respectively by said units will be additive when said vibratile members move in opposite directions and will oppose each other when said vibratile members move in the same direction.

2. A sound translating device according to claim 1, wherein said vibratile members are spaced apart a distance not to exceed $\frac{1}{4}$ wavelength at the highest frequency in the range to which the units are to be responsive.

3. In sound translating apparatus, the combination of means providing separate magnetic fields, a pair of movable conductors each responsive to the first order gradient of the sound pressure and vibratably mounted in separate ones of said fields, said conductors being disposed in closely spaced relation to and facing each other for movement in opposite directions in their respective fields in response to sound waves impinging thereon from a closely disposed sound source and directed between said conductors, and means connecting the signal outputs of said conductors to additively combine the voltages developed respectively therein when said conductors move in opposite directions in said mag-

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netic fields and to combine said voltages in opposing relation when said conductors move in the same direction in said magnetic fields.

4. A sound translating device comprising a pair of microphone units each of which comprises (1) a magnetic structure having an air gap with a magnetic field therein, (2) a conductor mounted in said field for vibration in response to the first order gradient of the sound pressure, said units being mounted in spaced apart relation along a common axis with their respective conductors facing each other in closely spaced apart relation, and means for so connecting the signal outputs of said units that their respective voltages will be additive when said conductors move in opposite directions in their respective magnetic fields and will oppose one another when said conductors move in the same direction in said magnetic fields.

5. A sound translating device comprising a pair of dynamic microphone units each having a vibratile member mounted for movement in response to the first order gradient of the sound pressure, said units being mounted in spaced apart relation along a common axis and having

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their respective vibratile members disposed facing each other with their axes of maximum response substantially colinear, and means for so connecting the signal outputs of said units that their respective voltages will be additive when said vibratile members move in opposite directions and will oppose each other when said vibratile members move in the same direction.

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