May 30, 1944. F. C. BEEKLEY 2,350,010

MICROPHONE

Filed Dec. 26, 1941

FIG. 1.

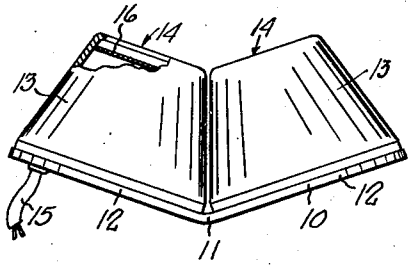



FIG. 2.

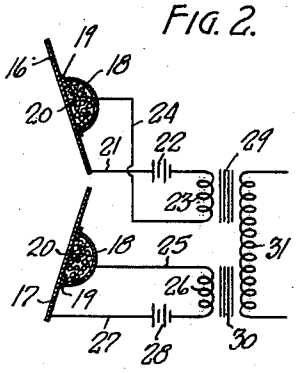



FIG. 3.

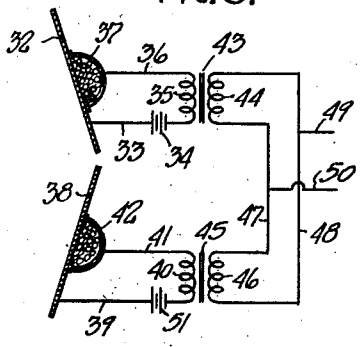



FIG. 4.

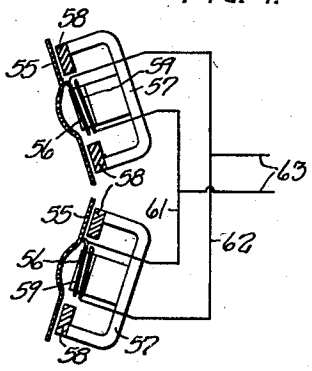



FIG. 6.

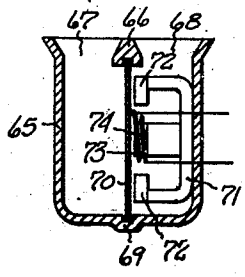



FIG. 7.

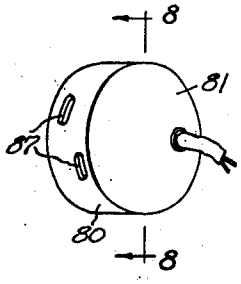



FIG. 8.

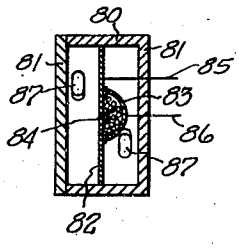
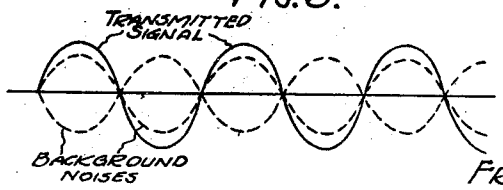



FIG. 5.




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# UNITED STATES PATENT OFFICE

2,350,010

## MICROPHONE

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Application December 26, 1941, Serial No. 424,437

16 Claims. (Cl. 179—1)

This invention relates to means responsive to sound for creating electric pulses, such as a microphone adaptable for use in radio broadcasting, radio and wire-telephone, communications, signaling, or public address systems.

In electrical transmission of sound, it is desirable to eliminate background noises to assure clarity and substantially perfect transmission of the speech, music, or other sounds which constitute the material intended to be transmitted. This is accomplished in radio broadcasting, for instance, by locating microphone and performer in a soundproof studio. There are, however, many cases where it is impracticable to locate a microphone in an enclosure properly soundproofed against external noises and internal reverberation. Examples of this include radio broadcasting of sports events and conventions and political gatherings, public address systems, military and other communications, where transmission must be made from noisy locations or reverberatory enclosures.

The primary object of this invention is to provide a microphone which may be used in a noisy or reverberatory location, which microphone will automatically cancel out all or a material portion of the background noise and thereby permit transmission of speech or other desired sounds having acceptable fidelity.

A further object is to provide a microphone with vibrating means so arranged therein as to be adapted to receive background noises from all directions in counterbalancing or cancelling relation; such microphone actuable only by vibrations applied thereto intentionally in an unbalanced relation.

A further object is to provide a microphone which is substantially unaffected by noises originating from any point at a distance and adapted to be excited only by vibrations originating close by and in properly directed relation.

A further object is to provide a microphone with diaphragm means subject to excitation in counterbalancing or cancelling relation, by vibrations originating at a distance therefrom and in any angular relation thereto.

Other objects will be apparent from the drawing and appended claims.

In the drawing:

Fig. 1 is a side elevation of one embodiment of the invention;

Fig. 2 is a diagrammatic view of an embodiment of the invention utilizing two sound-responsive units of the carbon granule type;

Fig. 3 is a diagrammatic view of the invention illustrating a different electrical connection between two sound-responsive units of the carbon granule type;

Fig. 4 is a diagrammatic view of a device utilizing two sound-responsive units of the magnetic type:

Fig. 5 is a diagrammatic view illustrating the cancellation of the background noises and the nature of the excitation waves of the microphone;

Fig. 6 is a cross sectional view of still another embodiment of the invention;

Fig. 7 is a perspective view of one form which the Fig. 6 embodiment may take; and

Fig. 8 is a sectional view taken on line 8—8 of Fig. 7.

Referring to the drawing, and particularly to Figs. 1 to 5, inclusive, which illustrate one embodiment of the invention, the numeral 10 designates a base plate having an elongated form bent centrally at 11 to provide two angularly disposed end portions 12. These end portions are preferably of a size and shape to have mounted thereon two casing portions 13 whose axes extend perpendicular to the plane of the face of the plate portion 12 upon which each is mounted. The faces 14 of the casing portions 13 have openings therein and are disposed in the same angular relation that the plate portions 12 bear to each other, namely, in obtuse angled relation. An electrical conductor 15 projects from the base 10 and is connected with the microphone.

The microphone further includes vibrating means including different sound-receiving portions spaced in close relationship, such as the diaphragms 16 and 17 (see Fig. 2) each of which may be located within one of the casings 14. Associated with each diaphragm is an electrical means including a button or housing 18 separated therefrom by a felt washer 19; said housing being filled with a plurality of loosely arranged small carbon granules 20. Diaphragm 16 is electrically connected by conductor 21, in which may be interposed a battery 22, with one end of the primary coil 23 of a transformer. The opposite end of said coil is connected by conductor 24 with the button associated with diaphragm 16. A conductor 25 connects the button 18 associated with diaphragm 17 with a second primary transformer coil 26 at the end of the coil 26 complementary to the end of coil 23 with which conductor 21 is connected. The opposite end of coil 26 is connected with diaphragm 17 by means of conductor 27 which may have battery 28 interposed therein. The coils 23 and 26 constitute separate primary coils of a suitable transformer having cores

29 and 30 associated with coils 23 and 26 respectively, and having a single secondary coil 31 associated with both cores. The two diaphragm units are connected to the transformer primaries in opposite or counterbalancing relation.

Referring to the Fig. 3 construction, two diaphragm units, each housed in a casing portion 13, are connected in counterbalancing electric relationship. Thus, diaphragm 32 is connected by conductor 33, including a battery 34, with the primary coil 35 of one transformer. The other end of coil 35 is connected by conductor 36 with the button 37 associated with diaphragm 32. The other diaphragm 38 is connected by conductor 39, which has battery 51 interposed therein, with one end of primary transformer coil 40. The other end of coil 40 is connected by conductor 41 with the button 42 associated with diaphragm 38. The transformer of which the coil 35 constitutes the primary has a core 43 and a secondary coil 44. The transformer of which the coil 40 constitutes the primary has a core 45 and a secondary coil 46. A conductor 47 connects adjacent ends of the transformer secondary coils 44 and 46, and a line 48 connects the opposite ends of transformer secondary coils 44 and 46. Lead line 49 is connected with line 48 and lead line 50 is connected with conductor 47.

In the embodiment illustrated in Fig. 4, diaphragm 55 has a coil 56 connected therewith. A permanent magnet 57 is associated with diaphragm 55 and carries two pole pieces 58 adjacent its ends and each extending adjacent opposite sides of coil 56. Another pole piece 59 is carried centrally by magnet 57 and extends within coil 56. The two units employed in the Fig. 4 embodiment are of similar construction, and like parts bear the same reference numerals. A conductor 61 connects one end of one coil 56 with the opposite end of the other coil 56, and a conductor 62 connects other ends of the two coils 56. Leads 63 extend from conductors 61 and 62.

Each of the Figs. 2, 3, and 4 embodiments is operable for the intended purpose of cancelling out background noises and transmits only properly directed vibrations emitted in close spaced relation to one diaphragm or membrane when the two following requirements are met. These two requirements are: first, that the diaphragms or membranes of the two units of each microphone shall be accurately balanced, that is, selected carefully to insure matching characteristics, and particularly matching periods of vibrations. The other essential requirement is that the phase angles of the two units shall be displaced substantially 180° so that they will fully counterbalance each other. When these two requirements are satisfied in any of the aforementioned embodiments, the output of each unit will be that represented diagrammatically in Fig. 5, wherein the output from one unit in reference to background noises will be represented by one of the dotted wave lines, while the output of the other will be represented by the other dotted wave line. Note that these wave lines are in counterbalancing relation and hence will cancel out and eliminate background or ambient noises. The full line in Fig. 5 represents the signal wave produced by the one unit against which vibrations are directed from a close spaced emission point. As used herein, the term "ambient" when referring to sounds or noises will be understood to mean unwanted surrounding sounds or noises, i. e. external sounds or noises not desired to be transmitted.

In the use of the microphones described above, it is essential that the vibrations constituting the signal to be transmitted shall be emitted at a point spaced close to and directed toward one only of the membranes or diaphragms, so as to reduce to a minimum the effect of the signal upon the other diaphragm. This avoids the cancelling effect which actuation of the other diaphragm will have on the intended signaling vibration. In this connection, tests of units embodying the aforesaid invention, and particularly the Fig. 4 embodiment, show that, whereas signals transmitted from a conventional microphone located in a military tank while that tank is operating have a poor percentage of intelligibility, the use of a microphone embodying this invention for transmitting signals under the same conditions with respect to volume and character of background noise produce a greatly increased degree of intelligibility. Hence, a microphone constructed according to this invention overcomes very serious obstacles heretofore encountered in radio transmission, especially for military communications, and raises the percentage of intelligibility over adverse conditions to an extent which reduces materially the possibility that signals will be misunderstood or undecipherable at the receiver. While two separate casing portions have been shown and described, it will be understood that this is illustrative only, and any housing means may be employed which permits equal or balanced application or impression upon the two membranes of sound waves originating at a distance therefrom.

Another embodiment of the invention producing cancellation of background noises is illustrated in Fig. 6. In this embodiment, housing 65 is open at one end and said opening is spanned by a crossbar 66 which defines two separate openings 67 and 68. Centrally within the housing 65 and supported at opposite ends by portions 69 and 66 of said housing is a diaphragm 70, which is so arranged that it is balanced with relation to both of the openings 67 and 68 and divides housing 65 into two chambers of substantially the same size and shape. Therefore, if vibrations or sound waves are applied equally at the housing openings 67—68, they will act equally and oppositely upon the diaphragm 70 to prevent vibration thereof. A magnet 71 having pole pieces 72 is carried by housing 65 at one side of diaphragm 70, and a pole piece 73 is carried centrally of magnet 71 and positioned intermediate the pole pieces 72. A coil 74 is connected to the diaphragm 70 in a well known manner. It will be observed that when the sound waves constituting a signal are emitted in close spaced relation to and are directed into one of the openings 67—68, the diaphragm 70 will be caused to vibrate, and hence to actuate the electromagnet portion of the microphone to transmit the intended signal.

The embodiment illustrated in Figs. 7 and 8, a variant of the embodiment illustrated in Fig. 6, has been found efficient in operation. In this embodiment, cylindrical housing 80 having plane parallel end members 81 has diaphragm or vibrating member 82 mounted centrally between and parallel to the end walls 81.

A button 83 confines carbon granules 84, and leads 85 and 86 extend from the diaphragm 82 and the button 83. The cylindrical body portion of the housing 80 has a pair of openings 87 formed therein. These openings are preferably elongated and equally spaced to either side of the

diaphragm 82, whereby the opposed surfaces of the diaphragm constitute spaced sound-receiving portions. These openings 87 are spaced apart circumferentially a small distance, preferably not greatly in excess of 3/8 inch and hence only a small fraction, i. e., not exceeding one fourth, of a wave length of sound of the highest frequency which it is desirable to cancel. It will be observed that sound waves entering these two openings 87 will act equally and oppositely upon the diaphragm 82, whereas sound waves applied in close spaced relation to one only of the openings 87 as indicated by the arrow in Fig. 8 will vibrate the diaphragm 82 to actuate the microphone. In practice, such application of a spoken signal intended for transmission is accomplished by speaking directly into one only of openings 87 while the microphone is held in close spaced relation to or even in contact with the lips of the user.

It will be observed that each of these embodiments of the invention employs the principle of automatically counterbalancing within the microphone sound waves impressed in balance at two spaced portions of the microphone. This counterbalancing cancels any unwanted signal or vibration which normally would excite a microphone positioned in a noisy location. These two portions may constitute either the two diaphragms in the embodiment of Figs. 1 to 4 or the opposite faces of a single diaphragm in the embodiment of Figs. 6 to 8. At the same time, an announcer may speak into the microphone or cause selected signals to be emitted in a selected direction and at close spaced relation to the microphone for the purpose of causing its operation to transmit the desired signal substantially without interference from background noises. The effect is produced when the device is properly constructed, and the only care required is to insure proper direction and emission of the sound waves which are to constitute the intended signal so that there will be a difference in either amplitude or phase of the sound received at the two portions of the microphone aforementioned.

I claim as my invention:

1. A microphone comprising vibration means having two non-directional sound-receiving portions, spaced apart a small fraction of a wave length of audible sound for normally equal impression of sound thereon, and electrical signal means responsive to said vibration means, said electrical means being rendered operative to transmit a signal only when sound is impressed unequally on said sound-receiving portions.

2. In a microphone, vibrating means, electrical means responsive to said vibrating means, and means spaced apart a small fraction of wave length of audible sound for simultaneously directing sound waves upon the vibrating means at spaced points whereby the effect of said waves on said electrical means is counterbalanced, said electrical means being actuable to transmit a signal only by sound waves directed preponderantly against one of said points.

3. In a microphone, vibrating means, means spaced apart not more than one fourth wave length for directing sound waves originating at a distance for impression upon said vibrating means in substantially identical phase and amplitude, and electrical means responsive to said vibrating means and actuable to transmit a signal only upon unbalanced application of sound waves to said directing means for unbalanced impression thereof on said vibrating means.

4. A microphone comprising diaphragm means, means spaced apart approximately three eighths of an inch for normally directing ambient sound waves for impression upon two surfaces of said vibrating means substantially in phase, and electrical means adapted to be energized by said diaphragm means, said electrical means transmitting a signal in response to sound waves impressed on said diaphragm surfaces in unbalanced relation only.

5. In a microphone, vibrating means, electrical means responsive to said vibrating means for transmitting a signal, and means arranged to permit ambient sound waves to impinge upon said vibrating means at spaced points substantially in phase and in substantially equal amplitude so that they oppose and substantially cancel out their combined effect.

6. A microphone comprising vibrating means, means for housing said vibrating means, said housing means having a pair of openings in complementary relation to said vibrating means for passage of sound waves to impress said waves on said vibrating means at spaced points in substantially identical phase and amplitude, and electrical means responsive to said vibrating means for transmitting a signal only when sound waves are emitted in close spaced relation to and directed at one opening.

7. A microphone comprising vibrating means having two sound-responsive surfaces, electrical means associated with said vibrating means, and means spaced apart less than one inch for directing sound waves originating at a distance from said microphone and from any or all directions to impress said waves upon said two sound-responsive surfaces in substantially identical phase and amplitude, said electrical means being actuable to transmit a signal only when sound waves are unequally applied to said two sound-responsive surfaces.

8. A microphone having a casing, and a diaphragm in said casing, said casing having a pair of openings in complementary relation to said diaphragm for exposing the opposite faces of said diaphragm to equal counterbalancing impact by ambient sounds originating at a distance from said microphone.

9. A microphone comprising housing means including two complementary independent chambers each having an opening, vibrating means having spaced portions each exposed at one chamber, and electrical means responsive to said vibrating means, said openings being close spaced and arranged in complementary relation to said vibrating portions, said electrical means being actuable to transmit a signal only upon unbalanced reception of sound in said chambers.

10. A microphone comprising a pair of diaphragms having substantially equal characteristics of vibration, means fixedly mounting said diaphragms in juxtaposed relation, and electrical means energized by each diaphragm, said electrical means having a counterbalancing phase relation.

11. A microphone comprising a pair of matching non-directional diaphragms, a mounting securing said diaphragms in fixed relation spaced a small fraction of a wave length of audible sound, and electrical means responsive to each diaphragm, the phase angles of said electrical means being 180° displaced.

12. A microphone comprising a pair of non-

directional units, each unit comprising vibrating means and electrical means actuated thereby, said units having substantially identical response characteristics, and means for fixedly positioning said units spaced apart less than one-fourth the wave length of audible sound to receive sound waves substantially in phase and equal amplitude, the electrical means of said units being connected 180° out of phase.

13. A microphone including a pair of vibrating membranes, said membranes having matching vibration characteristics, and means for counterbalancing equal components of vibration impressed simultaneously on both membranes.

14. A microphone comprising a housing having a pair of similar openings spaced apart less than one-fourth of a wave length of sound of the highest frequency of any selected portion of the audio frequency range, a vibrating membrane mounted in said housing in complementary relation to and between said openings, and electrical means associated with and responsive to vibrations of said membrane.

15. A microphone comprising a housing having a pair of similar openings spaced approximately three-eighths of an inch, a vibrating membrane mounted in said housing in complementary relation to and between said openings, and electrical means associated with and responsive to vibrations of said membrane.

16. A microphone comprising a housing, a vibrating membrane mounted substantially centrally in said housing, and electrical means associated with and responsive to vibrations of said membrane, said housing having a pair of close spaced divergently facing similar openings therein on opposite sides of and in complementary relation to said membrane.

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