April 14, 1959 R. E. ERICKSON 2,882,348

HEARING AID

Filed July 26, 1957 3 Sheets-Sheet 1

FIG. 1

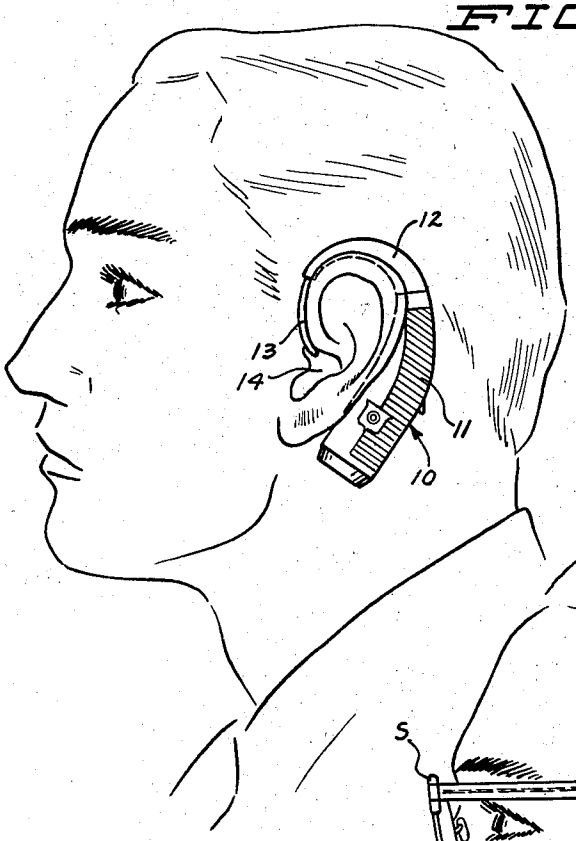



FIG. 4

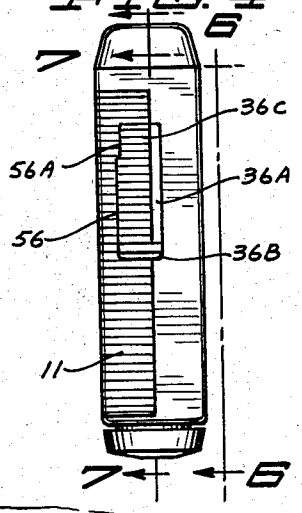



FIG. 2

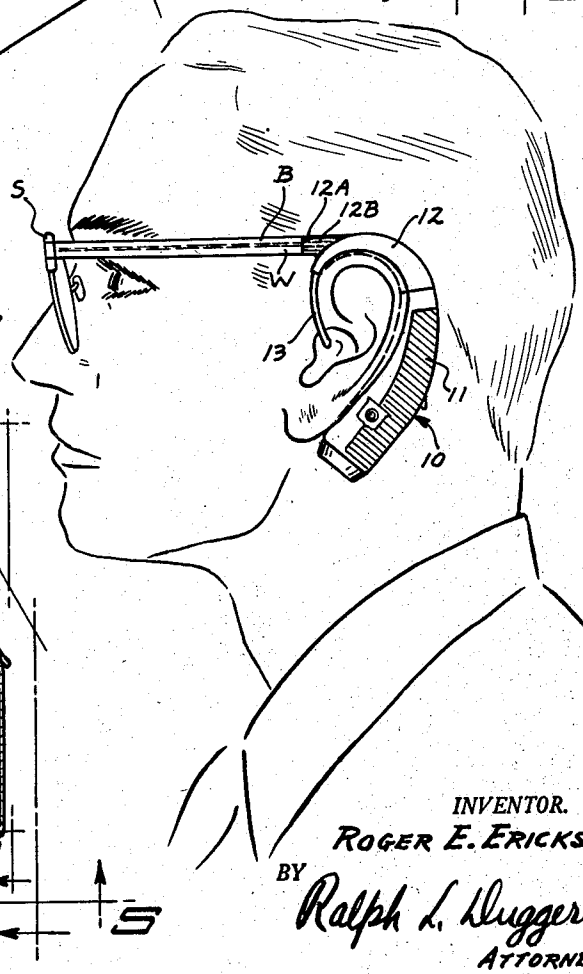
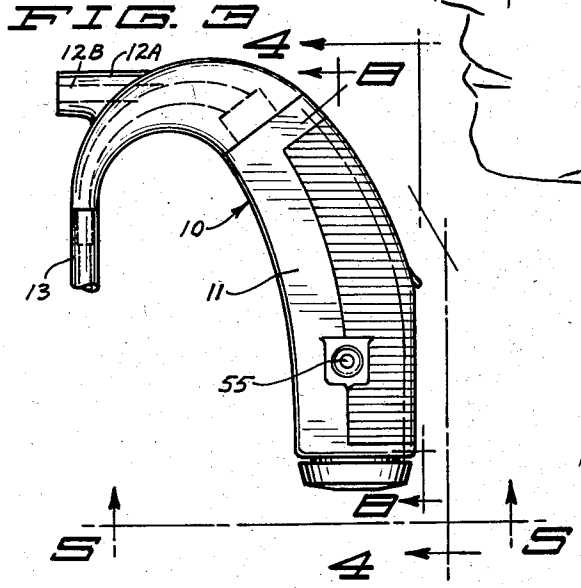



FIG. 3




INVENTOR.
ROGER E. ERICKSON
BY
Ralph L. Dugger
ATTORNEYS

April 14, 1959 R. E. ERICKSON 2,882,348

HEARING AID

Filed July 26, 1957 3 Sheets-Sheet 2

FIG. 6

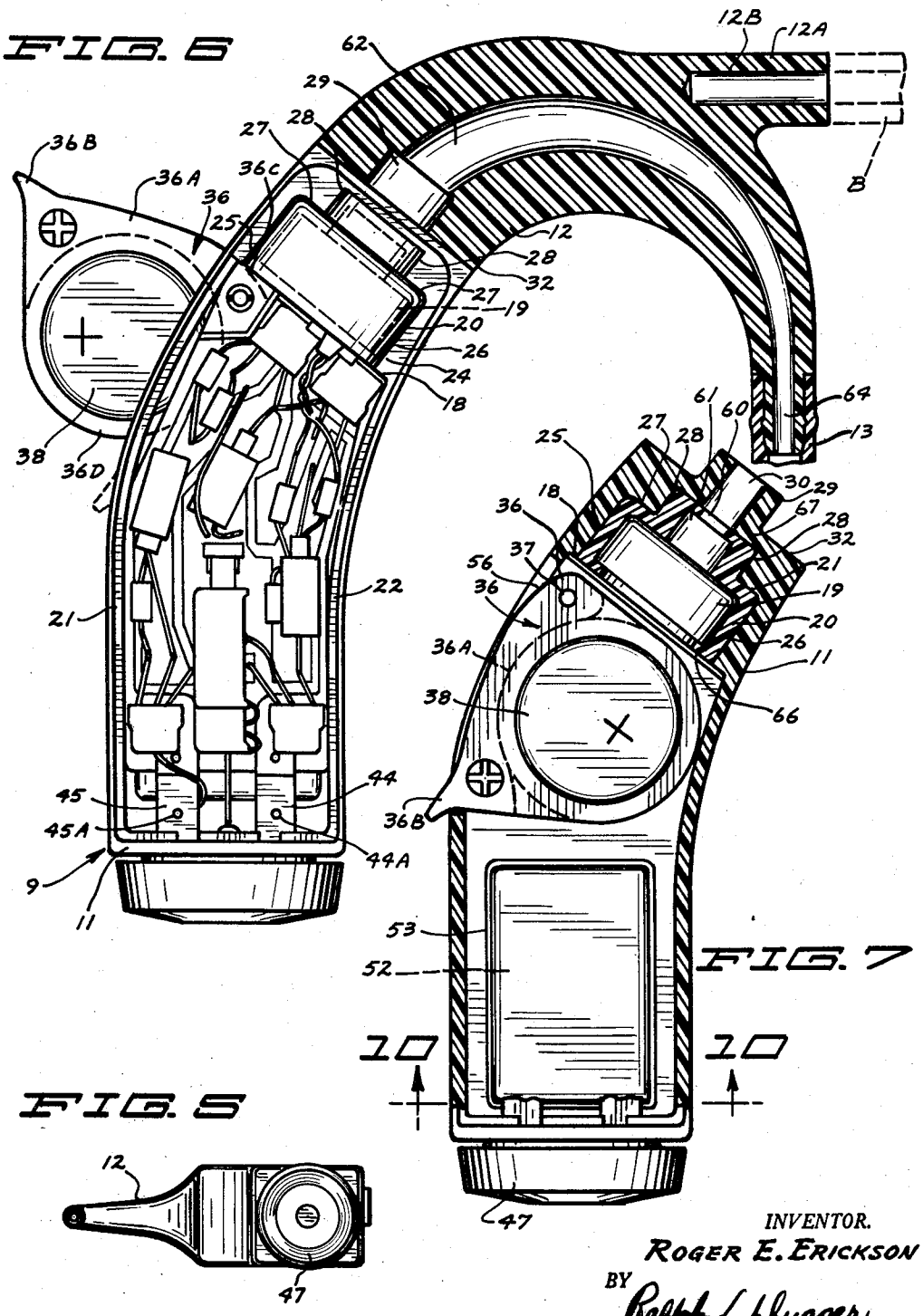



FIG. 7

FIG. 5




INVENTOR.
ROGER E. ERICKSON
BY
Ralph L. Hlugger
ATTORNEYS

April 14, 1959 R. E. ERICKSON 2,882,348

HEARING AID

Filed July 26, 1957 3 Sheets-Sheet 3

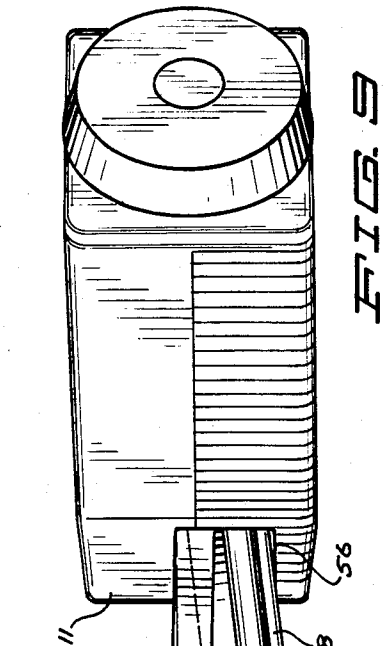


FIG. 9

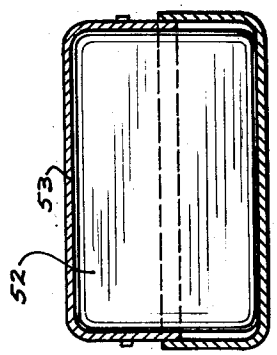


FIG. 10

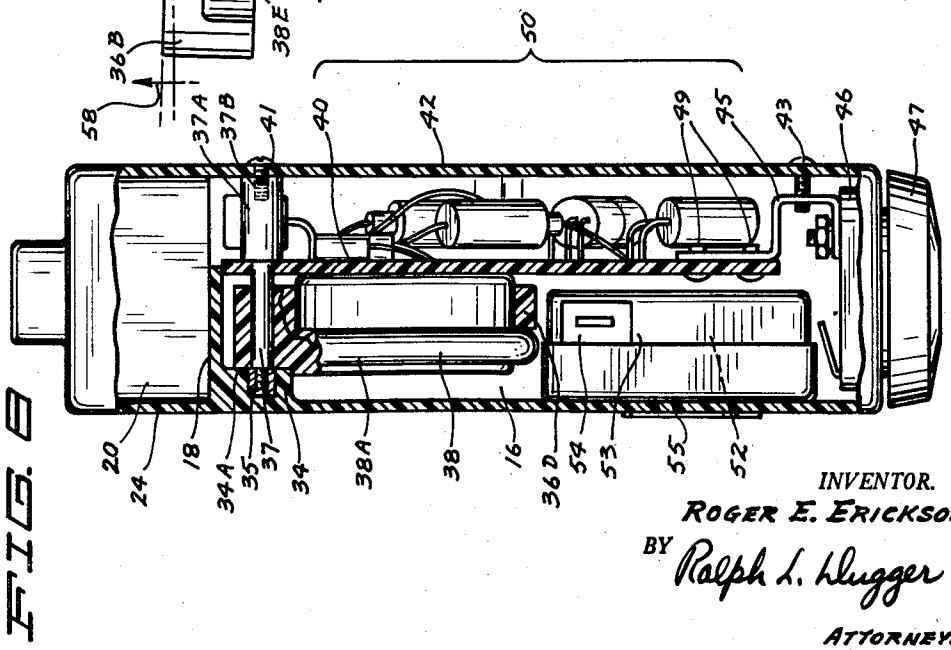


FIG. 8

INVENTOR.
ROGER E. ERICKSON
BY Ralph L. Hugger
ATTORNEYS

United States Patent Office 2,882,348 Patented Apr. 14, 1959



2,882,348

# HEARING AID

Roger E. Erickson, St. Paul, Minn., assignor to Telex, Inc., St. Paul, Minn., a corporation of Minnesota

Application July 26, 1957, Serial No. 674,343

4 Claims. (Cl. 179—107)

This invention relates to an improved self-contained battery powered hearing aid which may be worn directly adjacent and attached to the ear of the wearer, either with or without attachment to the bow of a standard spectacle. The invention relates particularly to a subminiature type of battery powered, transistor hearing aid, entirely self-contained, containing microphone and sound reproducer in mechanical arrangement so as to minimize microphonic feedback, and to provide adequate amplification of the sound frequencies normally heard by human individuals. It is an object of the present invention to provide a hearing aid of the aforesaid character and more particularly to provide a hearing aid capable of being fitted to the wearer without undue individual attention.

It is another object of the invention to provide an improved hearing aid of a shape, weight, and so constructed so that it can be worn comfortably by most individuals. It is another object of the invention to provide an improved hearing aid capable of being adapted readily for attachment to the earpiece bow of an ordinary spectacle, without any more adaptation than to snip off the spectacle bow at an appropriate length and attach it to the hearing aid component by adhesive or the like.

It is another object of the invention to provide an improved hearing aid wherein the battery is so contained as to be capable of being made available for easy access for replacement and yet so mounted that the battery cannot be readily dislodged and lost, thereby providing a structure which may be utilized easily by the elderly, and by those whose manual dexterity may be impaired. It is another object of the invention to provide an improved hearing aid which is free from interference due to fluorescent lights and the like electrical disturbances. It is a further object of the invention to provide an improved hearing aid of the design such that it can easily be made in either right or left so as to enable the hearer to mount the hearing aid adjacent either ear which may be impaired or to provide hearing aids for both ears, and thereby accomplish biaural sound reproduction for the wearer.

Other and further objects are those inherent in the invention herein illustrated, described and claimed and will be apparent as the description proceeds.

To the accomplishment of the foregoing and related ends, this invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principles of the invention may be employed.

The invention is illustrated with reference to the drawings wherein

Figure 1 is a side elevational view of a human individual's head showing one form of hearing aid apparatus



of the present invention mounted in position on the ear of the wearer.

Figure 2 is a side elevational view of the human head showing another form of hearing aid apparatus of the present invention in place on the ear of the wearer and attached to a spectacle bow.

Figure 3 is a side elevational view of the hearing aid apparatus shown in Figure 2 but removed from the ear of the wearer.

Figure 4 is a rear elevational view of the hearing aid apparatus shown in Figures 1 and 2 taken in the direction of arrows 4—4 of Figure 3.

Figure 5 is a bottom view of the hearing aid apparatus illustrated in Figure 3 taken in the direction of arrows 5—5 of Figure 3.

Figure 6 is a partial vertical sectional view taken along the lines and in the direction of arrows 6—6 of Figure 4. In this figure the hearing aid is viewed from that side which is normally adjacent the head of the wearer and the cover plate on this side, is removed in Figure 6. The sound tube horn, through which the sound is delivered to the ear of the wearer, is shown in section in Figure 6.

Figure 7 is a sectional view vertically (longitudinally) through the hearing aid apparatus, the sectioning being at a position and in the direction of arrows 7—7 of Figure 4. In this view the sound tube horn of the hearing aid apparatus, which delivers the sound to the wearer has been removed.

Figure 8 is a rear elevational view partly broken away taken just inside the rear wall along the line and in the direction of arrows 8—8 of Figure 3. Again, the sound tube horn which delivers sound to the ear of the wearer is removed from the hearing aid case in this view. The line of sectioning along which Figure 8 is taken is shown in Figure 3.

Figure 9 is a bottom view, looking directly upwardly, illustrating the hearing aid case when it is in normal wearing position as shown in Figures 1 and 2. For simplicity, the horn 12 is not shown in Figure 9. Also in this figure the battery frame is swung out and is slightly deflected in one direction and the battery is cocked in the other direction, preparatory to removal of the battery.

Figure 10 is a separated sectional view of the microphone metal sheath, with the microphone within it. The microphone is not shown in section. In this view these components are shown removed from the case of the hearing aid. This view is taken in the direction of arrows 10—10 and at the position of line 10—10 in Figure 7. The hearing aid case and other components are, for simplicity, not shown in Figure 10.

Throughout the drawing the same numerals refer to corresponding parts of the apparatus.

Referring to Figure 1 there is illustrated a hearing aid generally designated 10 shown attached to the ear of the human wearer. This hearing aid includes a body portion 11 and a detachable horn 12 which is attached at its small end to a clear flexible plastic tube 13 that in turn is attached to a plastic "earmold" 14 that is individually fitted to the wearer. The horn 12 is tapered and is press-fitted to tubular bars 29 on case 11, see Figures 6 and 7. The horn 12 is composed of a plastic material such as polyethylene plastic and has a moderate amount of flexibility, a good smooth "feel" and due to such flexibility is easily attached by frictional engagement to the harder plastic case, as shown particularly in Figures 6 and 7 to which reference will be made. The horn 12 has a tapered hole 62 through it for conducting the sound and the exterior of the horn also tapers out to end 64, where provision is

made for receiving the plastic tube 13, slipfitted to the end 64.

In Figure 1 the hearing aid 10 is shown attached to the left ear of the wearer but it will be understood that the apparatus may be made in either a "right" or "left" form and used for either ear of the wearer. The hearing aid is entirely self-contained and needs no exterior battery supply or microphone. The horn 12 may be made in the form shown in Figure 1, in which no provision is made to attach it to a cut-off end of a spectacle bow, or it may be provided with a boss 12A having hole 12B in it for fitting to the bow B of a spectacle as in Figures 2 and 6.

Thus in Figure 2 the hearing aid 10 and body portion 11 are identical to those shown in Figure 1 but the horn 12 has a protuberance 12A which is cast integral with the horn 12. This protuberance is apertured at 12B for a moderate depth, so as to receive the stiffening wire W which is normally used in the bow B of the spectacle S, as shown in Figure 2. The only necessity for fitting the horn 12 to a pair of spectacles is to snip off the spectacle bow, and strip back the plastic portion. The protuding wire W of the bow is then pushed into the aperture 12B. Any suitable adhesive is used to then cement the wire reinforcement W into the aperture 12B and the horn 12 is accordingly attached to the spectacle bow B and is carried therewith. This in effect makes the hearing aid 10 a part of the spectacle, by mere attachment thereto, added stability of wearing is thereby provided. However it should be understood that the hearing aid may be worn with sufficient stability as shown in Figure 1 because the horn 12 encircles the top of the ear and the hearing aid body 11 fits as a suspended unit closely behind the ear of the wearer. The small plastic tube 13 comes down in front of the ear and curls into and is attached to the earmold 14. While the tube 13 has some degree of flexibility and the horn 12 has a slight degree of flexibility, particularly towards its small end where it is attached to the tube 13, nevertheless the earmold attachment and the entire configuration of the unit serves to hold the unit with remarkable and entirely sufficient attachment to the ear of the wearer as shown in Figure 1, even where no attachment is made to a spectacle bow. Some users prefer the form of attachment shown in Figure 2 where the horn 12 is attached to the bow of the spectacle but this is not required for complete stability of the unit or for wearer comfort.

The horn 12 may be made as a solid boss and the portion 12A may be left unbored, and the agent who fits the hearing aid will then drill out the protuberance 12A to fit the diameter of the reinforcing wire W in the spectacle bow B, if that type of spectacle is to be attached thereto, or where a spectacle of the type having a metallic bow is used the protuberance 12A may be drilled to fit the particular diameter size of the spectacle bow wire and the latter may then be cemented firmly in place.

Referring particularly to Figures 3 through 9 the case 11 is a plastic molding formed so as to provide an interior space 16 which is of maximum depth throughout the portion from the bottom wall 17 to the wall 18 which defines the surface against which the sound reproducer 19, encased in a very soft rubber or plastic receptacle 20 is adapted to be positioned as shown in Figures 6, 7 and 8. The shape of the interior space 16, as viewed in Figure 6, is defined by the rear wall 21, the bottom wall 17, the wall 22, which is the surface that is normally adjacent the ear of the wearer, and the interior corner 18. The upper portion of the plastic molding 11 is then provided with a pocket at 24 which extends from the interior corner 18 and between the two walls 25 and 26 to the shoulders 27—27 and then extends into a pocket of smaller width at 28—28. Finally this smaller pocket terminates at a tubular nipple at 29 having an axial hole 30 therein. The tubular nipple connects with a pocket of corresponding size in the horn 12 and the horn has a push fit onto and seats on the nipple 29 and against the surface 32 of the plastic case. Adhesive may be used to hold the horn 12 attached to the case 11 at the nipple 22 and surface 32 if desired although normally the slight flexibility of the plastic of which the horn 12 is made is sufficient to provide a lasting gripping action sufficient to hold both parts together.

The aperture 16 is provided with an interior boss 34 at one corner into which there is molded a metallic screw anchor 35. This boss 34 provides a surface 34A upon which a battery frame generally designed 36 is adapted to be mounted by means of the screw stud 37 which serves as a pivot about which the frame 36 may be swung from the position shown in Figure 7 to the position shown in Figure 6. In the position shown in Figure 7 the frame 36 holds the battery 38 in electrical contact with appropriate contacts within the hearing aid case 11 and hence provides the electrical supply for the hearing air apparatus. When the frame 36 is swung to the position of Figure 6 the battery 38 can be taken out by deflecting the frame 36 and case 11 a little, as shown in Figure 9, but battery 38 will not fall out of its own accord. It may be noted parenthetically that a single mercury type cell forms the battery 38 and this provides sufficient power to energize the transistor amplifier circuits of this hearing aid apparatus.

The transistor amplifier is mounted upon a printed circuit board 40 which is anchored in place by an enlarged head 37A on the same stud 37 which holds the battery frame 36 in place in the apparatus. The stud 37 is provided with a screw threaded aperture 37B at its outer end to which a screw 41 may be attached for holding one corner of the removable cover 42 in place on that side of the case 11 which normally contacts the head of the ear. Other corners of the case are held by screws 43—43 which are entered into the metallic brackets 44 and 45 at the lower end of the housing, these brackets being provided with screw fitted apertures at 44A and 45A. The brackets 44 and 45 also serve as electrical connectors to a rheostat and switch 46 having a disc-like control knob 47. The brackets have a shape shown in Figure 8 and are riveted at 49 to the printed circuit board 40 and support the board 40 in the case 11.

Also there are a plurality of circuit components shown opposite the bracket 50, on the right side of the printed circuit board 40 as shown in Figure 8. These individual circuit components include the transistor, condensers, resistors, etc. making up the multiple stage transistor amplifier circuit of the hearing aid. In the hearing aid assembly when the circuit board 40 is held in place as illustrated, there is a space behind it as shown in Figure 6, and to the left of the element 40 as shown in Figure 8. It is into this space, which is illustrated in Figure 7, that the battery frame 36 swings and carries the battery 38 and thus brings the battery into position so as to form its electrical contact with the suitably disposed contact pieces on the hearing aid board 40 and elsewhere within the space 16. At the bottom of this space there is also the microphone apparatus 52 which is entirely ensheathed in magnetic material 53. The magnetic sheath 53 is made in the form of two pans which nest together as shown in Figure 10, and enclose the entire microphone except for openings as at 54 through which the electrical connections emerge from the microphone 52. The sheath 53 is of highly permeable magnetic material but the sheath is quite thin and the sound waves, which enter the case portion 11 through a small opening 55, see Figure 3, impinge against the adjacent flat surface of the microphone case metal 53 and by vibrating such case serve to operate the microphone 52 which is entirely encased by the metal case 53. The effect of this is that while the mechanical force of the sound waves are permitted to operate the microphone without substantially decreasing their effect in passing through the

case 53, still at the same time any magnetic disturbance in the region of the microphone 52 is shielded away from the microphone by means of the magnetically permeable metal forming the case 53. This serves to reduce that kind of noise interference which has been found to be due to the proximity of the hearing aid to electrical apparatus such as fluorescent lights, etc.

Referring to Figures 6–9 particularly, it will be noted that the frame 36 which serves as a swinging mounting for the battery 38 has a maximum thickness at the wall portion 36A which is exposed to the rear of the hearing aid case 11 when the frame 36 is swung closed as shown in Figures 4 and 7. This wall portion 36A terminates as a small projection 36B at the corner opposite the pivot screw 11 and the user may accordingly insert a fingernail behind the portion 36B for swinging the frame 36 outwardly to the position shown in Figure 6. The frame portion 36A is of slightly narrower width at the corner and the small aperture 56 in the rear wall of the hearing aid case 11 is likewise somewhat narrowed at its upper portion 56A. The remainder of the frame 36 is considerably thinner and forms a ring 36D, which is displaced to the position shown in Figure 8. Accordingly, the battery, which has a larger diameter flange 38A at one face, may seat with one portion of the battery case positioned in the ring 36D and the flange 38A resting on the surface of the ring. When the frame 36 is swung to its outward limiting position as shown in Figure 6 a certain portion of the battery 38 is still situated within the opening 56 and the battery 38 will therefore not simply fall out of the frame 36. This is an advantage for some users of hearing aids, particularly older people, may swing the frame 36 to its open position, either through curiosity or a misbelief that the battery is not operating properly, or for other reasons and if the battery 38 is able simply to fall out of the frame 36 when the frame 36 is in an open position, the battery could be easily lost and since it is no larger than a moderate size button, the battery can easily fall and roll to some place where it is irretrievably lost by the user. According to the present invention this problem of lost batteries is obviated, at least in part by making the frame 36 so that, while it permits the removal of the battery by a conscious act, yet the battery does not simply fall out of the frame when the frame 36 is moved to its open position. Hence as shown in Figure 6 and in Figure 9 the battery is ready to be removed but in order to do so the frame 36 must be deflected in the direction of arrow 58 as shown in Figure 9. This is possible due to a slight looseness of fit of the pivot bearing 37 in respect to the frame 36 and also due to the fact that the case 11 and the frame 36 are made of slightly flexible plastic material and the frame 36 when moved to its open position and is then pushed sideways in the direction of arrow 58 will deflect the case 11 a little bit. This provides enough room so that, in the position shown in Figure 9, the battery 38 may be cocked to the position shown in that figure, where the edge 38E is just ready to clear the hole in the battery frame 36 and the battery can then be withdrawn in the direction of the arrow 59. This is not at all difficult to do but it does require a conscious act of the user and in so doing the user is prevented from losing the battery through mere casual or inattentive opening of the battery frame 36.

Referring to Figures 6, 7 and 8, particularly, the sound reproducer or "receiver" 19 may be of the crystal or magnetic type and is enclosed in its usual case. Around the case, however, there is placed a very soft plastic sheath 20 which is in the form of a cup or collar, and is provided with an aperture 60 at one side, in alignment with the sound delivery tube 61 of the sound reproducer 19. Accordingly sound produced by receiver 19 can leave the tube 61 and proceed through the aperture 60 to the aperture 30 in the tubular connection 29 and thence enter the horn 12 and proceed through the gradually tapered curved aperture 62 and be delivered at the connection end 64 where attachment of the horn is made to a plastic tube 13 as previously described. The sound is then conducted through the plastic tube 13 to an "earmold" 14 which is of a shape that fits the external portions of the ear canal of the user.

The very soft plastic or rubber sheath 20 entirely surrounds the sound reproducer 19 and is provided with a flange 66 by which the back side of the sound reproducer is separated from the adjacent portions of the case 11 and the end surface of the hearing aid circuit board 40. Accordingly the mechanical conduction of sound vibrations from the receiver 19 to the microphone 52 are minimized to an unobjectionabl degree. At the same time the sound waves delivered by the sound reproducer 19 are sealed by the flange end 67 of the sheath 20 and these are not permitted to travel around through the air within the case to the microphone 52. Accordingly the sound waves are delivered and conducted through a sealed mechanical channel which begins at the sound delivery tube 61 of the sound reproducer 19 and thence enters through the port 30 of the nipple 29 and through the channel 62 of the horn 12 and through the tube 13 to the earmold 14 and being thus delivered directly to a soft portion of the ear canal and in sealed relation to the walls of the canal, very little sound is accordingly transmitted through the open air back to the microphone 52 and the sound reproducer 19 are in close mechanical proximity but with objectionable feedback either mechanically or through the air from the sound reproducer to the microphone.

As many widely apparently different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that I do not limit myself to the specific embodiments herein.

What I claim is:

1. A hearing aid comprising a case of slightly flexible material, a complete sound pickup and amplifier system in said case including a microphone, an electrical sound amplifier, a battery for said sound amplifier, and a sound reproducer, said apparatus being characterized in that said case is provided with a battery holder of generally planar shape attached to the case for movement edgewise from an operating position where the holder is within the case to a battery changing position where the holder is partially exposed outside of the case, said holder being shaped for receiving said battery therein when the battery is moved in a direction generally normal to the plane of said holder, said holder being shaped so that the battery when held therein is only partially exposed when the holder is moved with reference to the case to the battery changing position, said holder in said position and said case being deflectable relative to each other to a position such that the battery may be cocked to a position out of the plane of said holder and withdrawn from the holder and said case.

2. The hearing aid apparatus specified in claim 1 further characterized in that said battery holder is pivotally mounted on said case for swinging movement from its operating to its battery changing position.

3. The hearing aid apparatus of claim 1 further characterized in that said battery holder includes a small projecting section which overlaps the case when the battery holder is in its operating condition so as to enable the user thereof to insert an object behind said projecting section for operating said battery holder.

4. A hearing aid apparatus comprising a case of material such that magnetic waves may pass therethrough, said case including a complete electrical sound receiving and amplifying system including a microphone, a multiple stage electrical amplifier and a sound reproducer complete with power supply therefor, said apparatus being

connected in that the case includes an aperture through which sound vibrations from the exterior may enter the case and further characterized in that said microphone is housed in a sheath of paramagnetic material, said microphone in its sheath being positioned so that a surface of the microphone which normally receives the sound waves thereagainst and which is covered by said sheath is positioned in the case adjacent the aperture therethrough, said paramagnetic material sheath being sufficiently thin adjacent said aperture so as to permit the sound waves to be transmitted directly to the sheath to the microphone within the sheath.



**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,513,746 | Rohr | July 4, 1950 |
| 2,718,563 | Nicholides | Sept. 20, 1955 |
| 2,794,085 | De Angelis | May 28, 1957 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 494,016 | Italy | May 15, 1954 |
| 737,115 | Great Britain | Sept. 21, 1955 |
| 760,615 | Great Britain | Nov. 7, 1956 |
| 761,169 | Great Britain | Nov. 14, 1956 |