May 1, 1945. S. F. LYBARGER 2,375,010

AUDIPHONE RECEIVER

Original Filed Jan. 10, 1942

FIG. 1

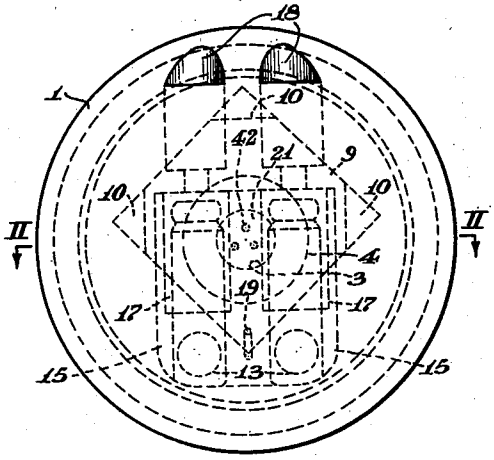
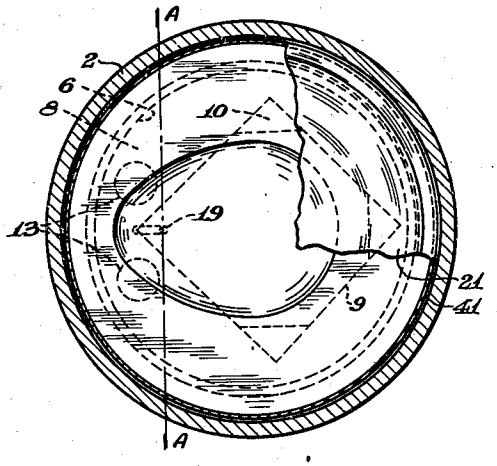


FIG. 4



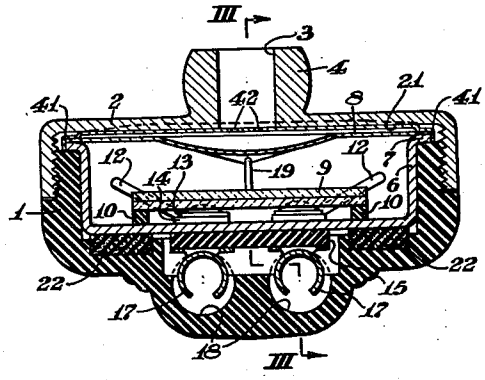


FIG. 2

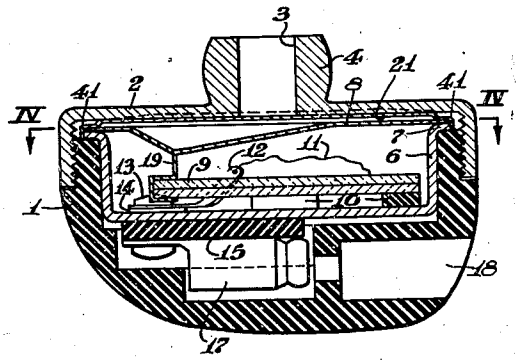


FIG. 3

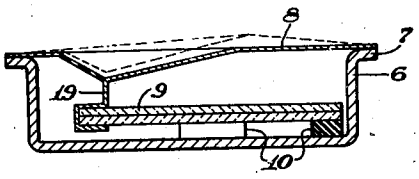


FIG. 5

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2,375,010

AUDIPHONE RECEIVER

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Original application January 10, 1942, Serial No. 426,343, now Patent No. 2,367,726, dated January 23, 1945. Divided and this application November 28, 1942, Serial No. 467,193

9 Claims. (Cl. 179—107)

This invention, which is a division of my copending application Serial No. 426,343, filed January 10, 1942, now Patent No. 2,367,726, granted January 23, 1945, relates to sound transmitters, such as microphones and receivers, and more particularly to very small telephone receivers of the type generally used for hearing aids or audiphones.

Most hearing aid receivers require repair work at one time or another, and often it is more advisable to discard the receiver and replace it with a new one than to attempt to repair it. This is particularly true of receivers which utilize piezo-electric crystals for converting the electric power supplied to them into acoustic energy that is delivered to the ear of the wearer. Such crystal receivers are so difficult to repair that the general practice is to make no attempt to do so. Due to the construction of the receivers known heretofore this means that the entire receiver, case and all, must be replaced.

It is among the objects of this invention to provide a receiver in which the sound reproducing elements form a separate unit that can readily be replaced by a dealer or user without replacing the receiver case, in which back radiation from the receiver case is reduced to the point where it does not feed back to the microphone or audiophone, in which the sound reproducing unit is very compact, and in which the diaphragm of that unit is protected by a member that aids in holding the unit tightly in position in the case.

According to this invention a cup-like member is removably mounted in a receiver case. The cup contains electrically responsive means by which the diaphragm thereon is vibrated in accordance with vibrations in electric voltage supplied to the unit through outside wires. The case is provided with openings for receiving those wires so that they can be detachably connected to means carried by the cup and electrically connected to the diaphragm actuating means inside of the cup. If the reproducing unit fails it can readily be removed from the case by merely opening the case and lifting it out after the outside wires have been pulled from the case. The diaphragm preferably is held in place and protected by a disc-like cap that overlies it and that is pressed by the case cover against the marginal portion of the diaphragm to clamp the cup tightly in the case. The bottom of the cup preferably is spaced from the case, and there may be resilient members or pads disposed between them. This invention has its greatest utility with crystal receivers because they are so difficult to repair.

The invention is illustrated in the accompanying drawing in which Fig. 1 is a greatly enlarged bottom view of my receiver as shown herein; Fig. 2 is a transverse section taken on the line II—II of Fig. 1; Fig. 3 is a transverse section taken on the line III—III of Fig. 2; Fig. 4 is a horizontal section taken on the line IV—IV of Fig. 3; and Fig. 5 is a somewhat diagrammatic section of the preferred type of reproducing unit illustrating in an exaggerated manner the vibration of the diaphragm.

Referring to Figs. 1 to 4 of the drawing, an audiphone receiver case is formed from a cup-like base member 1 of Bakelite or the like and a metal cover 2 screwed on the base. The cover is provided with a central opening 3 encircled by an integral boss 4 adapted to receive an ear tip (not shown) for holding the receiver in the ear of a person who is hard of hearing.

In accordance with this invention the reproducing elements of the receiver are not connected directly to the case as has been the practice heretofore, but they all are carried by a metal cup 6 that is removably mounted in the case and held therein only by the cover so that if any repairs are required the reproducing elements can be readily removed as a unit and a new unit quickly inserted in their place. The cup preferably is cylindrical with a flat bottom, and with an open top encircled by an integral flange 7 on which rests the marginal portion of a diaphragm 8 of metal or other suitable material.

The diaphragm is shown as being actuated or vibrated by a piezo-electric crystal 9 disposed within the cup below the diaphragm. The crystal preferably is square with three corners secured to slightly resilient triangular pads 10 affixed to the bottom of the cup close to its side wall. The fourth corner is therefore left free to vibrate when the crystal is supplied with varying electric voltage through wires 11 connected to a pair of metal terminals 12 attached to rivets 13 extending through the bottom of the cup on opposite sides of the free corner of the crystal. The rivets are insulated from the cup by encircling insulating headed sleeves 14 and by an insulating block 15 held against the outer surface of the cup's bottom by the rivets, as shown in Fig. 3. These rivets clamp against the insulating block a pair of tubular spring clips or sockets 17 for receiving and gripping the tips of wires (not shown) from the microphone with which the receiver is used. The bottom of the case has a thick central portion provided with a pair of parallel passages 18 through which the microphone wires are led to the clips. When varying electric voltage is supplied to the crystal from the microphone, the tendency of the crystal to twist causes its free corner to vibrate and this vibration is transmitted to the diaphragm through a driving pin 19 secured thereto and hooked around the free corner of the crystal to which it is cemented.

The cup 6 is clamped in the case by the cover 2 from which the diaphragm is spaced by a disc-

like metal cap 21 provided with a marginal portion resting on the marginal portion of the diaphragm as shown in Figs. 2 and 3. The cap is encircled by a flange 41 that overlaps flange 7 of the base member to center the cap. The major portion of the cap is pressed outwardly toward the cover 2 so that none of the diaphragm that does not touch flange 7 is touched by the cap either. The cap preferably is slightly convex and resilient so that when the cover is screwed onto the base member it first engages the center of the cap and then presses it inwardly, thereby insuring tight engagement between cap and cover to prevent the cap from vibrating. The center of the cap is provided with a few small holes 42 in line with opening 3 in the cover. The cap is cemented or otherwise attached to the cup 6 and thus prevents the delicate diaphragm from being injured when the cup is handled outside of the case, and it also minimizes the chance of foreign objects inserted in opening 3 reaching the diaphragm.

It will thus be seen that all of the electrical elements that reproduce sound in this receiver are carried by the cup as a unit. If anything goes wrong with this unit it is a simple matter to pull the microphone wires out of the sockets 17, unscrew the cover of the case, and remove the cup. The case need not be discarded because a new unit can readily be inserted in it. This type of receiver also makes it easy to change its response characteristics, simply by exchanging one cup unit for another having the desired characteristics. It likewise allows a customer to choose a case of the desired color for use with the proper cup unit.

To prevent vibration of the bottom of the cup from vibrating the bottom of the base 1 and thereby feeding sound back to the microphone, the bottom of the cup is spaced from base 1, and, if desired, its vibrations may be damped by resilient pads 22 of felt, sponge rubber, or the like mounted in the base in engagement with the bottom of the cup as shown in Fig. 2. In addition to this the design of the base is such that a relatively rigid wall is provided which does not vibrate readily. The side wall of the case is the point of least vibration of the case, and it is to that point that the cup is clamped by its flange 7. This feature also helps prevent the cup from vibrating the case.

As pointed out in the above-mentioned parent application, the crystal is connected to the diaphragm in such a manner that a much larger square crystal can be used than heretofore for the same size case. This results in a stronger crystal than the customary oblong "bender" crystal, one easier to handle, and a crystal that is affected less by humidity. These advantages are obtained by using a substantially square crystal which is nearly as far across diagonally as the inside of the case, whereby the free corner of the crystal is disposed laterally of the center or axis of the diaphragm, and by connecting that corner of the crystal to the diaphragm off center of the latter, or to its center through the medium of a lever. When driven off center the diaphragm preferably has a substantially stiff central portion to which the driving pin is connected. Most suitably, as shown in Figs. 2, 3, and 4, the central portion of the diaphragm is made stiff by providing it with a depression, preferably conical with the base of the cone either circular or elliptical (Fig. 4) and with the apex off center and nearly above the free corner of the crystal to which it is connected by pin 19. The stiff cone carries the vibrations of the crystal throughout the area of the diaphragm. If the stiff portion of the diaphragm is anything but round, it is preferred that its long axis extend in the direction of the crystal diagonal that passes through the driving corner. The driving pin preferably is flexible laterally so that it can yield and not cause the far side of the diaphragm cone to tilt down into the cup when the free corner of the crystal swings upwardly.

A feature of this receiver is that the amplitude of vibration of the major portion of the diaphragm can be increased over that of the vibrating free corner of the crystal. This may be accomplished in several ways, all of which make use of leverage. Thus, the flat area of the diaphragm surrounding the cone may be made with varying degrees of stiffness or resiliency, the resiliency being least in the area between the periphery of the diaphragm and the cone edge closest to it, which is at the left of the driving pin as seen in Figs. 3, 4, and 5. In such a case the resiliency or stiffness is so controlled that the total effective stiffness of the flat area of the diaphragm lying between a line A—A, shown in Fig. 4 extending across the diaphragm directly above the driving pin and perpendicular to the major axis of the cone's base, and the adjacent side of the cup is greater than the total effective stiffness of the remaining flat area of the diaphragm. It is important that the total stiffness of the diaphragm presented to the vibrating corner of the crystal be kept relatively low in order to prevent loss of amplitude at low frequencies. Due to the stiffness control, as shown in Fig. 5, the amplitude of vibration of the flat area at the left of the driving pin is constrained relative to the remaining flat area of the diaphragm to such an extent that it serves as a fulcrum for the adjacent end of the rigid conical portion which thereby acts as a lever and causes the major portion of the diaphragm to vibrate with a greater ampltiude than the apex of its conical portion. As driving pin 19 will yield laterally, it does not interfere with this canting movement of the diaphragm. Or the yielding of the apex of the cone will serve the same purpose.

Although this invention has been described in connection with a receiver, it will be understood that the same general principles can be used in a microphone to advantage. To permit a better understanding of the invention, I shall now give some of the approximate dimensions of a receiver constructed in accordance with this invention and which has proved to be very satisfactory. Of course, these dimensions are not the only ones that might be used, but are merely given by way of example and are approximate only.

The overall diameter of the cup 6 is $\frac{3}{4}$ inch and its inside diameter is $\frac{41}{64}$ inch. The diaphragm is made from aluminum foil .001 inch thick, and the apex of its conical portion is $\frac{3}{64}$ inch below the top of the diaphragm. The conical portion has an elliptical base and an eccentric apex formed by pressing the diaphragm with a die. The major and minor axes of the elliptical base of the conical portion are $\frac{7}{16}$ and $\frac{3}{8}$ inch, respectively. The shortest distance between the apex and a line passing through the edge of the base of the conical portion of the diaphragm is $\frac{3}{32}$ inch, while the longest distance is $\frac{11}{32}$ inch. The narrowest width of the flat portion of the diaphragm surrounding the conical portion is $\frac{1}{8}$ inch, and the greatest width is $\frac{3}{16}$ inch.

According to the provisions of the patent

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statutes, I have explained the principle and construction of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. An audiphone receiver comprising a case, a cup removably mounted therein, a diaphragm mounted on the cup, electrical actuating means mounted inside the cup for vibrating the diaphragm, and means electrically connected to said actuating means and secured to said cup for direct detachable engagement with outside electric wires, said case being provided with openings adapted to removably admit said wires to the inside of the case.

2. An audiphone receiver comprising a case, a cup removably mounted therein, a diaphragm mounted on the cup, a piezo-electric crystal mounted in the cup behind the diaphragm and operatively connected to the diaphragm for vibrating it, and means electrically connected to said crystal and secured to the outside of said cup for detachably receiving outside electric wires, said case being provided with openings adapted to removably admit said wires to the inside of the case for engagement with said means.

3. An audiphone receiver comprising a case, a cup removably mounted therein with its bottom spaced from the case, resilient vibration-damping means compressed between the cup bottom and the case, a diaphragm mounted on the cup, electrical actuating means mounted inside the cup for vibrating the diaphragm, and means electrically connected to said actuating means for detachable connection to outside electric wires, said case being provided with openings adapted to removably admit said wires.

4. An audiphone receiver comprising a case, a cup removably mounted therein, a diaphragm mounted on the cup, a resilient disc-like cap compressed between the cup and case with the cap spaced from the operative area of the diaphragm, said cap being surrounded by an integral peripheral flange that surrounds the edge of the diaphragm, electrical actuating means mounted inside the cup for vibrating the diaphragm, and means electrically connected to said actuating means and secured to the outside of said cup for detachable connection to outside electric wires, said case being provided with openings adapted to removably admit said wires.

5. An audiphone receiver comprising a case having a recessed base member and a cover mounted thereon, a flanged cup removably mounted in the case with its flange resting on the top of the base member beneath the cover, a diaphragm resting on the cup flange, a disc-like cap having its marginal portion engaging the marginal portion of the diaphragm above said cup flange, the major portion of the cap being spaced from the diaphragm and biased toward the lower surface of said cover whereby the cover causes the cap to press the cup flange tightly against the top of the base member, electrical actuating means mounted inside the cup for vibrating the diaphragm, and electric sockets electrically connected to said actuating means and secured to the bottom of said cup for detachable connection to outside electric wires, said case being provided with openings adapted to removably admit said wires to said sockets.

6. An audiphone receiver comprising a case having a recessed base member and a cover mounted thereon, a flanged cup removably mounted in the case with its flange overlying the top of the base member beneath the cover, a diaphragm resting on the cup flange, electrical actuating means mounted inside the cup for vibrating the diaphragm, and electric sockets mounted on the bottom of the cup and electrically connected to said actuating means, said base member being provided with a recess for receiving said sockets and with openings for removably admitting outside wires for insertion in the sockets.

7. An audiphone receiver comprising a case having a hollow base member and a cover mounted thereon, a cup removably mounted in the case in fixed position, a diaphragm resting on the cup, electrical actuating means mounted inside the cup for vibrating the diaphragm, and electric sockets mounted on the bottom of the cup and electrically connected to said actuating means, the bottom of said base member having a downwardly offset portion provided with a recess inside the case for receiving said sockets and also provided with lateral openings in line with said sockets for removably receiving outside wires adapted to be inserted in the sockets.

8. An audiphone receiver comprising a case, a cup removably mounted therein with its bottom spaced from the case, resilient pads inserted between the cup bottom and the case in contact therewith for damping vibrations of the cup bottom, a diaphragm mounted on the cup, electrical actuating means mounted inside the cup for vibrating the diaphragm, and means electrically connected to said actuating means and secured to the outside of said cup for detachable connection to outside electric wires, said case being provided with openings adapted to admit said wires.

9. An audiphone receiver comprising a case having a recessed base member and a cover mounted thereon, said cover having a substantially flat lower surface, a flanged cup removably mounted in the case with its flange resting on top of the base member beneath the cover, a diaphragm resting on the cup flange and spaced from said cover, a resilient disc-like cap having a downwardly offset marginal portion resting on the marginal portion of the diaphragm engaging the cup flange, said cap being surrounded by an integral peripheral flange surrounding the edge of the diaphragm, the central portion of the cap being spaced from the diaphragm and pressing against said lower surface of the cover whereby the cover causes said marginal portion of the cap to press the cup flange tightly against the top of the base member, electrical actuating means mounted inside the cup for vibrating the diaphragm, and electric sockets electrically connected to said actuating means and secured to the bottom of said cup for removably receiving outside electric wires, said base member being provided with openings in line with said sockets adapted to removably receive said wires for insertion in the sockets.

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