

[54] **MICROPHONE AND CONNECTOR UNIT THEREFOR**

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[58] Field of Search 179/1 PC, 107 R, 111 E,
179/121 R, 121 C, 146 R, 157, 178, 179

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"The Foil-Electret Microphone" by Sessler & West in Bell Laboratories Record, Aug. 1969, Vol. 47, No. 7, pp. 245-248.

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[57]

ABSTRACT

An electret microphone provided with a protruding pin shaped terminal member which is adapted to pierce the tie or other clothing of the user and engage a connector unit located behind the clothing of the user. The connector unit is electrically connected to a power unit supported remotely on the user.

14 Claims, 5 Drawing Figures

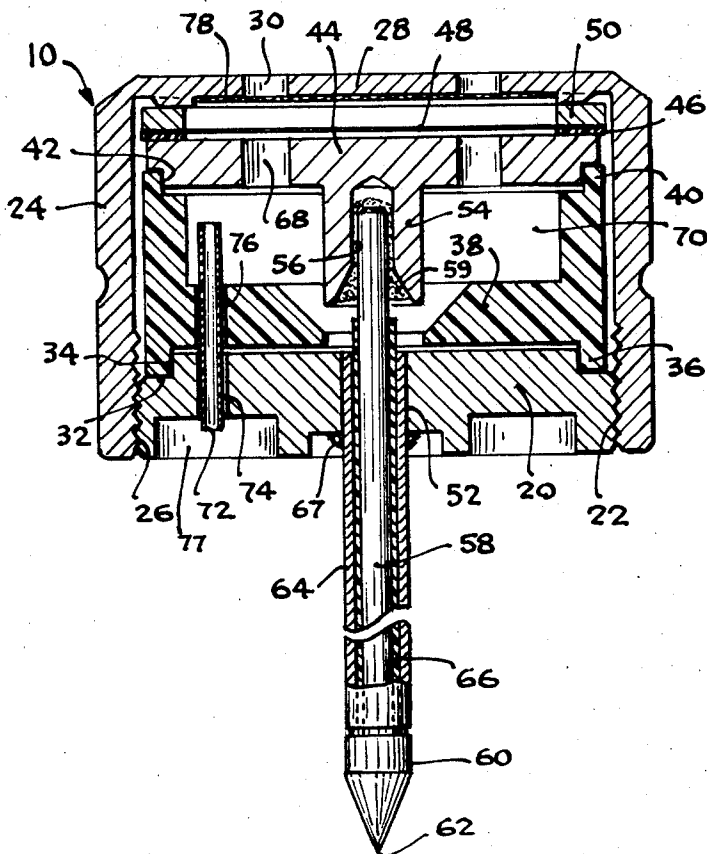


FIG. 1

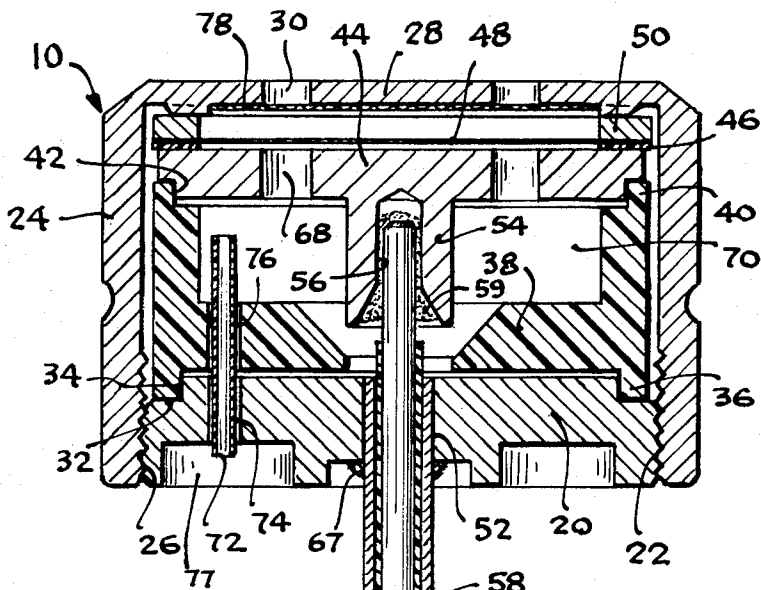
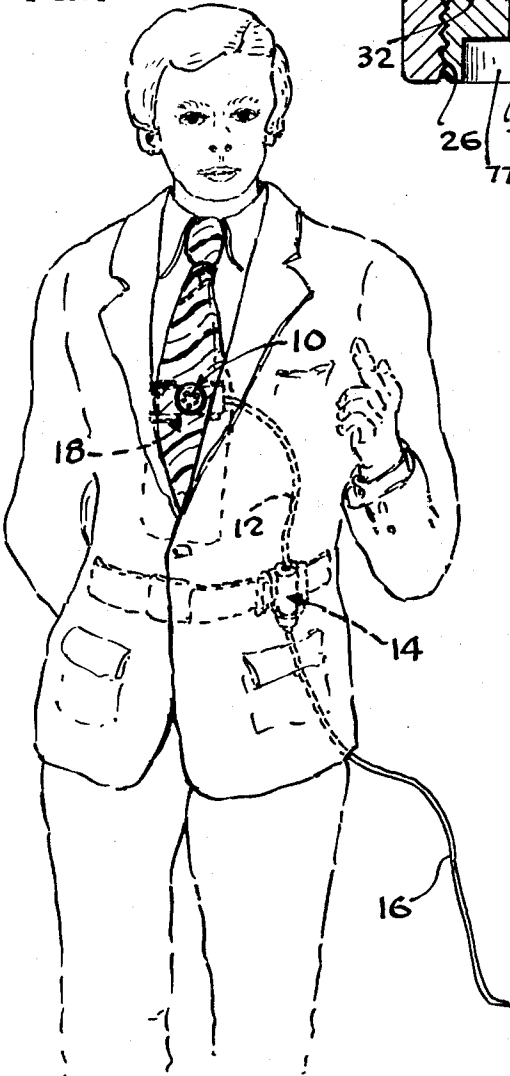


FIG. 4

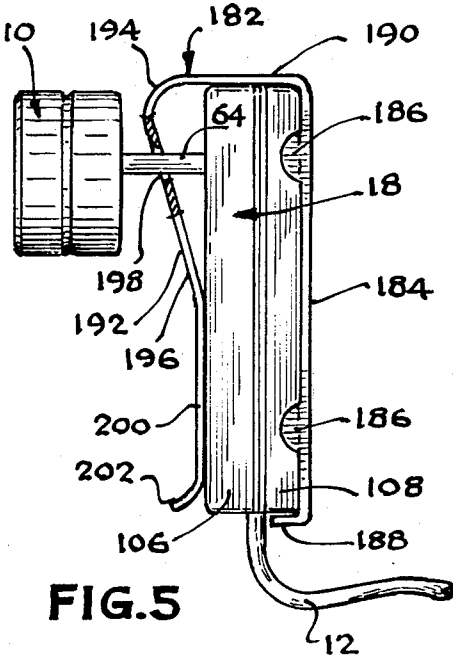


FIG. 5

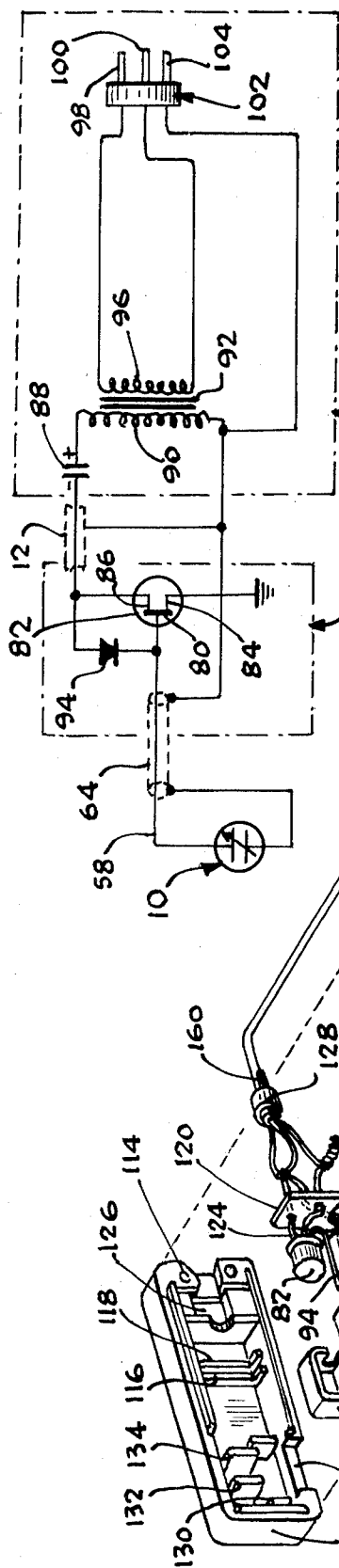
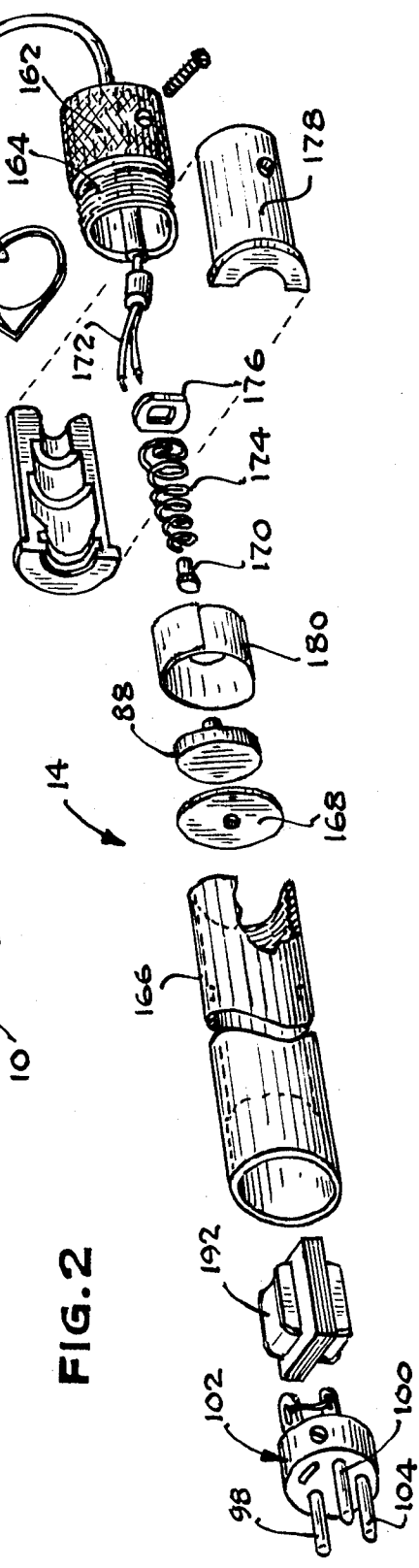


FIG. 3



MICROPHONE AND CONNECTOR UNIT THEREFOR

The present invention relates to microphones, and particularly to microphones which are adapted to be worn on a person's body during use, such as lavalier microphones.

There are many occasions in which it is desirable to position a microphone closely adjacent to the mouth of the person whose utterances are to excite the microphone. Large auditoriums occasionally have acoustical properties which make other types of microphones unsatisfactory, or, the speaker may move over too large an area to permit use of a single stationary microphone. Lavalier type microphones have become frequently used solutions for such problems. The conventional lavalier microphone is a microphone suspended at the chest of the user by means of a ribbon or band which extends about the user's neck. A lavalier microphone may or may not be a wireless microphone, and if it is not a wireless type microphone, the cord extends from the microphone across the floor to associated electronic equipment.

One of the objections to lavalier microphones is that they occasionally pick up undesired sounds as a result of movement relative to the wearer's body. As the person wearing the microphone moves, the microphone will move relative to his clothing, will bump against portions of his body, and hence will produce unwanted noises.

Another objection to lavalier microphones is that they are unduly visible to any audience. Not only is the microphone itself visible at the chest of the wearer, but the band which suspends the microphone from the wearer's neck is also visible.

Hearing aid microphones are subject to the same difficulties indicated above for lavalier microphones, and the hearing aid art has attempted to develop hearing aids in which the microphone is mounted on the clothing of the person using the hearing aid. U.S. Pat. No. 2,616,985 to Levy entitled "Hearing Aid Device" discloses a hearing aid in which the microphone is mounted on the lapel of the suit of the person using the hearing aid, the microphone having an extension or short neck which can be accommodated by the button-hole of the lapel and extends between the microphone and the casing for the amplifier and the batteries of the unit. U.S. Pat. No. 2,673,898 of Reichert is directed to a hearing aid in which the microphone has a pin structure which is adapted to pierce the clothing of the person using the microphone and engage the terminals of a cable or an electronics unit located behind the clothing of the user. In the hearing aid art, of course, the microphone is positioned to receive sounds originating primarily from sources other than the wearer, and the electronics unit is connected at its output to a receiver communicating with the ear of the person using the unit.

Hearing aid units of the type described above, have not been suitable for public address or broadcast use. Hearing aids are constructed with microphones sensitive primarily in the range of optimum hearing of the person wearing the hearing aid and the amplifier is designed to amplify those frequencies which can be heard by the person wearing the hearing aid without regard for the other frequencies which are necessary for high quality or high fidelity reproduction. Presently known

techniques for designing microphones and amplifiers permit miniaturization of these units by restricting the frequency response range of the units but conversely, the frequency response range of a hearing aid, such as described above, cannot be expanded without increasing the size of the microphone and amplifier units, and in most cases, true high fidelity cannot be achieved with the microphones used in hearing aid constructions.

It is a general object of the present invention to provide a microphone which is adapted to be worn on the clothing of a person whose utterances are to drive the microphone which is less conspicuous than prior art devices, of minimum inconvenience to the user, capable of high fidelity sound conversion, and sufficiently durable for commercial use in broadcasting or public address work.

The present invention utilizes a microphone and a connector unit which are adapted to be positioned on opposite sides of the clothing of the person using the unit. The microphone is an electret microphone which is capable of high fidelity response, durable, and may be constructed in extremely small sizes. Further, an electret microphone achieves the acoustical advantages of a condenser microphone without requiring a permanent power supply to be associated with the microphone, and therefore the connector unit, concealed beneath the clothing of the person using the microphone, requires little electronic equipment, and can be manufactured in a small, light package for coupling the microphone to a microphone cable. The weight of the cable, and power elements of the unit, are secured about the waist of the person wearing the microphone, particularly by the belt utilized to hold up trousers. The microphone itself is constructed with an elongated connector assembly protruding perpendicularly from the rear side of the microphone, thus permitting the microphone and connector unit to function as a tacket to further conceal the microphone.

The invention is more fully described in the following specification, particularly in view of the drawings, in which:

FIG. 1 is a front elevational view of a man wearing a microphone constructed in the manner of the present invention;

FIG. 2 is an exploded view of a microphone unit, connector unit, and power unit which constitutes the microphone of the present invention;

FIG. 3 is an electrical circuit diagram of the microphone of FIGS. 1 and 2;

FIG. 4 is a vertical section view of the microphone unit of the microphone shown in FIGS. 1, 2 and 3; and

FIG. 5 is an elevational view of the connector unit assembled with a clip adapted to facilitate mounting of the connector unit at the edge of the user's clothing.

FIG. 1 illustrates the manner in which a microphone constructed according to the present invention is utilized. The person whose utterances are to drive the microphone, is shown wearing a conventional suit and tie, and the microphone 10 is illustrated as a tie clip which both holds the tie in position and positions the microphone to respond to the person's utterances. A connecting cable 12, which may be very thin and light weight, beneath the clothing of the person extends to a power unit 14 which is connected to a conventional microphone cable 16.

FIG. 2 illustrates the microphone in exploded form, the microphone unit 10 being shown confronting a connector unit 18, which is positioned in use beneath the clothing of the user directly behind the microphone unit 10. The cable 12 between the connector unit 18 and the power unit 14 has been broken in FIG. 2 for clarity of illustration.

The microphone unit 10 is best illustrated in FIG. 4, and has a housing formed by a circular disc 30 provided with threads 22 about its perimeter and a cylindrical shell 24 having threads 26 on the inner surface of one end which mate with the threads 22 of the disc 20. The shell 24 has a wall 28 across the end thereof opposite the threads 26, and the wall 28 is provided with a ring of circular perforations 30 which permit sound waves to enter the interior of the housing.

The disc 20 has a peripheral groove 32 confronting the wall 28 of the housing, and the groove 32 forms a shoulder 34 which mates with a cylindrical flange 36 of a spacer 38. The spacer 38 is cylindrical in shape and is disposed within the cylindrical wall of the shell 24. The spacer 38 has a second flange 40 extending outwardly from the perimeter thereof toward the front wall 28, and the second flange 40 is snugly disposed within a recess 42 of a plate 44 which extends generally parallel to the wall 28.

The plate 44 is electrically conducting and will form one of the electrodes of the electret microphone. The spacer 38 is constructed of electrically insulating material, such as plastic, and it positions the plate 44 in spaced insulated relation to the shell 24, which is also electrically conducting. A thin ring 46 constructed of electrically insulating material is positioned about the perimeter of the plate 44, and a diaphragm 48 is mounted on the side of the ring 46 opposite the plate 44. The diaphragm 48 is constructed of plastic, and is provided with an electrically conducting film on the surface thereof opposite the plate or electrode 44. A second ring 50 constructed of electrically conducting material is disposed between the diaphragm 48 and the confronting surface of the front wall 28 of the housing, the ring 50 being in abutment with the confronting surface of the diaphragm 48 and the wall 28 to form electrical connection between the diaphragm 48 and the shell 24 through the wall 28. The spacer 38, electrode or plate 44, first ring 46, diaphragm 48 and second ring 50 are all maintained in position as a result of compression placed on the assembly by the disc 20 and shell 24.

The disc 20 has an axial channel 52 which extends therethrough and confronts a depending portion 54 on the plate or electrode 44. The depending portion 54 has a bore 56 aligned with the axis of the channel 52, and an electrically conducting pin 58 has one end thereof disposed in the bore 56 and electrically connected thereto by solder or a conductive epoxy 59. The pin 58 extends through the channel 52 and has on its end opposite the bore 56 an outwardly extending flange portion 60 which terminates in a relatively sharp point 62. The flange portion 60 forms one terminal for the microphone unit 10 and is electrically connected to the electrode or plate 44.

An electrically conducting sleeve 64 is disposed about the pin 58 and insulated electrically therefrom by a layer 66 of insulating material, such as plastic. The sleeve extends substantially through the disc plate 20 and is connected thereto mechanically and electrically by a layer of solder 67. The sleeve 64 terminates at its

end opposite the disc 20 a small distance from the flange portion 60 of the pin 58, and the layer 66 of electrical insulation flares outwardly to fill the space between the sleeve 64 and the flange portion 60. The disc 20 is constructed of electrically conducting material, as is the shell 24, to form electrical connection between the sleeve 64 and the electrically conducting film of the diaphragm 48. Thus the sleeve 64 forms a second terminal for the microphone unit, and the sleeve 64, layer 66 and pin 58 constitute an electrical connector assembly for the microphone unit. It will be noted that the sleeve 64 and pin 58 form a coaxial connector which shields the output of the microphone against spurious signals, such as hum, and also prevents shorting of the output by clothing in the event of high humidity conditions.

The region between the diaphragm 48 and the confronting surface of the plate or electrode 44 is acoustically a diaphragm chamber which affects the acoustical response of the microphone. In the present construction, a plurality of openings 68 extend through the plate 44 to communicate with a cavity 70 formed between the plate 44 and the spacer 38 to improve the high frequency response of the microphone. Because a lavalier microphone is not in line with the sound source, it is desirable to provide a bass roll off and a high frequency boost to compensate for the loss of high frequencies impinging on the microphone. A high frequency boost is achieved by resonating the system consisting of the diaphragm 48, the inertance of the openings 68 in the plate 44, the cavity 70 and the diaphragm chamber.

In addition, a tube 72 extends through a bore 74 in the disc 20 and an aligned bore 76 in the spacer 38 to provide a base roll off and pressure equalization between the interior and exterior surface of the diaphragm 48. The tube 72 is hollow and provides a highly inertive acoustical coupling to the exterior of the microphone unit to achieve bass rolloff. Also, the disc 20 has a recess 77 about the bore 74 to assure adequate acoustical coupling to the ambient atmosphere even when clothing is in abutment with the disc 20.

The region between the diaphragm 48 and the wall 28 of the shell 24 constitutes a forward acoustical chamber, and soundwaves have access to this chamber through the perforations 30 in the wall 28. The inner surface of the wall 28 is provided with a layer 78 of cloth which is pervious to sound waves.

FIG. 3 illustrates the electrical circuit of the microphone. It will be noted that the microphone unit 10, connector unit 18, and power unit 14 are all indicated on the electrical circuit diagram. The microphone unit 10 is connected to the connector unit 18 through a coaxial cable formed by the pin 58 and sleeve 64 of the microphone unit. It will be noted that the sleeve 64 constitutes a ground terminal, and that the pin 58 is electrically connected to the control electrode 80 of a field effect transistor 82. The source and drain electrodes 84 and 86 of the transistor 82 are connected in a series circuit with a battery 88 and the primary winding 90 of a transformer 92. A diode 94 is connected between the source electrode 86 and the control electrode 80 of the transistor 82 to provide the proper bias.

It will be noted that the transformer 92 and battery 88 are located in the power unit 14, and the cable 12 extends between the power unit 14 and the connector unit 18. The weight of the transformer 92, and other elements of the power unit 14, are therefore positioned

remotely from the microphone unit 10, and may be attached to the belt of the user, as previously indicated. The transistor 82 converts the high impedance output of the microphone unit 10 which appears on the pin 58 and sleeve 64 to allow impedance which may be transmitted through the cable 12 to the matching transformer 92. The transformer 92 has a secondary winding 96 which is connected to two terminals 98 and 100 of a connector 102. The connector 102 also has a third terminal 104 which is a ground terminal and is connected to the outer shield of the cable 12, the drain of the transistor 82, and the sleeve 64 of the microphone unit 10.

The mechanical construction of the connector unit 18 and the power unit 14 is shown in the exploded view of FIG. 2. The connector unit 18 has a housing formed by a front portion 106 and a rear portion 108, the front portion 106 and rear portion 108 form a chamber in the housing which accommodates the electrical elements of the connector unit 18. The rear portion of the housing is provided with a pair of parallel ribs 116 and 118 which mount an electrically insulating board 120 which has apertures 122 for the wire terminals 124 of the transistor 82 and the diode 94, these elements being mounted on one side of the board 120. The rear portion 108 of the housing also has a recess 126 on the side of the board 120 opposite the transistor 82 which accommodates a clamp 128 at the end of the cable 12 and secures the end of the cable 12 on the housing of the connector unit.

The rear portion 108 of the housing of the connector unit is provided with four spaced posts 130, 132, 134, and 136 at the end of the rear portion opposite the cable 12, and these posts secure an insulator cup 136 in position. The cup 136 accommodates a contact block 138 of electrically conducting material which is connected to the control electrode 80 of the transistor 82. The block has a conical recess 140 therein confronting the front portion 106 of the housing and is adapted to accommodate and engage the pointed end 62 of the flange 60 of the microphone unit 10, and hence make electrical connection between the control electrode of the transistor 82 and the electrode or plate 44 of the microphone unit.

The posts 132 and 134 also form a seat for guiding a translatable slide plate 142. The rear portion 108 of the housing is provided with a recess 144 in the wall opposite the posts 132 and 134, and a button 146 attached to one end of the slide plate 142 is translatably disposed within the recess 144, the button having a protruding flange 148 which is adapted to abut the interior surface of the rear portion 108 of the housing. The opposite end of the slide plate 142 from the button 146 is provided with an outwardly extending finger 150 which is disposed within a spiral spring 152, the end of the spring 152 opposite the slide plate 142 abutting the confronting surface of the rear portion 108 of the housing. The spring 152 urges the slide plate 142 and its attached button 146 outwardly causing the flange 148 of the button to rest in abutment with the inner surface of the rear portion 108 of the housing.

The slide plate 142 has a central opening 154 which has a v-shaped contour at its end remote from the button 146, the contour being designated 156. The opening 154 is aligned with an opening 158 in the front portion 106 of the housing, the opening 158 and the opening 154 being adapted to accommodate the sleeve 64

and pin 58 of the microphone unit 10 and snugly engage the sleeve 64. When the sleeve 64 and pin 58 are inserted through the opening 158 of the front portion 106 of the housing and extend through the opening 154 of the slide plate 142, the flange 60 of the pin 58 abutting the conical seat 140 of the conducting block 138, the spring 152 forces the slide plate 142 into engagement with the sleeve 64 and retains the microphone unit 10 in position. The slide plate 142 is electrically conducting, and hence in this position, makes electrical contact with the sleeve 64. The front portion 106 and rear portion 108 of the housing are constructed of plastic and provided with an electrically conducting coating, and the slide plate 142 abuts this coating to electrically connect the sleeve 64 of the microphone to the housing.

The cable 12 is provided with an outer armored ground shield, which has a tab 160 electrically connected to the clamp 128 on the end of the cable 12. The clamp 128 is in abutment with the electrically conducting surface of the front portion 106 and rear portion 108 of the housing, and hence the slide plate 142 connects the sleeve 64 of the microphone unit to the armored ground shield of the cable 12.

The cable 12 extends to the power unit 14 which has a cap 162 at one end at which the cable 12 enters the power unit. The cap 162 has a threaded end 164 which engages the end of a tubular housing 166, the threaded end 164 engaging threads not shown within the end of the housing 166. The opposite end of the housing from the cap 162 is secured on the connector 102, and the housing 166 accommodates the transformer 92 and the battery 88. One terminal of the battery abuts an electrically conducting disc 168 which forms one terminal for the battery, and the other terminal of the battery abuts the rivet 170 which is electrically connected to the central wire 172 of the cable 12. The rivet 170 is mounted on a spring 174 by means of a washer 176, and the assembly including the spring 174 is mounted within a plastic sleeve 178 formed by two mating parts which are secured together by cement, not shown. The battery mounting and connecting devices including the disc 168 and the sleeve 178 are disposed within the housing 166 and surrounded by an insulating strip 180.

The entire power unit 14 is generally hung from the belt of the person using the microphone, and a separate microphone cable with a connector mating with the connector 102, illustrated in FIG. 1 as cable 16, extends to an external amplifier, not shown, or other associated equipment. The power unit may be secured to the person using the microphone by any convenient device, such as placing the power unit in a person's belt by use of a metal clamp 181 provided with a ring 183 adapted to be disposed and secured between the cap 162 and tubular housing 166.

FIG. 5 illustrates a convenient clamp designated 182 for mounting the connector unit 18 on the shirt of a person using the microphone. As illustrated in FIG. 1, the microphone is perhaps most conveniently utilized as a tie tak, and is perhaps least conspicuous when so used. The clamp 182 is intended to facilitate use of the microphone as a tie tak.

The clamp 182 has a flat back 184 with tabs 186 extending inwardly from both edges or sides of the back 184, only two of the tabs being shown in FIG. 5, the other two tabs being located directly behind the two tabs illustrated. In addition, a tab 188 extends from one

end of the back, and a flat portion 190 of a spring clamp member 192 extends from the other end of the back 184. The entire connector unit 18 is accommodated between the clamp member 192 and the back 184 of the clamp 182, the surface of the rear portion 108 being in direct abutment with the back 184 of the clamp 182.

The clamp member 192 is provided with a bend 194 immediately adjacent to the flat side 190, and the bend exceeds 270°. The clamp thereafter is provided with a second flat portion 196 which contains an opening 198 to permit the sleeve 64 and pin 58 of the microphone unit 10 to pass through the clamp 182 to engage the connector unit 18. The flat portion 196 extends to a third flat portion 200 which is adapted to be parallel with the back 184 of the clamp 182, and an end portion 202 curving outwardly from the back surface 184 terminates the clamp member 192. In use, the connector unit 18 is positioned within the clamp 192, the microphone unit 10 having been removed. A portion of a shirt or other clothing is slipped between the curved end 202 of the clamp member 192 and the front portion 106 of the casing of the connector unit 18, the clothing being translated into abutment with the flat portion 190 of the clamp. Thereafter, the microphone unit 10 is inserted through the opening 198 into the connector unit 18.

Those skilled in the art will recognize many applications and advantages of the present invention from the foregoing specification. For purposes of illustration and not limitation, the present invention may be utilized in a wireless microphone construction by simply replacing the power unit here set forth with a known transmitting unit. It is therefore intended that the scope of the present invention be not limited by the foregoing specification, but rather only by the appended claims.

The invention claimed is:

1. A microphone unit adapted to engage a connector unit disposed on the opposite side of a part of the clothing of a person using the microphone comprising a housing provided with a front perforated side, a back side opposite the front perforated side having an opening confronting the front perforated side, and a continuous peripheral wall acoustically sealed at the perimeter of the front side and the back side to define an inner chamber acoustically coupled to the exterior of the housing through the front perforated side, an electrically conducting plate disposed within the chamber and having a flat surface confronting the front perforated side, said plate being acoustically sealed on the peripheral wall to form a first cavity between the said surface of the plate and the front perforated side of the housing and a second cavity between the plate and the back side of the housing, a plastic diaphragm disposed in the first cavity spaced from and parallel to the flat surface of the plate, said diaphragm having an electrically conducting film on the surface thereof and carrying an electrical charge with respect to the plate, an electrical connector assembly mounted on the back side of the housing and extending through the opening thereof, said assembly having a unitary rigid elongated central pin of electrically conducting material in abutment with and electrically connected at one end on the plate and extending from the chamber of the housing to the exterior thereof, said electrical connector assembly having a rigid electrically conductive sleeve disposed

about the pin and spaced therefrom, said sleeve being electrically connected to the film of the diaphragm.

2. A microphone unit comprising the combination of claim 1 wherein the housing is constructed of electrically conducting material, and the electrically conducting plate is electrically insulated from the housing, the sleeve of the connector assembly being electrically connected to the film of the diaphragm through the housing.

3. A microphone unit comprising the combination of claim 1 wherein the pin of the electrical connector assembly extends further from the plate of the housing and terminates in a pointed surface, said connector assembly having a layer of insulating material between the pin and the sleeve.

4. A microphone adapted to be affixed on a part of the clothing of a person using the microphone comprising a microphone unit according to claim 3 in combination with a connector unit, said connector unit comprising a casing having a cavity therein and an opening adapted to accommodate the electrical connector assembly of the microphone unit, and electrical contact means disposed within the cavity adapted to engage the pin and the sleeve of the microphone unit and provide electrical connection thereto, said contact means including a block of electrically conducting material mounted within the casing confronting the opening therein, said block having a seat adapted to engage the end of the pin of the microphone unit when inserted through the opening in the casing of the connector unit.

5. A microphone unit comprising the combination of claim 1 wherein a first acoustically sealed chamber is disposed between the electrically conducting plate and the diaphragm and a second acoustically sealed chamber is disposed on the opposite side of the electrically conducting plate, said first and second chambers being acoustically coupled through apertures in the electrically conducting plate.

6. A microphone unit comprising the combination of claim 5 in combination with a hollow open tube extending between the exterior of the housing and the second chamber to roll off the low frequency response of the microphone.

7. A microphone unit comprising the combination of claim 6 wherein the tube extends through an aperture in the back side of the housing, said back side of the housing being provided with a recess extending about the aperture therein and the tube terminating in said recess.

8. A microphone adapted to be affixed on a part of the clothing of a person using the microphone comprising a microphone unit according to claim 1 in combination with a connector unit, said connector unit comprising a casing having a cavity therein and an opening adapted to accommodate the electrical connector assembly of the microphone unit, and first and second electrical contact means disposed within the casing adapted to engage the pin and the sleeve respectively of the microphone unit and provide electrical connection thereto.

9. A microphone comprising the combination of claim 8 wherein the second electrical contact means includes a plate of electrically conducting material mounted within the casing confronting the opening thereof for translation in a single path normal to the axis of the opening, said plate having an opening adapted to accommodate the sleeve of the microphone

unit, and spring bias means operatively engaging the translatable plate urging the plate to move in one direction along its path.

10. A microphone and clip adapted to be affixed on a part of the clothing of a person using the combination in accordance with claim 8 in combination with a clip, said clip having a back adapted to accommodate one surface of the connector unit and a clamp portion extending from the back and being bent to confront the back and abut the connector unit, said clamp portion being adapted to hold securely a piece of clothing disposed between it and the connector unit, and said clamp portion having an opening therein confronting the opening in the connector portion and accommodating the pin and sleeve of the microphone unit.

11. A microphone comprising the combination of claim 8 in combination with a cable extending from the casing and having a first conductor and a second conductor, and a field effect transistor amplifier electrically connected between the first and second conductors and the first and second electrical contact means.

12. A microphone comprising the combination of claim 11 wherein the field effect transistor amplifier includes a transformer and a battery located in a separate power unit remote from the connector unit and connected thereto through the cable.

13. A microphone comprising the combination of claim 12 wherein the power unit has a housing provided with a clip adapted to mount the power unit on the belt of a person using the microphone.

14. A microphone unit adapted to engage a connector unit disposed on the opposite side of a part of the clothing of a person using the microphone, comprising a housing constructed of electrically conducting material having a cylindrical shell with a perforated wall at one end, the other end of the shell being open and being provided with inwardly facing threads, said housing also having a disc with a cylindrical perimeter provided with threads engaging the threads of the shell, said disc having an axial channel extending therethrough and a bore extending therethrough from a recess disposed on the side of the disc opposite the wall of the shell, a cylindrical spacer constructed of electrically insulating material disposed within the housing in

abutment with the disc, said spacer having a circular peripheral flange extending toward the disc and mating in a circular peripheral recess of the disc, said spacer also having an aperture in alignment with the aperture of the disc and a protruding circular flange extending outwardly from the periphery thereof remote from the disc, a circular electrically conducting plate disposed within the housing in abutment with the side of the spacer remote from the disc, said plate having a peripheral groove mating and engaging the peripheral flange of the spacer, said plate also being provided with a plurality of apertures extending therethrough and a depending stem aligned with the axis of the channel of the disc and provided with an inwardly extending axial bore confronting the channel of the disc, an electrically insulating circular washer disposed about the periphery of the plate on the side opposite the spacer, a thin plastic diaphragm extending over the washer on the side opposite the plate and confronting the plate, said diaphragm being provided with a thin electrically conducting film on the surface thereof remote from the plate, an electrically conducting washer mounted between the perforated wall of the shell and the diaphragm in alignment with the electrically insulating washer, the diaphragm, insulating washer, and plate forming a diaphragm chamber which is in acoustical communication with a back chamber disposed between the plate and spacer, a hollow tube extending through the apertures in the spacer and disc and acoustically sealed thereon, said tube acoustically coupling the back chamber to the ambient atmosphere, an elongated pin having one end secured within the bore of the plate and electrically connected to the plate, said pin extending through the channel of the disc to the exterior thereof and being provided with a protruding flange remote from the plate and terminating in a conical end, an electrically conducting sleeve sealed within and electrically connected to the channel of the disc and extending toward the flange of the pin, a layer of electrical insulating material disposed between the pin and the sleeve and the flange and the sleeve, the diaphragm being permanently charged electrically with respect to the plate.

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