Jan. 30, 1962 S. G. McCARRELL 3,019,305

TRANSDUCER MOUNTING MEANS

Original Filed Aug. 19, 1957 2 Sheets-Sheet 1

Fig. 1

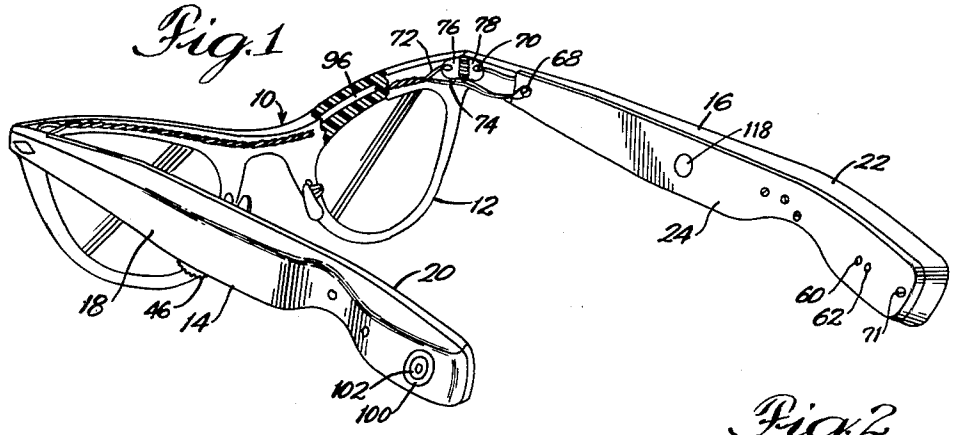


Fig. 2

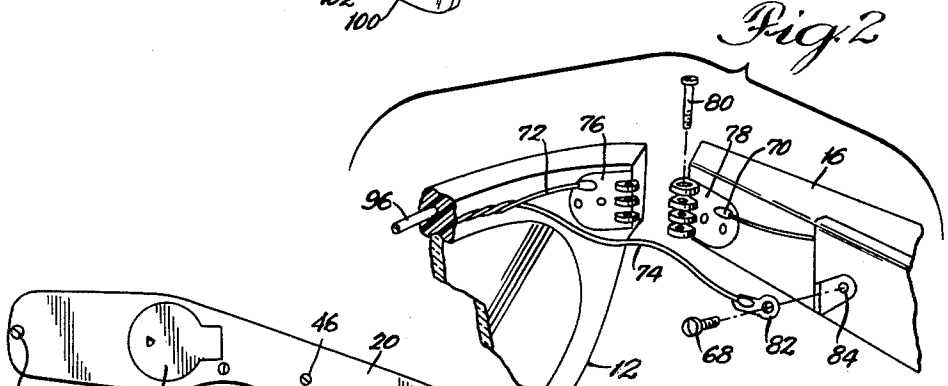


Fig. 3

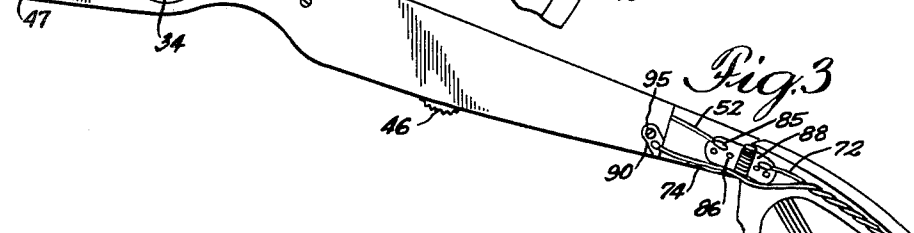
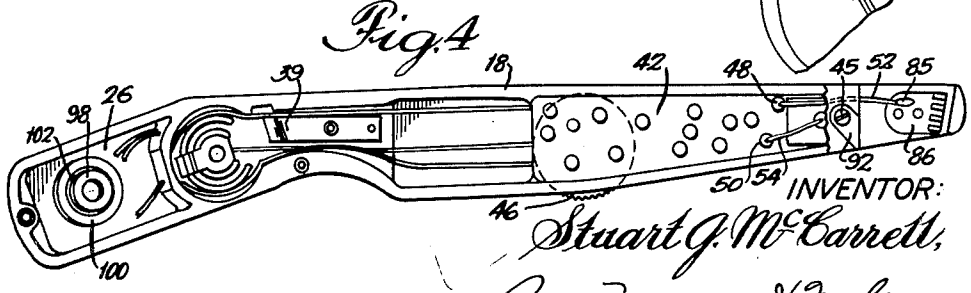


Fig. 4



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Fig. 5

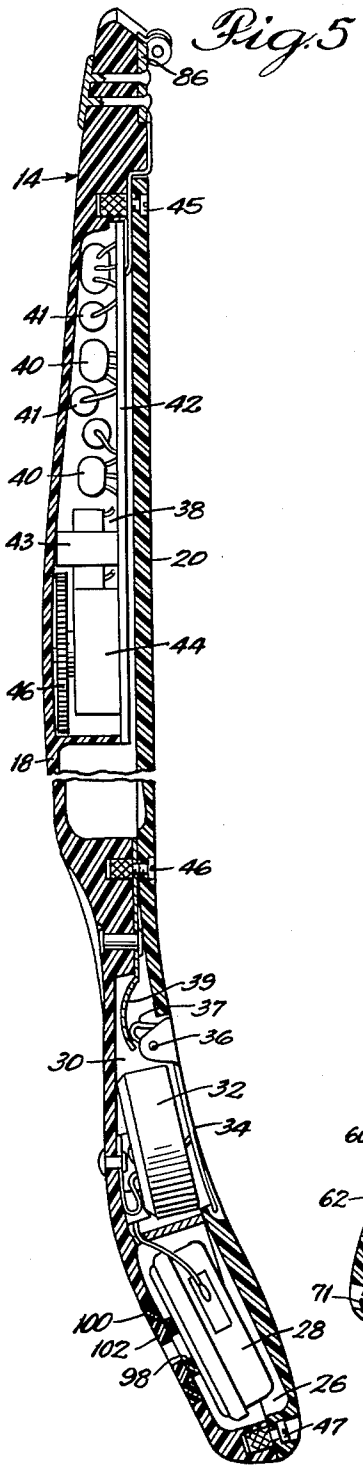


Fig. 6

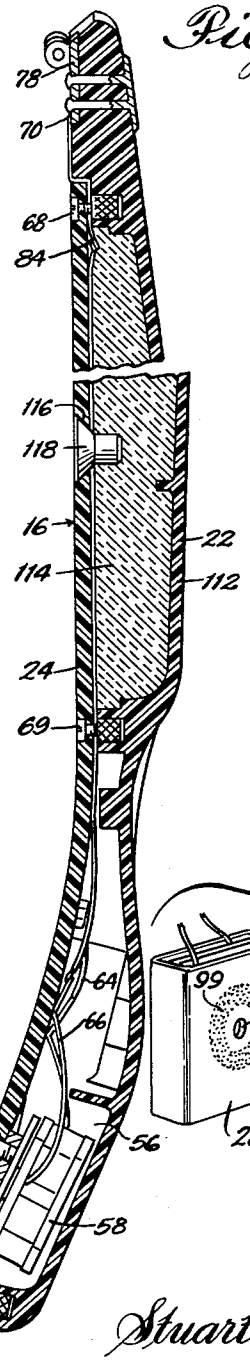
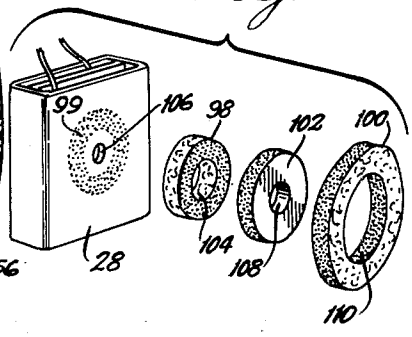


Fig. 7



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3,019,305

TRANSDUCER MOUNTING MEANS

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Original application Aug. 19, 1957, Ser. No. 678,980. Divided and this application July 5, 1960, Ser. No. 40,389

6 Claims. (Cl. 179—146)

This invention relates generally to improvements in transducer mounting means and more particularly to improvements in such transducer mounting means of the type advantageously utilized in compact electrical devices, such as hearing aids. This application is a division of my co-pending application Serial No. 678,980, filed August 19, 1957, entitled Hearing Aids.

While the invention will be described hereinbelow as advantageously utilized in an eyeglass type of hearing aid for purposes of illustration those skilled in the art will appreciate that the invention may be used with equally good results in other types of hearing aids and compact communication or control devices.

The eyeglass or spectacle supported hearing aids known in the art fall into two general categories commonly referred to as the bone conduction type and the ear conduction type. In both types of hearing aids, the components of the hearing aid circuit, such as the microphone, battery, amplifier, controls and the receiver, are positioned within one or both of the temples of the eyeglasses to the end that the hearing aid apparatus is maintained relatively inconspicuous.

Conventionally, the air conduction hearing aids are provided with a hollow plastic tube which extends between the receiver and the ear, and the bone conduction hearing aids are provided with temples that extend to a point behind the ear such that the vibration of the receiver is communicated to the mastoid bone of the wearer for transmitting sound energy to the auditory nerves.

The bone conduction eyeglass hearing aids of the prior art have not proved satisfactory due to the failure to properly meet the problem posed by a pair of contradictory requirements for such hearing aids. Thus, the temples should exert a relatively high pressure against the mastoid area in order to provide good response, while at the same time, the microphone must be sufficiently isolated from the receiver to minimize vibratory and acoustical feedback therebetween. In other words, to provide the necessary pressure of the receiver against the mastoid area, it is necessary to construct the eyeglasses frame of relatively stiff material such that the temples are enabled to grip the head of the wearer. However, it will be fully appreciated by those skilled in the art that as a natural result of such construction, the incidence of undesirable acoustical and vibratory feedback from the receiver to the microphone is greatly increased.

In order to overcome the serious problem posed by these two opposed requirements in bone conduction eyeglass hearing aids, the prior art constructions have utilized relatively insensitive microphones and/or low gain amplifiers, or alternatively, the entire hearing aid assembly has been constructed with materials and couplings too flexible to provide adequate mastoid pressure. Unfortunately, this type of construction has reduced the pressure of the temples against the mastoid area below the value required to secure sufficient gain for correction of even the most moderate of hearing losses. Generally, about 10 to 12 ounces of pressure is required and therefore, the response provided by such constructions has not been satisfactory.

In addition, the prior art constructions have been deficient in that the high frequency feedback between the receiver and microphone has added to the above-described

difficulties to even further reduce the amount of gain that could be incorporated without the hearing aid breaking into self-oscillation and thus becoming useless.

Accordingly, it is a general object of this invention to provide an improved construction for an eyeglass type hearing aid.

More specifically, it is an object of this invention to provide a more efficient construction for a bone conduction eyeglass hearing aid.

It is another object of this invention to provide an improved hearing aid construction in which the microphone is floated by means of a special double resilient compound mounting to produce greater isolation of the microphone from acoustical and vibratory feedback, thereby enabling the use of microphones of greater sensitivity.

It is still another object of this invention to provide an improved hearing aid construction of the bone conduction eyeglass type which is characterized by its increased efficiency and sensitivity, and by its relative freedom from acoustical and vibratory feedback.

These and other objects are realized in accordance with a specific illustrative embodiment of the invention in which the temples of the eyeglasses frame are formed of a lightweight material, such as plastic or metal, of the type which is relatively stiff, but which may be bent considerably at higher temperatures without breaking. Each temple is formed of a body and a cover panel which define recesses therebetween adapted to receive the circuit components of the hearing aid, and as these components now are available in miniature and subminiature sizes, they can be fitted within these recesses in a fully concealed manner. Advantageously, transistors and printed circuits are used to reduce the size of the hearing aid circuit.

Accordingly, one temple is adapted to have disposed therewithin a microphone, mounted in a novel manner as described in greater detail below, a battery, an amplifier and suitable controls such as an On-Off switch, and a volume control for the hearing aid, and the other temple has disposed therewithin a bone conduction receiver and novel means for damping feedback, also described in greater detail below. It is a feature of this invention that the bone conduction receiver is securely attached to the cover panel of the temple in which it is mounted to the end that a substantial portion of the cover panel, and hence, the entire area around the mastoid bone is vibrated by the receiver. Thus, by not limiting the area of vibratory contact between the hearing aid and the mastoid bone to a single point contact, the effective output of the receiver is greatly increased since the optimum point for contact varies from individual to individual.

It has been found with prior art devices that mounting the receiver to the temple in such a solid manner often led to highly objectionable feedback from the receiver to the microphone. This undesirable result is obviated in accordance with a further feature of this invention wherein the microphone is isolated from such feedback by means of a novel compound double resilient mount that serves to provide a degree of isolation between the receiver and the microphone sufficient to enable the attainment of several decibels of additional gain without feedback. Thus, in the specific illustrative embodiment of the invention, described herein, the microphone is supported by a flat annular mount which advantageously is formed of unicellular closed cell rubber such as sponge rubber. This sponge rubber mount is positioned so that its inner opening is generally aligned with the microphone opening, and the other face of the mount is secured to an annular mounting washer, advantageously formed of plastic or the like. The washer is positioned within the inner opening of a flat annular cushion, which advantageously is also formed of unicellular closed cell rubber, and this cushion is cemented in a suitable opening in the cover pan-

el of the temple supporting the microphone. This novel compound mount, in which the rubber always is in shear rather than compression in all planes, serves to float the microphone such that the latter is effectively isolated from feedback through the eyeglasses frame. Further, a very small volume is required to incorporate the two vibratory isolating rubbers in series contained in the compound mount.

It will be appreciated by those skilled in the art that the novel mounting of the microphone and the isolation attained thereby allows the eyeglasses frame to be constructed of a relatively stiff material to the end that the receiver can be mounted with about 10 to 12 ounces of pressure against the mastoid area. This pressure may be attained in one advantageous embodiment of the invention by a spring steel bar embedded in the top front portion of the eyeglasses frame. Such spring steel bar construction is further advantageous when used with a plastic eyeglasses frame since the plastic used in such applications flows at higher temperatures to allow insertion of the lenses therein, and the spring steel bar provides the required pressure even at such high temperatures.

In accordance with a still further feature of this invention, several additional decibels of gain without undesirable feedback at high frequencies is made possible by the use of novel damping means disposed in one temple adjacent the receiver. Advantageously, the portion of the temple adjacent the receiver is recessed to receive a quantity of granular material, such as gravel or the like, and it is a feature of this invention that the use of such granular material serves as an effective means of damping undesirable high frequency vibratory coupling between the microphone and receiver.

In the illustrative embodiment of the invention disclosed herein, it is contemplated that the amplifier in one temple may be electrically connected to the receiver of the other temple by means of a pair of conductors extending across the rear of the front portion of the eyeglasses frame. As the hearing aid circuit occasionally will require maintenance and repair, and further as it is frequently undesirable to maintain the eyeglasses frame as an integral unit during such maintenance and repair, means are provided for facilitating the removal of the temples from the front portion of the eyeglasses frame during such times. In accordance with a feature of this invention, this is attained by utilizing the hinge connecting each temple to the front portion of the frame as one of the connecting conductors between the amplifier and the receiver. Thus, removal of the hinge screw and separation of the temple and front portion of the frame opens the circuit formed by the hinge. An additional conductor is provided at each hinge and this conductor has a solder lug at one end thereof which is adapted to be connected by a screw to a terminal in the temple. Thus, either temple may be dismantled from the front portion of the eyeglasses frame by merely removing the two screws described above. This advantageous construction considerably simplifies the assembly and disassembly as well as the stocking and servicing of the eyeglass hearing aid frame.

The above and other features of novelty which characterize the invention are pointed out with particularity by the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference is had to the accompanying drawing and descriptive matter in which is shown and described an illustrative embodiment of the invention.

In the drawing:

FIGURE 1 is a perspective view, partially broken, of a bone conduction hearing aid glasses frame embodying the invention;

FIGURE 2 is a partial view showing the hinge connection between a temple and the front portion of the eyeglasses frame in accordance with the invention;

FIGURE 3 is a perspective view of the inner portion of the eyeglass temple supporting the microphone, battery, amplifier and control assembly of the hearing aid;

FIGURE 4 is a side elevational view of the temple shown in FIGURE 3 with cover panel removed;

FIGURE 5 is an elevational view in cross section of the temple shown in FIGURE 4;

FIGURE 6 is an elevational view in cross section of the temple supporting the receiver and damping means in accordance with the invention; and

FIGURE 7 is an exploded view of the microphone and the compound mounting assembly for the microphone in accordance with the invention.

Referring now to the drawing, there is shown a specific illustrative embodiment of a bone conduction hearing aid embodying the invention which comprises an eyeglasses frame, shown generally at **10** having a lens receiving portion **12** and a pair of side temples **14** and **16**, respectively, positioned at opposite ends of the lens receiving portion **12**. In accordance with one embodiment of this invention, temple **14** is adapted to support the microphone, battery, amplifier, volume control and On-Off switch of the hearing air circuit, and the temple **16** is adapted to support the vibratable receiver of the circuit.

Temple **14** is advantageously comprised of a generally U-shaped body **18** of suitable depth to the end that several component parts of the hearing aid may be recessed therein, and a generally flat cover panel **20** adapted to be secured over the open side of the temple body **18** for concealing the components therewithin. In a similar manner, temple **16** is formed of a generally U-shaped body **22** of suitable depth to enable a receiver to be recessed therein and a generally flat panel cover **24** adapted to be fastened over the open side of body **22** for concealing the receiver therewithin. It will be readily appreciated by those skilled in the art that the body and cover panel of each temple may be formed of a suitable lightweight deformation resistant material, such as plastic or the like.

The manner in which the component elements are mounted in temple **14** is shown in detail in FIGURES 4 and 5 of the drawing. It can be seen that the rear portion of temple body **18** is provided with a recess **26** in which is fitted a microphone **28** of relatively small size. Microphones suitable for this purpose are known in the art, and therefore, a detailed description of the microphone is not necessary.

Forwardly of the microphone **28** a recess **30** is provided for receiving a source of potential for the hearing aid circuit, such as battery **32**. Advantageously, a cover **34** is hingedly positioned in cover panel **20** above the recess **30**, as by the hinge pin **36**, for facilitating the insertion and removal of the battery **32** therewithin. Preferably, hinged cover **34** is snap operated to its open and closed positions due to the action of the hinge operating member **37** and the resilient leaf spring **39** with which the operating member cooperates. Manifestly, other means for providing access to battery **32** may be used in lieu of the above-described construction.

Forwardly of the battery **32** in temple **18**, an elongated recess **38** is provided for receiving the amplifier and control circuitry of the hearing aid. In order to reduce the size of temple **18** as much as possible, it has been found advantageous to employ an amplifier comprised of a plurality of transistors and miniature capacitors **41** which are mounted on a printed circuit panel **42** having resistors printed thereon. Also mounted on printed circuit panel **42**, there is provided a miniature transformer **43** and a combined volume control potentiometer and On-Off switch **44**. The volume control and On-Off switch are adapted to be manually actuated by means of a rotatable finger wheel **46**. Preferably, a suitable slot is provided at the lower part of temple body **18** so that the finger wheel **46** may extend therethrough to enable the hearing aid to be controlled in a readily accessible manner.

Cover panel 20 is secured to body 18 of temple 14 by suitable fasteners, such as screws 45, 46, and 47. Thus, it can be seen that assembly and disassembly of temple 14 has been greatly simplified to facilitate the construction and maintenance of the hearing aid. Advantageously, one output terminal 50 of the amplifier is connected by conductor 54 to terminal 92 associated with screw 45. The other output terminal 48 is connected by conductor 52 to the hinge terminal 86.

Temple 16 comprises a body 22 and a cover panel 24, having substantially the same external shape and size as their corresponding parts in temple 18. At the rear end of the temple 22 there is provided a recess 56 of sufficient size to receive a miniature vibratable receiver 58. It is a feature of this invention that receiver 58 is securely mounted to cover panel 24, as by means of the screws 60 and 62, to the end that vibration of receiver 58 in response to the audio signals picked up and amplified by the hearing aid causes a substantial portion of the cover panel 24 to vibrate in a similar manner against the mastoid area of the wearer when the invention is in use.

It will be appreciated by those skilled in the art that as a result of the vibration of a large portion of the cover panel 24 against the mastoid area, as contrasted to the single point contact provided by certain prior art devices, the effective output of the hearing aid is materially increased.

Cover panel 24 is secured to body 22 of temple 16 by suitable fasteners, such as the three screws 68, 69 and 71 which as explained above, greatly simplifies the assembly and disassembly of the temple.

Receiver 58 is connected to the conductors 64 and 66 which extend through the length of temple body 16 and terminate at the front portion of temple 16. Advantageously, conductor 64 is connected to terminal 84 with which screw 68 is associated and conductor 66 is connected to terminal 70 on hinge 78.

The circuit between the amplifier and the receiver is completed in accordance with one embodiment of this invention by means of a pair of conductor leads 72 and 74 which extend across the inner side of the lens portion 12 of the eyeglasses frame 10.

It is an important feature of this invention that the removal of the temples from the lens portion 12 is facilitated by means of a novel conducting hinge arrangement which requires the removal of only two screws for each temple. Thus, as illustrated in FIGURE 2, conductor lead 72 is connected to the hinge member 76 of the lens portion 12 and conductor terminal 70 is connected to the hinge member 78 of the receiver temple 16. The hinge members 76 and 78 are formed of conducting material and therefore, when the two hinge members are operatively associated with each other by the screw 80, a complete electrical path exists between conductor lead 72 and terminal 70.

Conductor lead 74 at the inner side of lens portion 12 is extended beyond the hinge members 76 and 78 and terminates in terminal lug 82 which is adapted to be fastened to the terminal 84 by means of the screw 68. Accordingly, it can be seen that by merely removing screws 80 and 68, the electrical circuit is completely opened and that temple 16 can be removed from the lens portion 12 of the eyeglasses frame 10 in quick and simple manner, whenever desired.

In a similar manner, the conductor lead 52 at the amplifier output is connected to terminal 85 on hinge member 86 of temple 14, and the conductor lead 72 at the inner side of lens portion 12 is connected to the hinge member 88. Conductor lead 74 is extended beyond lens portion 12 and terminates in a lug 90 which is connected to terminal 92 of temple 14 by the screw 45. Thus, it can be seen that the temple 14 may be assembled and disassembled from the lens portion 12 of the eyeglasses frame by the removal of merely two screws.

It can be seen, and particularly in FIGURES 5 and 6, that the temples 14 and 16 curve inwardly at their rear portions to the end that opposite points of the head are gripped at the mastoid bones behind the upper ears of the wearer. As explained heretofore, it is desirable for satisfactory response that the portion of temple 16 supporting the vibratable receiver 58 be positioned against the mastoid area with about 10 to 12 ounces of pressure. Accordingly, the gripping action afforded by the shape of the temples leads towards this end.

It will be appreciated by those skilled in the art that plastic has a tendency to flow at higher temperatures, and therefore, when the eyeglasses frame 10 is formed of plastic, as in the preferred embodiment, it is difficult to maintain the desired pressure against the mastoid area. In accordance with an aspect of this invention, this undesirable characteristic of plastic is met by means of a spring steel bar 96 which advantageously is embedded across the top of the lens portion 12 of the eyeglasses frame. Thus, it will be understood that the resilient characteristics of the spring steel bar 96 allows the temples to be separated during the placement of the eyeglasses frame of the head of the wearer, and during the removal of the frame from the head of the wearer, while also serving to enhance the gripping action of the temples against the mastoid area when the eyeglasses are in position on the head. It is fully within the spirit of this feature of the invention that other resilient means may be utilized in lieu of spring steel bar 96, such as a leaf spring band and the like to provide this advantageous result.

It further will be understood by those skilled in the art that there is a normal tendency for vibratory and acoustical feedback to take place from the receiver to the microphone in eyeglass type hearing aids. The problems introduced by such feedback are made even more acute when the coupling between the receiver and microphone is stiffened as it must be to secure sufficient pressure on the mastoid, as for example, in the manner described above by the addition of a spring steel bar to the eyeglasses frame. This problem is resolved in a unique manner in accordance with an important feature of this invention by means of a novel compound resilient mount for the microphone which serves to effectively float the microphone with respect to the temple 14, and therefore, effectively isolate the microphone from such vibratory and acoustical feedback. This novel compound resilient mount, shown in greater detail in FIGURES 4, 5, and 7, comprises a pair of unicellular, closed cell rubber rings, namely mount 98 and cushion 100, and a plastic washer 102 adapted to be interposed therebetween.

In the illustrative embodiment of the invention shown in the drawing, one face of the smallest diameter ring or mount 98 is cemented to the front of the microphone 28, by a suitable adhesive 99 shown on the front of microphone 28 in FIGURE 7. The aperture 104 at the central portion of mount 98 is greater than the aperture 106 at the front of microphone 28 and therefore, audio signals pass through apertures 104 and 106 to the sound receiving portion of the microphone.

A washer 102 of relatively stiff material, such as plastic, is cemented to the other face of the rubber mount 98. Advantageously, aperture 108 at the central portion of washer 102 is aligned with apertures 104 and 106 to provide a path for the audio signals to the microphone. The other unicellular, closed cell rubber ring 100 serves as a cushion for the microphone and advantageously, the diameter of the aperture 110 in rubber cushion 100 is slightly larger than the outer diameter of the plastic washer 102 to permit the outer circumferential surface of washer 102 to be cemented to the inner circumferential surface of rubber cushion 100. The microphone 28 therefore is completely supported in temple 16 by the double resilient compound mount described above, when the outer circumferential surface of rubber cushion 100 is ce-

mented to the circumferential surface of a hole provided at the outer side of body 18 in temple 16.

In the unique microphone mount construction described above herein, the rubber rings supporting the microphone always are in shear, rather than compression, in all planes and consequently, the microphone is effectively isolated from all vibratory and acoustical feedback resulting from the vibration of receiver 58 in temple 16. This provision of effective isolation for the microphone has permitted the eyeglasses hearing aid to incorporate a more rigid construction and high electro-acoustical gain without feedback. Both of these features are required in an effective bone conduction hearing aid.

An additional limitation often found in prior art devices is the presence of high frequency signal feedback from the receiver to the microphone. In many such prior art devices, this drawback has made necessary the use of microphones of decreased sensitivity to high frequencies. This undesirable expedient is avoided in accordance with an aspect of this invention by the provision of special high frequency damping means in the temple 16 adjacent the receiver 58.

As shown in FIGURE 6, the temple body 22 is provided with elongated recess 112 adjacent the receiver recess 56. Advantageously, elongated recess 112 is filled with a granular material 114, such as gravel or the like through a suitable opening 116 provided in the cover panel 24. In accordance with one embodiment of the invention, the gravel is uniformly packed within recess 112 by vibrating the temple body 22 during the insertion of the gravel in the recess. When the recess 112 is filled with gravel 114, the opening 116 may be closed by a suitable closure member, such as plug 118. It has been found that use of the granular material 114 in recess 112 adjacent the receiver 58 has resulted in very effective damping of the high frequency feedback from the receiver 58 and, as a result, the use of very sensitive microphones has been made practical.

It will be appreciated by those skilled in the art that modifications may be made in the construction and arrangement of the parts and in the materials used in the above-described transducer mounting means without departing from the real spirit of the invention and that it is intended to cover by the appended claims any modified forms of structure or use of equivalents which may reasonably be included within their scope.

What is claimed as the invention is:

1. The improvement of a microphone support for a hearing aid comprising a base adapted to be worn by the hearing aid user and having an opening extending therethrough, a microphone, a first apertured member of deformable material secured to the sound receiving face of said microphone, an apertured second member of stiffer material secured to said first apertured member, a third apertured member of deformable material, means mounting said third apertured member in the opening of said base, and means mounting said second apertured member in the aperture of said third apertured member whereby said microphone is floatingly supported in the base by said first, second and third members to minimize acoustical and vibratory feedback to said microphone.

2. The improvement of a support for a microphone in a hearing aid housing comprising a first annular rubber member, adhesive means securing said first annular rubber member to the hearing aid housing, a second annular rubber member having a pair of opposed flat surfaces, adhesive means securing one of said flat surfaces to a microphone, and linking means comprising a relatively stiff member connecting said first and second annular rubber members in series for minimizing acoustical and vibratory feedback from the hearing aid housing to the microphone.

3. The improvement of a support for a transducer in a rigid housing comprising a first resilient member having a centrally located aperture, adhesive means securing said first resilient member to a rigid housing, a second resilient member having a pair of opposed flat surfaces, adhesive means securing one of said flat surfaces to a transducer, and linking means comprising a relatively stiff member connecting said first and second resilient members in series for minimizing acoustical and vibratory feedback between the rigid housing and the transducer.

4. The improvement of a transducer support for a hearing aid comprising a rigid hearing aid case having a sound opening extending therethrough, a transducer supported within said case, a first apertured member of deformable material secured to a face of said transducer, a second apertured member of stiffer material secured to said first apertured member, a third apertured member of deformable material, means mounting said third apertured member in the sound opening of said case, and means mounting said second apertured member in the aperture of said third apertured member whereby said transducer is floatingly supported in the case by said first, second and third members to minimize acoustical and vibratory feedback with respect to said transducer.

5. The improvement of a microphone support comprising a rigid case having an opening extending therethrough, a microphone, a first annular member of deformable material secured to the face of said microphone, a second annular member of stiffer material secured to said first apertured member, a third annular member of deformable material, means mounting said third annular member in the opening of said case, and means supportingly mounting said second annular member within the central opening of said third annular member whereby said microphone is floatingly supported in the case by said first, second and third annular members to minimize acoustical and vibratory feedback to said microphone.

6. The improvement of a microphone support in a hearing aid housing comprising a first resilient annular member having inner and outer circumferential edges, adhesive means securing said outer circumferential edge to the walls of an opening in the hearing aid housing, a second resilient annular member having a pair of opposed flat faces, adhesive means securing one of said flat faces to the housing of a microphone, and linking means comprising a relatively stiff annular member connecting said first and second annular rubber members in series for minimizing acoustical and vibratory feedback from the hearing aid housing to said microphone, said linking means having one flat face thereof secured to a flat face of said second resilient annular member and an outer circumferential edge thereof secured to the inner circumferential edge of said first resilient annular member.

No references cited.