

SPECIFICATION

Miniaturized unidirectional electret microphone

5 This invention relates to a minaturized unidirectional electret microphone which employs an electret as a diaphragm and has a unidirectional characteristic.

10 In a conventional unidirectional electret microphone, a diaphragm, a back electrode and a back electrode holder are formed as a diaphragm unit, and an impedance converter for converting the microphone output into a low-impedance output is housed in a rear compartment to form an impedance
15 converter unit. The diaphragm unit and the converter unit are disposed in a case in axial relationship. Since the diaphragm unit and the impedance converter unit thus separately prepared are combined, the conventional electret microphone has the defect
20 that the length in its axial direction, that is, the thickness is large. The combination of such separate units calls for many parts, resulting in increased manufacturing cost. Further, the directional characteristic of the microphone is adjusted before the diaphragm
25 unit is assembled with the impedance converter unit; but, for re-adjustment of the directional characteristic after assembly, it is necessary to disassemble the diaphragm unit from the case, and this is very troublesome.

30 The object of the invention is to provide a miniaturized unidirectional electret microphone in a simple and convenient form.

According to the invention a unidirectional electret microphone comprises in combination a tubular
35 case having at one end a front end plate formed integrally therewith, the front end plate having a front sound hole formed therein to allow the introduction of sound into the case, an electret diaphragm disposed in the case in opposing relation to
40 the front end plates, a back electrode disposed in the case in spaced parallel relation to the electret diaphragm so as to form a space therebetween, the back electrode having a plurality of holes formed therein to allow the introduction of sound into said space, a
45 ring shaped spacer inserted between the marginal portion of the electret diaphragm and the back electrode to define the space therebetween, a damper cloth disposed in contact with the back of the back electrode for providing a desired acoustic resistance,
50 a terminal plate disposed behind the damper cloth in contact therewith and electrically connected with the back electrode through a hole formed in the damper cloth, the terminal plate having a plurality of holes formed therein so as to form acoustic paths between
55 the rear of the terminal plate and the rear of the electret diaphragm via the holes of the terminal plate, the damper cloth and the holes of the back electrode, a tubular back electrode holder disposed in the case coaxially therewith, the inner peripheral
60 surface of the back electrode holder at the end adjacent the electret diaphragm being concentrically cut out to form a thinner portion having an increased inner diameter and a stepped portion defining the thinner portion thereby to receive the terminal plate,
65 the damper cloth and the back electrode the length

of the thinner portion in the axial direction being made smaller than the combined thickness of the terminal plate, the damper cloth and the back electrode so as to form an air gap between the end face
70 of the thinner portion and a marginal portion of the ring-shaped spacer, a printed circuit board disposed at and closing the other end of the back electrode holder and forming therewith a rear compartment, an impedance converter formed on the printed circuit
75 board in the rear compartment and connected with the terminal plate for converting a high impedance input into a low-impedance output, and at least one rear sound hole for intercommunicating the rear compartment with the outside of the case to
80 introduce sound from the outside of the case into the rear compartment and wherein the rear end portion of the case is bent to engage the printed circuit board, the extent of deformation of the case controlling the degree of compression of the damper cloth
85 to achieve the required unidirectional characteristics of the microphone.

In the accompanying drawings:—

Figure 1 is a cross-sectional view showing a conventional unidirectional electret microphone;

90 Figure 2 is a cross-sectional view, similar to Figure 1, illustrating an embodiment of an electret microphone in accordance with the invention;

Figure 3 is a perspective view showing a back electrode holder 22 used in the embodiment of Figure 2;
95 and

Figures 4 and 5 are cross-sectional views illustrating other embodiments of unidirectional electret microphone in accordance with the invention.

To facilitate a better understanding of the invention, a description will be given with reference to
100 Figure 1 of a conventional unidirectional electret microphone.

In a cylindrical case 11, there are arranged, in the axial direction, an electret diaphragm unit 12 and an
105 impedance conversion unit 13. The electret diaphragm unit 12 is disposed in a capsule 14, and an electret diaphragm 16 secured to a ring 15, is placed in adjacent but spaced relation to a front panel 17 of the capsule 14 with diaphragm 16 being on the
110 remote side of the ring to the panel. A back electrode 19 is disposed opposite the electret diaphragm 16 with a ring-shaped spacer 18 held therebetween, the back electrode 19 having sound holes 20 extending therethrough. At the back of the back electrode 19,
115 there is disposed in contact therewith a damper cloth 21. The damper cloth 21 and the back electrode 19 are held together by a back electrode holder 22 made of a synthetic resin. The rear end portion of the capsule 14 is bent inwardly to be pressed against the
120 back of the back electrode holder 22, fixing the electret diaphragm unit 12 in its entirety. On the front panel 17 of the capsule 14 there is secured a cloth 24 to cover a central opening 23 formed in the front panel 17. The back electrode holder 22 has formed therein holes 40 in opposing relation to the damper
125 cloth 21.

In the impedance conversion unit 13, a tubular holder 25 is disposed on the inside of the case 11 coaxially therewith, the front end portion of the holder 25 being engaged with the electret diaphragm
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unit 12 and the rear open end portion being closed by a printed circuit board 26. On the printed circuit board 26 there is formed an impedance converter 27, which is housed in the holder 25. At the centre of the electret diaphragm unit 12, the back electrode 19 projects into the impedance conversion unit 13 to provide a terminal 28, which is connected with input leads to the impedance converter 27. The case 11 has bored therethrough sound holes 29, and in alignment therewith, holes 30 are also formed in the holder 25 permitting intercommunication between a back compartment defined by the holder 25 and the surrounding medium. Consequently, sound entering into the back compartment 31 from the outside through the sound holes 30 also reach the electret diaphragm 16 from behind through the holes 40, the damper cloth 21 and the sound holes 20. The magnitudes of the sounds reaching the electret diaphragm 16 both from behind and from in front are selected to bear a proper relationship to each other, thereby achieving the unidirectionality directivity.

As described above, in the prior art unidirectional electret microphone, the electret diaphragm unit 12 and the impedance conversion unit 13, prepared separately of each other, are housed in the case 11, so that the length of the microphone in its axial direction is inevitably large. On top of that, the electret diaphragm unit 12 is incorporated in the case 11 after its directivity is measured and regulated, but when the directivity varies after assembling, it is necessary to disassemble the electret diaphragm unit 12 from the case 11 for re-adjustment.

Figure 2 shows an embodiment of the electret microphone of the present invention. In a cylindrical metal case 14 having its front end closed, there is disposed an electret diaphragm 16 in adjacent but spaced relation to a front end plate 17 of the case 14. The electret diaphragm 16 is a film of a synthetic resinous material polarized in the direction of its thickness and has a metal layer deposited on one surface of the film. The electret diaphragm 16 has the metal layer secured to a metal ring 15, which is, in turn, held in contact with the front end plate 17 of the case 14. A back electrode 19 is disposed opposite the electret diaphragm 16 with a ring-shaped spacer 18 held therebetween, and behind the back electrode 19, a damper cloth 21 of felt, non-woven cloth, air-permeable porous urethane or like material is disposed. The back electrode 19 has sound holes 20 bored therethrough.

A terminal plate 32, which has a centrally-disposed projection 33, is placed behind the damper cloth 21 in contact therewith, and the projection 33 is snugly fitted in a through hole 34 formed in the damper cloth 21 centrally thereof and is held in contact with the back electrode 19 by, for example, spot welding. The terminal plate 32 has a plurality of holes 35 formed therein. The back electrode 19, the damper cloth 21 and the terminal plate 32 are held together by a back electrode holder 22.

The back electrode holder 22 is a cylindrical member made of a synthetic resinous material, and in its front end portion is defined an internal step 39 which forms a holding portion 37 (Figure 3). In the holding portion 37, the terminal plate 32, the damper

cloth 21 and the back electrode 19 are sequentially placed one on another while being held on the step 39. In this case, the front of the back electrode 19 projects out forwardly of the holding portion 37 to define an air gap 41 between the spacer 18 and the front edge of the holding portion 37, as shown in Figure 2.

A printed circuit board 26 is disposed in contact with the rear end face of the back holder 22. The rear end portion of the case 14 is bent inwardly to be staked against the back of the printed circuit board 26 so that the parts in the case 14 are fixedly urged against the front end plate 17. In the case 14, an impedance converter element 27 is mounted on the printed circuit board 26, and an input terminal 42 of the impedance converter element 27 is connected with the terminal plate 32. The impedance converter element 27 is to convert a high-impedance input into a low-impedance output and is usually formed by a semiconductor integrated circuit in which a field effect transistor and a resistance element are interconnected in the source follower manner. A terminal lead-out portion of the impedance converter element 27 faces towards the inner surface of the back electrode holder 22, and the input terminal 42, an output terminal 43 and a grounding terminal 44 (not shown in Figure 2) are bent forwardly and backwardly of the impedance converter element 27, and the terminals 43 and 44 are connected with the printed circuit board 26.

The back electrode holder 22 defines a rear compartment 45 in the case 14, and the rear compartment 45 is made to communicate with the outside. In Figure 2, the printed circuit board 26 has formed therein a plurality of sound holes 29. Accordingly, sounds entering into the back compartment 45 from the outside through the sound holes 29 reach the back of the electret diaphragm 16 passing through the holes 35 and the damper cloth 21, and the sounds reaching the electret diaphragm 16 both from behind and from in front are made to bear a suitable relationship to each other in terms of magnitude to achieve the unidirectional directivity. On the back of the printed circuit board 26, there are deposited blobs 48 of solder corresponding to the terminals respectively to enable external connections to be made to the microphone.

The electret microphone according to the invention differs from the conventional electret microphone as shown in Figure 1 in that the electret diaphragm 16, the back electrode 19, the back electrode holder 22 and the impedance converter element 27 are encased in the case 14 and formed as a unitary structure without the necessity of forming the electret diaphragm unit; consequently the electret microphone according to the invention has a reduced axial length. The thickness of the electret microphone can be reduced about by half as compared with prior art electret microphones. Further, the construction of the electret microphone requires less parts and steps in its manufacture and hence is less expensive.

Moreover, by selecting the degree of staking the rear end portion of the case 14, the gap 41 can be made larger or smaller to thereby permit adjustment

of the degree of compression imparted to the damper cloth 21; as a consequence, the magnitude of the sound reaching the electret diaphragm 19 through the damper cloth 21 can be adjusted, permitting adjustment of the directional characteristic of the electret microphone. Accordingly, adjustment of the directional characteristic of the electret microphone according to the invention does not involve the troublesome operation of disassembling the electret diaphragm unit from the case as is involved in the conventional electret microphone as shown in Figure 1.

Further, by sealing the rear compartment 45 with a printed circuit board 26 having no sound holes 29, a non-directional microphone can be obtained; therefore, almost all the parts can be used in the construction of unidirectional and non-directional microphones. The demand for unidirectional microphones is generally smaller than the demand for non-directional microphones, so that it is economically disadvantageous to use a large number of parts which are employed solely for the unidirectional microphone. However, the electret microphone according to the invention can be produced in either form using many of the same parts as those for the non-directional microphone, and hence it can be produced at low cost.

In the construction shown in Figure 4, the parts corresponding to those in Figure 2 are identified by the same reference numerals. It is possible to interpose a ring-shaped washer 46 between the outer peripheral surface of the damper cloth 21 and the inner surface of the back holder 22 in contact with the back electrode 19 and the terminal plate 32. By closely contacting both end faces of the washer 36 with the back electrode 19 and the terminal plate 22 respectively, sounds can be prevented from escaping from between the back electrode 19 and the damper cloth 21 or from between the damper cloth 21 and the terminal plate 32. When the clamping force for the damper cloth 21 is weak, or when the damper cloth 21 has a smaller thickness or a rough surface, there is a risk of sounds escaping from between the back electrode and the terminal plate. With the use of the washer 46 of rubber or a like elastic material, however, it is possible to prevent such escape of sounds. By closely contacting the inner peripheral surface of the holding portion 37 and the peripheral surface of the back electrode 19 with each other and the outer peripheral surface of the back electrode holder 22 and the peripheral surface of the case 14 with each other, sounds can similarly be prevented from escaping from between the damper cloth 21 and the back electrode 19 or the terminal plate 32 even if the washer 46 is not employed.

Sounds from the outside may be introduced into the rear compartment 45 not only through the apertures 29 in the printed circuit board but also as shown in Figure 5 through apertures 29 in the case 14 which register with sound holes 47 formed in the peripheral wall of the back electrode holder 22 defining the rear compartment 45. But the structures of Figures 2 and 4 excel the structure of Figure 5 in the following points: The structures of Figures 2 and 4 do not require positioning of the sound holes 29 and

47 in alignment with each other and hence permit easy assembling. Since the case 14 has no holes, its mechanical strength is not impaired; consequently, the case 14 is not likely to be deformed when staking its rear end portion. Similarly, as the sound hole 47 is not made in the back electrode holder 22, the mechanical strength of the holder is not impaired. Further, the case 14 is sometimes inserted into a cylindrical attachment of rubber; in such a case, the structures of Figures 2 and 4 neither require making a hole in the attachment corresponding to the sound hole 29 nor call for positioning the hole in alignment with the sound hole 29.

CLAIMS

1. A unidirectional electret microphone comprising in combination, a tubular case having at one end a front end plate formed integrally therewith, the front end plate having a front sound hole formed therein to allow the introduction of sound into the case, an electret diaphragm disposed in the case in opposing relation to the front end plate, a back electrode disposed in the case in spaced parallel relation to the electret diaphragm so as to form a space therebetween, the back electrode having a plurality of holes formed therein to allow the introduction of sound into said space, a ring-shaped spacer inserted between the marginal portion of the electret diaphragm and the back electrode to define the space therebetween, a damper cloth disposed in contact with the back of the back electrode for providing a desired acoustic resistance, a terminal plate disposed behind the damper cloth in contact therewith and electrically connected with the back electrode through a hole formed in the damper cloth, the terminal plate having a plurality of holes formed therein so as to form acoustic paths between the rear of the terminal plate and the rear of the electret diaphragm via the holes of the terminal plate, the damper cloth and the holes of the back electrode, a tubular back electrode holder disposed in the case coaxially therewith, the inner peripheral surface of the back electrode holder at the end adjacent the electret diaphragm being concentrically cut out to form a thinner portion having an increased inner diameter and a stepped portion defining the thinner portion thereby to receive the terminal plate, the damper cloth and the back electrode, the length of the thinner portion in the axial direction being made smaller than the combined thickness of the terminal plate, the damper cloth and the back electrode so as to form an air gap between the end face of the thinner portion and a marginal portion of the ring-shaped spacer, a printed circuit board disposed at and closing the other end of the back electrode holder and forming therewith a rear compartment, an impedance converter formed on the printed circuit board in the rear compartment and connected with the terminal plate for converting a high impedance input into a low-impedance output, and at least one rear sound hole for intercommunicating the rear compartment with the outside of the case to introduce sound from the outside of the case into the rear compartment and wherein the rear end portion of the case is bent to engage the printed circuit board, the extent of deformation of the case controlling the



of the degree of compression imparted to the damper cloth 21; as a consequence, the magnitude of the sound reaching the electret diaphragm 19 through the damper cloth 21 can be adjusted, permitting adjustment of the directional characteristic of the electret microphone. Accordingly, adjustment of the directional characteristic of the electret microphone according to the invention does not involve the troublesome operation of disassembling the electret diaphragm unit from the case as is involved in the conventional electret microphone as shown in Figure 1.

Further, by sealing the rear compartment 45 with a printed circuit board 26 having no sound holes 29, a non-directional microphone can be obtained; therefore, almost all the parts can be used in the construction of unidirectional and non-directional microphones. The demand for unidirectional microphones is generally smaller than the demand for non-directional microphones, so that it is economically disadvantageous to use a large number of parts which are employed solely for the unidirectional microphone. However, the electret microphone according to the invention can be produced in either form using many of the same parts as those for the non-directional microphone, and hence it can be produced at low cost.

In the construction shown in Figure 4, the parts corresponding to those in Figure 2 are identified by the same reference numerals. It is possible to interpose a ring-shaped washer 46 between the outer peripheral surface of the damper cloth 21 and the inner surface of the back holder 22 in contact with the back electrode 19 and the terminal plate 32. By closely contacting both end faces of the washer 36 with the back electrode 19 and the terminal plate 22 respectively, sounds can be prevented from escaping from between the back electrode 19 and the damper cloth 21 or from between the damper cloth 21 and the terminal plate 32. When the clamping force for the damper cloth 21 is weak, or when the damper cloth 21 has a smaller thickness or a rough surface, there is a risk of sounds escaping from between the back electrode and the terminal plate. With the use of the washer 46 of rubber or a like elastic material, however, it is possible to prevent such escape of sounds. By closely contacting the inner peripheral surface of the holding portion 37 and the peripheral surface of the back electrode 19 with each other and the outer peripheral surface of the back electrode holder 22 and the peripheral surface of the case 14 with each other, sounds can similarly be prevented from escaping from between the damper cloth 21 and the back electrode 19 or the terminal plate 32 even if the washer 46 is not employed.

Sounds from the outside may be introduced into the rear compartment 45 not only through the apertures 29 in the printed circuit board but also as shown in Figure 5 through apertures 29 in the case 14 which register with sound holes 47 formed in the peripheral wall of the back electrode holder 22 defining the rear compartment 45. But the structures of Figures 2 and 4 excel the structure of Figure 5 in the following points: The structures of Figures 2 and 4 do not require positioning of the sound holes 29 and

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CLAIMS

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degree of compression of the damper cloth to achieve the required unidirectional characteristic of the microphone.

2. A unidirectional electret microphone according to claim 1, wherein the rear sound hole is made in the printed circuit board.
3. A unidirectional electret microphone according to claim 1, wherein the rear sound hole is composed of a first sound hole made in the peripheral wall of the back electrode holder in the portion thereof forming the rear compartment and a second sound hole in the case in alignment with the first sound hole.
4. A unidirectional electret microphone according to claim 1, wherein the terminal plate is disc-shaped and has a centrally-disposed forward projection making electrical contact with the back electrode through the hole in the damper cloth.
5. A unidirectional electret microphone according to claim 1, further comprising a ring-shaped washer of an elastic material disposed between the outer peripheral surface of the damper cloth and the inner peripheral surface of the back electrode holder and having its sides closely contacting the back electrode and the terminal plate respectively.
6. A unidirectional electret microphone comprising the combination and arrangement of parts substantially as hereinbefore described with reference to Figures 2 and 3 of the accompanying drawings.
7. A unidirectional electret microphone comprising the combination and arrangement of parts substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.
8. A unidirectional electret microphone comprising the combination and arrangement of parts substantially as hereinbefore described with reference to Figure 5 of the accompanying drawings.