Nov. 11, 1941. D. DOMIZI 2,261,979

ACOUSTIC DEVICE

Filed March 20, 1939

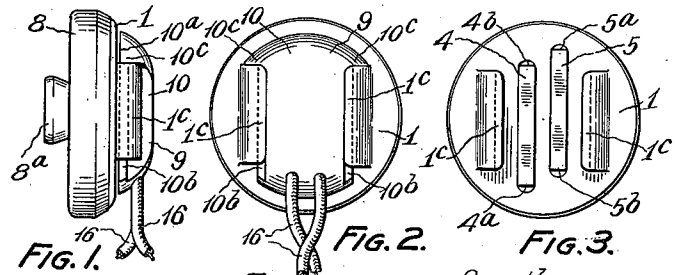

FIG. 1.

FIG. 2.

FIG. 3.

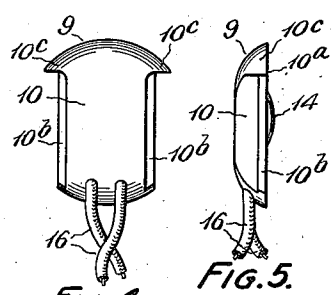

FIG. 4.

FIG. 5.

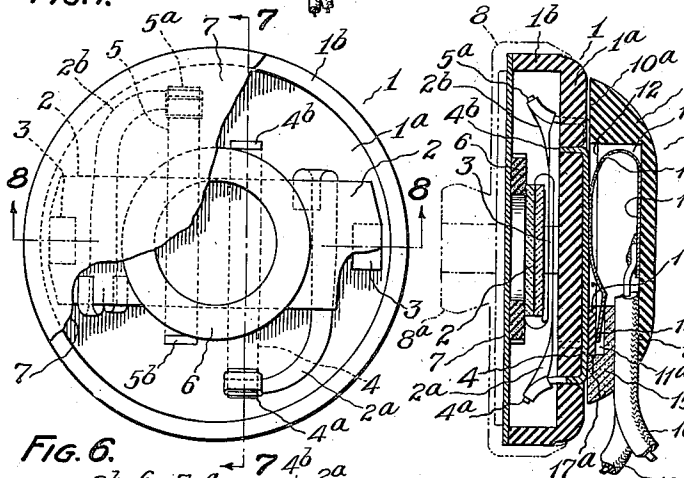

FIG. 6.

FIG. 7.

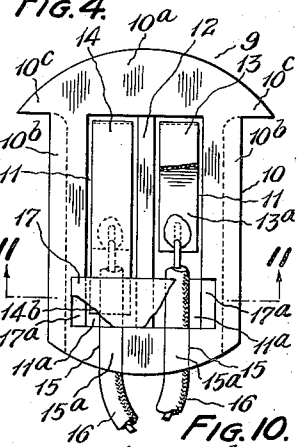

FIG. 10.

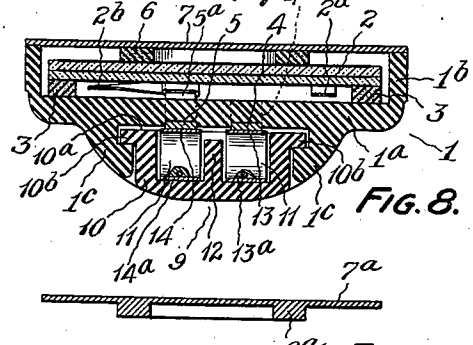

FIG. 8.

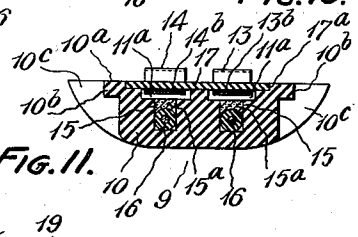

FIG. 11.

FIG. 9.

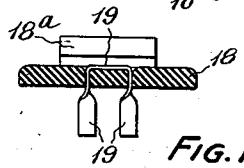

FIG. 15.

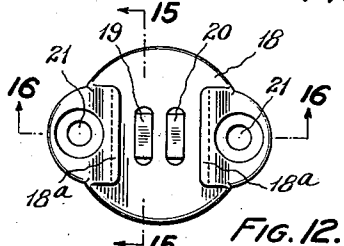

FIG. 12.

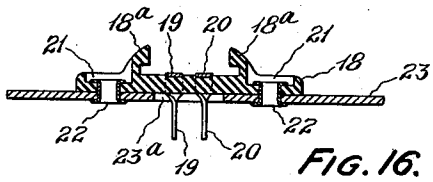

FIG. 16.

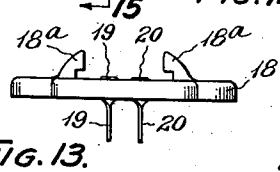

FIG. 13.

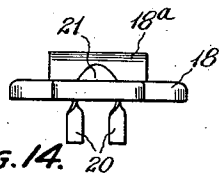

FIG. 14.

INVENTOR :

DANTE DOMIZI

BY H. H. Christensen

ATTORNEY

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ACOUSTIC DEVICE

Dante Domizi, Cleveland Heights, Ohio, assignor to The Brush Development Company, Cleveland, Ohio, a corporation of Ohio

Application March 20, 1939, Serial No. 262,878

10 Claims. (Cl. 179—110)

This invention relates to acoustic devices such as transmitters and receivers and to connecting means for electrical apparatus especially adapted for use on receivers of small size.

An object of this invention is to provide a small, thin connecting means suitable for use on a wide variety of devices but especially adapted for use on acoustic devices of small size intended for inconspicuous wear by individuals of impaired hearing.

Another object of this invention is to provide an improved construction for piezo-electric acoustic devices of small size.

Another object of this invention is to provide an improved means for connecting a piezo-electric unit to an acoustic diaphragm.

For the purpose of illustration the invention will now be described with reference to the accompanying drawing. In order to better illustrate some of the smaller parts, all of the figures are larger than the actual devices are apt to be made, but the invention should not be limited to any particular dimensions. Figures 6 to 11 inclusive are drawn on a larger scale than the remaining figures.

Fig. 1 is an edge elevation of an acoustic device embodying the features of this invention.

Fig. 2 is a plan view of the device of Fig. 1.

Fig. 3 is a view similar to Fig. 2 but with the connector removed to reveal the terminals of the acoustic device.

Fig. 4 is a plan view of the connector.

Fig. 5 is an edge elevation of the connector of Fig. 4.

Fig. 6 is a plan view of the acoustic device of Figs. 1 to 3, showing the opposite side, with some of the parts broken away to reveal inner construction.

Fig. 7 is a sectional view on the line 7, 7 of Fig. 6.

Fig. 8 is a sectional view on the line 8, 8 of Fig. 6.

Fig. 9 is a sectional view of an alternative diaphragm construction.

Fig. 10 is a plan view of the terminal side of the connector shown in Figs. 4, 5, 7 and 8, with some of the parts broken away to reveal inner construction.

Fig. 11 is a sectional view on the line 11, 11 of Fig. 10.

Fig. 12 is a plan view of a separate receptacle for the connector of Figs. 4, 5, 10 and 11.

Fig. 13 is a side elevation of the receptacle.

Fig. 14 is an edge elevation of the receptacle.

Fig. 15 is a sectional view taken on the line 15, 15 of Fig. 12 with a contact member shown in elevation.

Fig. 16 is a sectional view showing a receptacle in cross-section corresponding to that of line 16, 16 of Fig. 15, said receptacle being secured to a portion of a wall section of electrical apparatus.

In Figs. 1 to 11, the acoustic device comprises a cup-shaped housing 1 of hard rubber, Bakelite or any other suitable insulating material having a main wall section 1*a* and circular wall section 1*b*. Within the housing is disposed a substantially rectangular piezo-electric bimorph unit 2 of the bending type such as is disclosed in United States Letters Patent Reissue 20,213. The unit is supported at its ends on small blocks 3, 3 of soft material such as viscoloid or rubber, which are supported by the wall section 1*a* of the housing. The blocks 3, 3 may readily be secured to the unit and housing by cement. The ends of the unit are slightly beveled to permit use of a larger unit than would otherwise be possible.

The outer face of main wall section 1*a* carries a connector receptacle comprising connector retaining flanges 1*c*, 1*c* which may, as shown, be formed as integral parts of the housing 1. The receptacle further comprises thin strip-like terminal contacts 4, 5. The terminals 4 and 5 are mounted in channel-shaped recesses in the outer face of wall section 1*a* by forcing the terminal ends through suitable engaging recesses in the wall section. The end 4*a* of terminal 4 extends inwardly and terminates close to an edge of unit 2 while the other end 4*b* terminates flush with the inner surface of wall section 1*a*. Similarly end 5*a* of terminal 5 extends inwardly and terminates close to the opposite edge of the unit 2, and the other end 5*b* terminates flush with the inner surface of wall section 1*a*. It is not necessary that the ends 4*b*, 5*b* extend into the wall section but such construction adds to the ruggedness of the assembly. For further strength these ends may be made longer and bent over on the inner face of wall section 1*a*. The electrical leads 2*a*, 2*b* of the unit 2 are connected to ends 4*a*, 5*a* respectively of the terminals.

In assembling such units of very small size, it is difficult to solder the connection without damaging the crystal unit by excessive heat. It has been found that the connections to piezo-electric units, such as unit 2, need not have the low resistance usually required in other devices as long the the connections are mechanically rigid. A satisfactory connection may be made by wrapping the lead 2*a* or 2*b* several times around terminal end 5*a* or 5*b* and then applying a drop of

cement or lacquer or other suitable binder. The binder may, if desired, contain particles of a conducting material.

On the outer face of unit 2 approximately midway between its ends is cemented a ring 6 of yielding vibration conductive material such as viscoloid or rubber. A diaphragm 7 of suitable material such as Celluloid, aluminum, Bakelite or mica is secured to the wall section 1*b* of the casing by cement or other suitable means and at its inner face is cemented to the ring 6.

When a circuit supplying a voltage of sound frequency is connected to the terminals 4, 5 the piezo-electric unit 2 vibrates and through ring 6 causes diaphragm 7 to vibrate with resultant radiation of sound. Conversely, sound waves acting on diaphragm 7 apply a varying pressure through ring 6 to the unit 2, and as a result an alternating voltage appears between terminals 4 and 5.

It has been found that when a ring-like member such as 6 in Figs. 6, 7 and 8 is substituted for other coupling means between a piezo-electric unit and a diaphragm, the ratio of acoustic output to applied voltage is increased and consequently a device using this new coupling means may be reduced in size. The increase in sensitivity probably results from the better distribution of forces over the diaphragm so that the net volume displaced by the diaphragm is greater, and from the more favorable mechanical impedance match between the piezo-electric unit and the diaphragm. Due to the thinness of the ring, very little motion is lost between the piezo-electric unit and the diaphragm, and due to the yielding nature of the ring, it does not appreciably constrain the flexing motion of the piezo-electric unit.

It is not necessary that the member 6, referred to for convenience in these specifications and the appended claims as a ring, be of circular form. Indeed it may be square or elliptical or any other suitable geometric shape and of any suitable cross-sectional shape, the essential feature being a large area of contact with the diaphragm. Furthermore, the ring need not be a separate member cemented to the diaphragm. It may be formed as a part of the diaphragm, for example, as shown in the sectional view, Fig. 9. In this figure the diaphragm 7*a* is molded or otherwise formed with a ring 6*a* projecting from one side. The diaphragm 7*a* with its integral ring 6*a* may be substituted for diaphragm 7 and cemented ring 6 in the device of Figs. 1 to 8.

When used as an earphone the device of Figs. 1 to 11 may be held close to the user's ear in any suitable manner. One convenient arrangement for an earphone of small size is to provide the phone with a metal shell 8 (shown in Fig. 1, and represented in dot and dash outline in Fig. 7) having a projection 8*a* which is adapted to engage a recess in an ear insert member or earpiece of the type commonly used with hearing aid devices. The shell 8 may be secured to the phone by providing threads on the outer surface of wall section 1*b* or simply by cementing to the phone. It may serve to clamp the diaphragm 7 to the wall section 1*b*, if the diaphragm is not cemented thereto. Alternatively, the shell 8 may be omitted and the earphone directly connected to the ear insert by cementing it thereto or by providing a threaded recess in the insert and suitably engaging threads on the outer surface of wall section 1*a*.

To connect an external electrical circuit to the terminals 4, 5 a connector 9 is provided. It comprises a main body member 10 molded of suitable insulating material and having a flat face 10*a*. Outwardly projecting flanges 10*b*, 10*b* are adapted to engage connector retaining flanges 1*c*, 1*c* of the connector receptacle which are carried by the main wall section 1*a* of the acoustic device. Projections 10*c*, 10*c* at one end of the connector serve as stops which engage ends of retainer flanges 1*c* to locate the connector on the device. The connector is provided with two main recesses 11, 11 separated by a thin wall 12. Within each recess is disposed a generally U shaped spring strip contactor member, designated as 13 and 14, formed of thin spring brass or other suitable material. When the connector 9 engages the receptacle, the contactor members 13 and 14 register with terminals 4 and 5 and are slightly compressed so as to be held against said terminals under slight pressure. Two slots 15, 15 formed in the connector body 10 extend from one end face into the recesses 11 and outwardly toward the flat face 10*a*. Flexible lead wires 16, 16 fit into the slots with a tight press fit and are further held by a suitable cement 15*a* (Figs. 7 and 11). The wires are soldered to the inner ends 13*a*, 14*a* of the contactor members. In Fig. 10 part of contactor member 13 is broken away to reveal the soldered joint. The outer ends 13*b*, 14*b* of the contactor members fit into shallow extensions 11*a*, 11*a* of recesses 11, 11. A thin plate 17 of suitable insulating material is cemented into a registering cavity 17*a* to form an overhanging portion of the body which loosely holds the ends 13*b*, 14*b* of the contactor members in alignment in their recesses. In Fig. 10 the plate 17 is partly broken away to better reveal the inner construction.

It will be noted that an acoustic device embodying the features of this invention may be made very small and compact so as to be very inconspicuous when worn as an earphone. Several features contribute to this compactness. They include (*a*) the use of a thin piezo-electric actuating unit disposed in a shallow housing flatwise adjacent the main wall section, (*b*) the use of a thin ring of yielding vibration conductive material to couple the actuating unit to the diaphragm, (*c*) the use of a receptacle carried by the main wall section of the device and adapted to receive in sliding engagement a thin connector and (*d*) location of the ends of the receptacle terminals adjacent the edges of the piezo-electric unit in a space otherwise unoccupied and in positions adapted for ready connection to the leads of the unit.

The relatively long U shaped construction of the contactor members in the connector insures sufficient pressure to obtain good electrical connections and to hold the connector in place in the receptacle without requiring great accuracy in the fabrication of the parts. Since the wires 16, 16 are both pressed and cemented into the slots 15, 15 most of the stress on the wires is taken by the main body 10 rather than by the contactor members 13, 14.

It is usually unnecessary to provide polarized terminals for piezo-electric devices and it will be observed that the connector provided by this invention may engage the receptacle from either side thus facilitating rapid and easy connection. However, if desired, the connector retaining flanges 1*c*, 1*c* may be provided with a barrier to prevent entrance of the connector from one side.

Although in many cases it is advantageous, in the interest of compactness and simplicity, to

embody the connector retaining flanges as integral parts of the electrical apparatus and to carry the receptacle terminals in a wall section of the apparatus, as illustrated in the acoustic device of Figs. 1 to 11, it may be desirable in other cases to provide as a separate unit a connector receptacle which may be secured to electrical apparatus by screws or rivets. Figs. 12 to 16 illustrate such a separate receptacle. It comprises an insulating base 18 having connector retaining flanges 18a, 18a adapted to engage the flanges 10b of the connector. Generally U shaped contact members 19 and 20 formed of thin sheet metal are carried by the insulating base and may conveniently be secured thereto by forcing their ends through suitable apertures in the base. If desired, the ends may be twisted as shown in Figs. 13 to 16. Holes 21, 21 are provided to accommodate screws or rivets for securing the receptacle to the electrical apparatus with which it is to be associated. When connector 9 is inserted in the receptacle, the contact members 19 and 20 engage contactor members 13 and 14 of the connector and sufficient pressure is maintained by members 13 and 14 to maintain good contact and to insure that the connector remains in position. To facilitate mounting of the receptacle, the contact surfaces of members 19 and 20 are made somewhat shorter than the corresponding contact surfaces of members 4 and 5 of the acoustic device so that the projecting ends are grouped within a relatively small space. To mount the receptacle on any device it is only necessary to provide three holes in the device, two of the holes registering with holes 21, 21 to accommodate mounting rivets or screws and the third hole providing clearance for the ends of contact members 19 and 20. In Fig. 16 the receptacle is shown riveted to a portion of a thin sheet-like member such as the housing of an amplifier used in a portable hearing aid. Eyelets 22, 22 secure the receptacle to the wall 23 and the extended ends of contacts 19 and 20 project through an opening 23a to a position permitting ready connection to the eletcrical circuit.

Inasmuch as some of the inventions disclosed herein have been divided herefrom for assertion in divisional cases, I expressly disclaim any or all inventions disclosed herein except those defined in the following claims and in the claims of each and all of any divisional cases which issue in my name solely or jointly.

What I claim is:

1. In an acoustic device comprising an acoustic diaphragm, and a flexing-type piezo-electric unit disposed with a face thereof adjacent and substantially parallel to a face portion of said diaphragm, the novel feature which consists of a ring of yielding, vibration-conductive material disposed between said piezo-electric unit and said diaphragm in vibration-conductive relationship with each.

2. In a telephone receiver, the combination of a disc-shaped diaphragm supported at its periphery, a flexing type piezo-electric unit disposed substantially symmetrically with respect to the center of said diaphragm and with a face of said unit substantially parallel to a face of said diaphragm, and a circular ring of pliable vibration-conductive material disposed substantially concentrically upon said diaphragm between and in contact with said faces.

3. An acoustic device for converting electrical vibrations into audible vibrations and vice versa, said device comprising the combination of: a plate-like flexing type piezo-electric unit having a flat face which becomes warped when said unit functions piezo-electrically; an acoustic diaphragm having a relatively thin ring-shaped portion projecting in flatwise relation from a face thereof and terminating in a surface which contacts the said flat face of the piezo-electric unit, said ring-shaped portion being composed of material having a pliable nature which enables it to conform flexibly to the warping of said face of the unit while conducting vibrations between said unit and the diaphragm.

4. An acoustic device as claimed in claim 3 wherein the said ring-shaped portion is integral with said diaphragm.

5. A telephone receiver comprising the combination of: a disc-shaped diaphragm supported at its periphery; a plate-like flexing type piezo-electric unit retained in spaced relationship adjacent said diaphragm with a face thereof substantially parallel to said diaphragm; and a circular ring composed of flexible material having a pliable nature disposed between said diaphragm and said unit and retained in vibration conductive relationship with each.

6. An acoustic device for converting electrical impulses into sound, said device comprising the combination of: an acoustic diaphragm; a plate-like flexing type piezo-electric unit having a face which is substantially flat when the unit is not functioning piezo-electrically, but which becomes warped when said unit functions piezo-electrically; and means for coupling said face to said diaphragm to effect large volume displacement of the latter without imposing appreciable restraint upon the flexing motion of said unit when secured thereto, said means comprising a ring of pliable and conformable vibration conductive material retained flatwise between said diaphragm and said face in contact with each.

7. An acoustic device as claimed in claim 6 wherein said ring is integral with said diaphragm.

8. An acoustic device for converting electrical vibrations into audible vibrations and vice versa, said device comprising the combination of: an acoustic diaphragm; a plate-like flexing type piezo-electric unit; and means for coupling said diaphragm and unit together without introducing substantially more constraint upon the flexing motion of said unit than is imposed thereon by the diaphragm, said means comprising a ring of pliable and conformable vibration conductive material retained between said diaphragm and unit in vibration conductive relationship with each.

9. An acoustic device as claimed in claim 8 wherein said ring is relatively thin and is retained flatwise between said diaphragm and unit in vibration conductive contact with each.

10. In an acoustic device for converting electrical impulses into sound, the combination of: an acoustic diaphragm; a relatively thin plate-like flexing type piezo-electric unit having a flat face which becomes warped when said unit functions piezo-electrically, said diaphragm being coupled to the piezo-electric unit through a ring-shaped member of yielding vibration conductive material retained between and in contact with said diaphragm and the said face of the piezo-electric unit.

D. DOMIZI.