United States Patent

Weiss

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[45] May 23, 1972

[54] DIRECTIONAL RESPONSIVE HEARING AID

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[73] Assignee: Beltone Electronics Corporation

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[21] Appl. No.: 877,258

[52] U.S. Cl. ..... 179/107 S

[51] Int. Cl. G02c 11/06

[58] Field of Search ..... 179/107 R, 107 BC, 107 H, 107 S, 179/1 DM, 121 D

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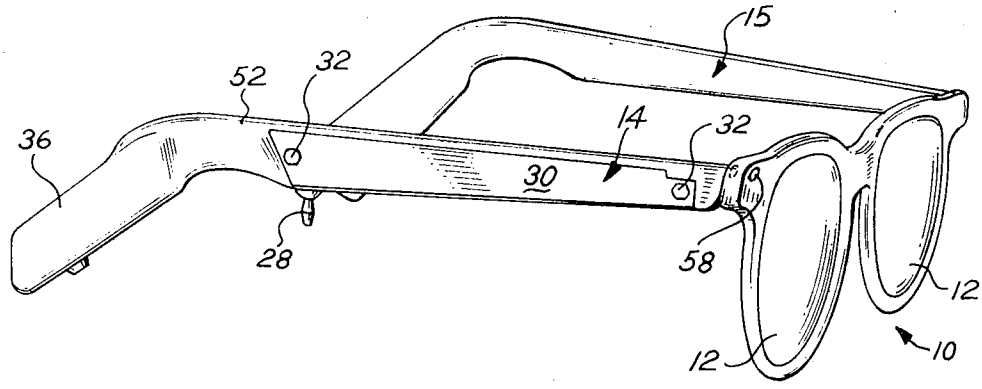
[57] ABSTRACT

A spectacle mounted directional responsive hearing aid includes various hearing aid components carried in an earpiece of the spectacles. An elongated hollow sound conduit extends over a major portion of the longitudinal length of the earpiece, one end of the conduit communicating with a microphone enclosed in the earpiece and the other end of the conduit opening to the front of the spectacle lens carrying frame in a plane substantially tangent to the hearing aid user's forehead. The conduit is dimensioned to increase the frequency response of the hearing aid in a predetermined frequency range.

2 Claims, 10 Drawing Figures



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2 Sheets-Sheet 1

Fig. 1

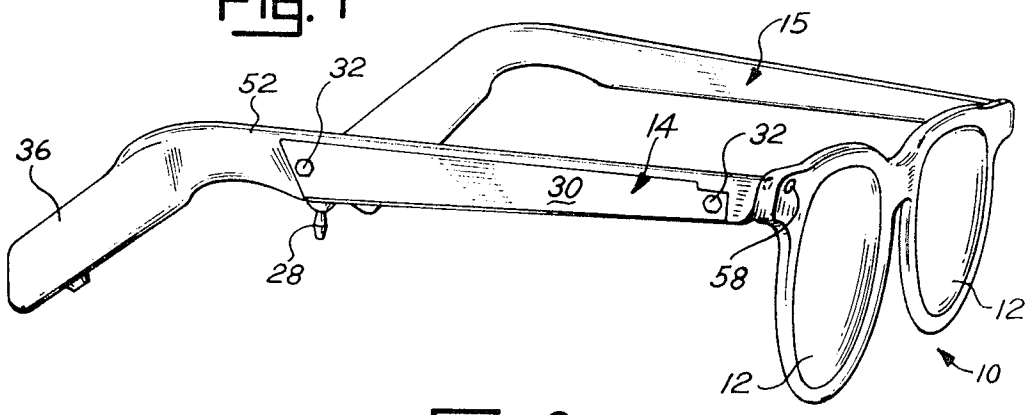

Fig. 2

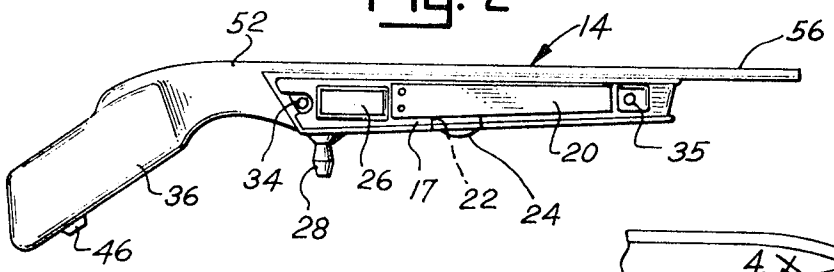

Fig. 3

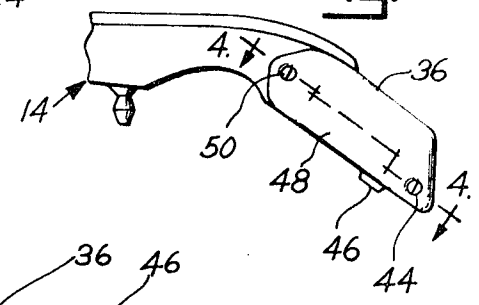

Fig. 5

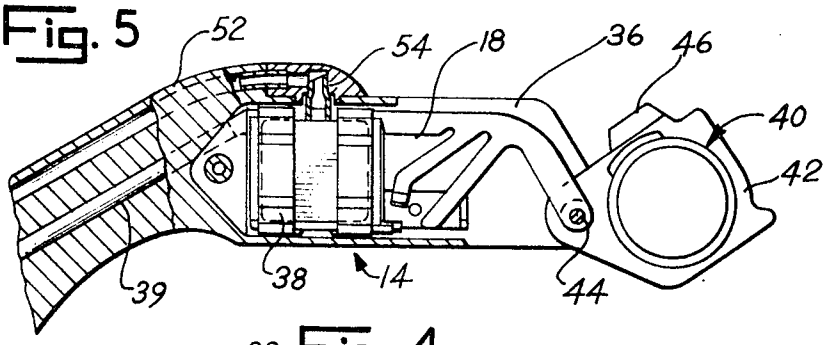

Fig. 4

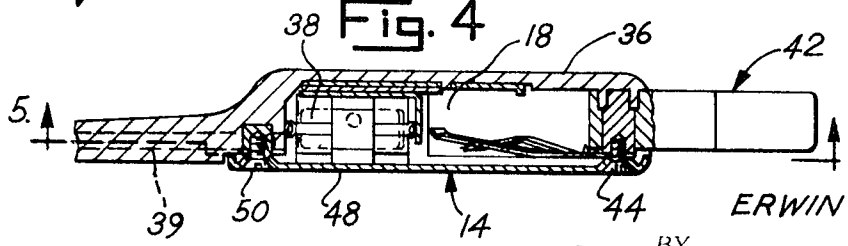

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Fig. 6

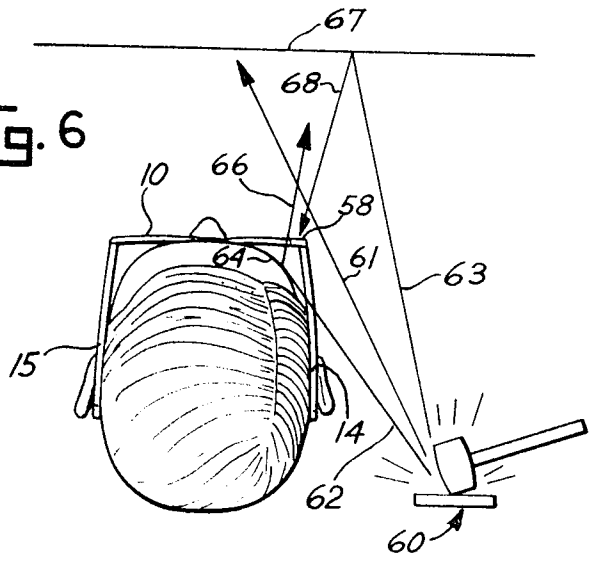


Fig. 8

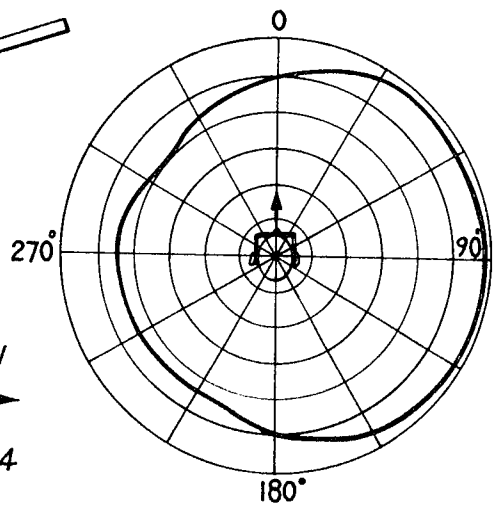


Fig. 7

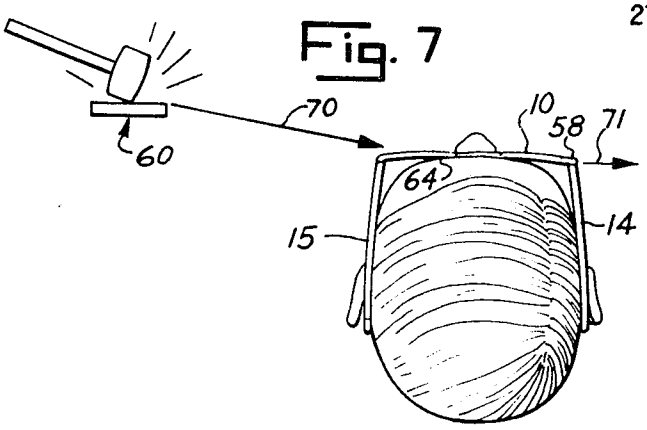


Fig. 9

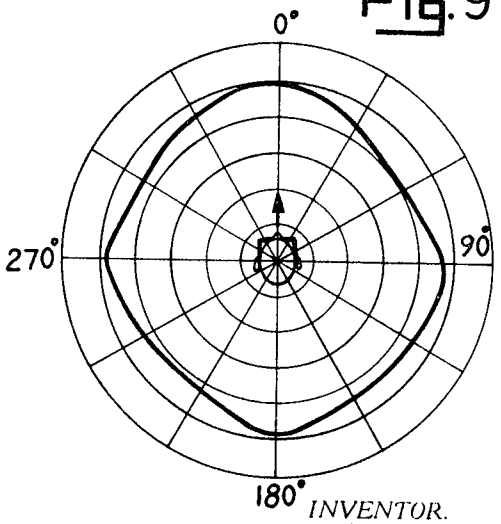
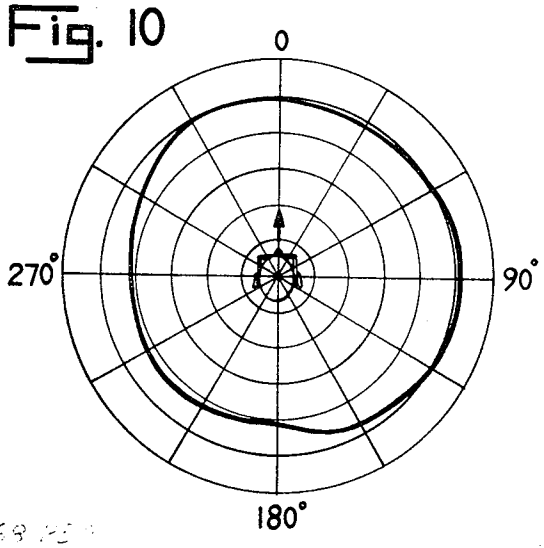


Fig. 10



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DIRECTIONAL RESPONSIVE HEARING AID

BACKGROUND OF THE INVENTION

This invention relates to a directional responsive hearing aid and, more particularly, to a directional responsive hearing aid adapted to be spectacle mounted.

In the past various hearing aid arrangements have been provided which have been spectacle mounted and in which an earpiece of the spectacles carries the various components of the hearing aid including the sound wave receiving microphone. Since the microphone in such prior hearing aids is carried by the earpiece, the microphone usually faces to the side of the head of the hearing aid user. In such side facing microphones, considerable head shadow effect is present, such that the sound intensity of sounds emanating from the side of the head opposite the microphone is substantially reduced and thus the sound becomes difficult to hear by the user. Moreover such side facing microphones are subjected to increased reception of noise emanating from behind the hearing aid user. Such rear reception results in increased interference with sounds desired to be heard which are usually located forward of the user and, in some instances, completely impairs sound emanating from that direction. For example, where the hearing aid user is in a theater, the desirable sounds emanating from the stage will frequently become inaudible to the hearing aid user because of competing conversations or noise in rows behind the user. Moreover, such side facing microphones generally produce maximum sound reception of sounds emanating from the side of the user on which the microphone faces and somewhat less than maximum reception in a direction forward of the user, the latter direction being that in which other persons conversing with the hearing aid user would normally be positioned. Frequently such condition results in the tendency of the hearing aid user to awkwardly and conspicuously turn his head to the side in order to facilitate reception of the speech of the other conversing party. Also since hearing aid microphones are generally of a substantially small size, selective frequency response control of the microphone is difficult. Thus, frequency response in certain desired frequency ranges, such as human voice frequencies, is generally difficult to selectively tune with respect to other less desirable frequencies.

Various attempts have been made to correct some of the aforementioned difficulties. In one prior spectacle mounted hearing aid arrangement, a microphone has been mounted in the nose piece between the lenses of the lens carrying spectacle frame and wires extending from the microphone connect the microphone to the various hearing aid components carried in the earpiece. Such arrangement has a number of disadvantages including the unsightly and obvious presence of the microphone upon the bridge of the nose of the user. Such arrangement is also difficult to service and assemble since the sound receiving microphone is located on a portion of the spectacles which are normally maintained by a craftsman not having electronic experience, e.g. an optometrist and the like. Also in such arrangement, the microphone is closely positioned adjacent the forehead of the user and is exposed to perspiration of the user resulting in the increased probability of shorting or damage.

In order to overcome head shadow effect, another prior arrangement has utilized a pair of side facing microphones, one of the microphones being located on the side of the user's head opposite the aided ear. The latter microphone is electrically coupled, along with the other microphone, to an amplifier and receiver. Such arrangement necessitates the use of more than one microphone and results in a rather complex construction. Such arrangement also is inoperative to decrease interference from sources emanating from the back of the hearing aid user.

The directional responsive hearing aid constructed in accordance with the principles of my invention overcomes the numerous difficulties encountered by the prior hearing aid arrangements. The hearing aid of my invention substantially attenuates sound emanating from behind the hearing aid user while at the same time substantially reduces head shadow effect on sounds emanating from a source on the side of the head opposite the aided ear while employing only a single microphone. Moreover, the hearing aid of my invention is capable of substantially improved frequency response in selective frequency ranges. The hearing aid constructed in accordance with the principles of my invention may be totally contained in the earpiece of a pair of spectacles thus obviating extensive modification of the lens carrying frame and the need of a second craftsman in maintaining the frame. The hearing aid of my invention also substantially reduces the possibility of damage or short circuiting of the microphone and other components due to perspiration or the like. Moreover, since the sound receiving structure maximizes sound reception forward of the user in the direction in which a second conversing party would most likely be positioned rather than to the side, the tendency of the user to awkwardly and conspicuously turn the side of his head toward the sound source is virtually eliminated. Moreover, the hearing aid construction of my invention is simple and compact and is capable of concealment of unsightly components from the view of other persons.

SUMMARY OF THE INVENTION

In a principal aspect, the directional responsive hearing aid constructed in accordance with the principles of my invention comprises an earpiece which is adapted to receive a hearing aid microphone therein and a hollow elongated sound conduit mounted on the earpiece and extending longitudinally over a major portion of the length of the earpiece. One end of the conduit communicates with the microphone and the other end defines an aperture adjacent the end of the earpiece which is adapted to be mounted to the lens carrying frame of the spectacles, the sound waves being transmitted through the hollow conduit from the aperture to the microphone.

These and other objects, features and advantages of the present invention will be more clearly understood through a consideration of the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the course of this description, reference will frequently be made to the attached drawings in which:

FIG. **1** is an overall view of a pair of spectacles which incorporate a preferred embodiment of hearing aid of my invention;

FIG. **2** is an elevation view of an earpiece of the spectacles shown in FIG. **1**, in which the cover has been removed to expose a hearing aid component carrying cavity;

FIG. **3** is a fragmentary elevation view of the opposite side of the earpiece shown in FIG. **2**;

FIG. **4** is a cross sectioned plan view of the earpiece taken substantially along line **4** — **4** of FIG. **3**;

FIG. **5** is a cross sectioned side elevation view of the earpiece taken substantially along line **5** — **5** of FIG. **4**;

FIG. **6** is a schematic representation of the operation of the hearing aid of my invention in the attenuation of interferring noises emanating from behind the hearing aid user;

FIG. **7** is a schematic representation of the operation of the hearing aid in the reduction of head shadow effect;

FIG. **8** is a plot showing the sound receiving characteristics of a conventional single side facing microphone hearing aid;

FIG. **9** is a plot showing the sound receiving characteristics of a dual side facing microphone hearing aid wherein the microphone on the side of the head opposite the aided ear is coupled to the hearing aid amplifier; and

FIG. **10** is a plot showing the sound receiving characteristics of the preferred embodiment of directional responsive hearing aid constructed in accordance with the principles of my invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a pair of spectacles are shown comprising a lens carrying frame **10** having appropriate optical lenses **12** mounted therein and a pair of earpieces **14** and **15** are hinged to the frame for mounting the frame on the head of the spectacle user. The earpiece **15**, on the unaided side of the hearing aid user's head, is of conventional design and the other earpiece **14** is modified according to the principles of my invention to carry the necessary hearing aid components for use in aiding the aided ear of the user.

In general, earpiece **14** is of substantially the same overall shape as earpiece **15**. Earpiece **14** includes a pair of cavities **17** and **18**, as shown in FIGS. **2** and **4**, a portion **20** of cavity **17** being adapted to contain a conventional hearing aid amplifier and includes an aperture **22** communicating therewith through which a volume adjusting wheel **24** extends to the exterior of the earpiece. A portion **26** of the cavity **17** is also adapted to receive a suitable sound emitter for transmitting the aided sound through an appropriate connector **28** to the ear of the hearing aid user. A cover plate **30** is adapted to fit over the cavity **17** to enclose the components located therein and is attached in position by suitable screws **32** which are received in threaded apertures **34** and **35** located at the distal ends of cavity **17**.

The second cavity **18** is located in the downturned end **36** of the earpiece **14** and is adapted to contain the hearing aid microphone **38** which is coupled by a suitable conductor **39** to the amplifier and a battery power supply **40**. The battery **40** may be carried in a moveable holder **42** which is adapted to be rotated in and out of the cavity **18** about a pivot screw **44** to enable replacement of the battery as necessary. A finger engageable tab **46** is provided on the battery holder **42** to facilitate manipulation of the holder. The entire cavity **18** is also covered by a cover plate **48** which is attached to the earpiece **14** by the pivot screw **44** and by a screw **50** to enclose the components in the cavity.

An elongated hollow sound transmitting conduit or tube **52** is integrally moulded along the top of the earpiece **14** and extends beyond the end of the earpiece which is adapted to be attached to the lens carrying frame **10**. One end **54** of the conduit **52** is coupled to and communicates with the microphone **38** and the other end **56** of the conduit extends beyond the hinge end of the earpiece. An aperture **58** is provided in the lens carrying frame **10**. Prior to hinging the earpiece **14** to the frame, the end **56** of the conduit **52** is cut to a length such that the open end of the conduit is positioned closely adjacent the back face of the frame and in axial alignment with the aperture **58** to provide a substantially continuous sound conducting passage as shown in FIG. **1** when the earpiece is moved to its operative position about the hinge. Preferably the conduit and earpiece are of such integral one piece design that the overall shape and appearance of the earpiece does not differ substantially from that of the conventional earpiece **15**.

In operation, sounds emanating from the sound source enter the aperture **58** of the lens frame **10** and are conducted down the elongated conduit **52** to the microphone **38**. Since the sound carrying conduit **52** is of substantial length, it may be selectively dimensioned in length and/or width to operate in a manner similar to an organ pipe such that the frequency response of the acoustic load presented to the microphone **38** may be substantially increased in a desired frequency range, for example that of a human voice.

Preferably, the sound receiving aperture **58** in the front face of the lens carrying frame **10** is positioned such that the sound enters at a point which lies in a plane which is substantially tangent to the forehead of the hearing aid user and faces the direction in which the user faces. When the sound receiving aperture **58** is so positioned, the hearing aid becomes directionally responsive such that sounds emanating from behind the user tend to be attenuated, thus improving the sound discrimination of the hearing aid. Referring to FIG. **6**, a sound source **60** positioned behind the user is shown. The primary sound waves **61**, **62** and **63** emanating from the sound source **60** travel away from the source. Wave **61** substantially completely passes the forward facing aperture **58** without a component thereof entering as it would in a side facing microphone. Wave **62** strikes the forehead **64** of the user, glancing off the forehead in a direction ahead of the user as indicated at **66** also by-passing the aperture **58**. Sound wave **63** is reflected back toward the user from various objects **67** in the vicinity of the user as indicated at **68**. The forehead reflected wave **66** tends to cancel the wave **68** which is reflected back toward the user, acting to further reduce interference caused by the undesirable sound sources located behind the user.

Sounds emanating from a sound source opposite the aided ear are enhanced by the forward facing sound receiving aperture **58**. Referring to FIG. **7**, sound waves **70** emanating from such side located sound source **60** tend to strike the forehead **64** of the user and glance off as indicated at **71**. Since the sound receiving aperture **58** is located substantially in a plane tangent to the user's forehead, the glancing sound waves **71** tend to impinge upon the sound receiving aperture **58** with substantially the same pressure that they impinged upon the forehead **64** of the user. Thus, side shadow effect is substantially reduced by the aforementioned hearing aid construction resulting in increased sound receptivity from the unaided side of the user.

The relative magnitude of rear sound attenuation and side shadow effect reduction of the above described hearing aid are shown in the plots of FIGS. **8** - **10**, the concentric circles representing units of sound intensity. Referring to FIG. **8**, the sound receiving characteristics of a conventional single side facing microphone are shown. In the plot, the hearing aid user is facing in a direction of 0° as indicated by the arrow. It will be observed that the sound emanating from a direction directly behind the head of the user, i.e. 180°, is received with equal facility as the sounds emanating from directly ahead of the hearing aid user, i.e. 0°. Such equal reception tends to interfere with and impair the reception of the desired ahead sounds and reduces the capabilities of hearing aid. Moreover, sounds emanating from a direction opposite the side of the aided ear, i.e. 270°, are proportionately difficult to pick up by the microphone in relation to the sounds emanating from 90° due to the substantial reduction in sound intensity caused by the shadow effect produced by the user's head.

Referring to FIG. **9**, a plot of the sound receiving characteristics is shown wherein a second side facing microphone is provided on the side of the head opposite the aided ear and is coupled to the amplifier for the purpose of reducing head shadow effect. Again, the hearing aid user is facing in a direction of 0° as indicated by the arrow. It will be seen from the plot that such arrangement does operate to reduce head shadow effect. However, as in the single side facing arrangement, sounds emanating from a source directly behind the user, i.e. 180°, are received with equal facility as the sounds emanating directly ahead of the user, i.e. 0°, and thus the double microphone arrangement is ineffective to reduce interference caused by rear originating sounds.

Referring to FIG. **10**, the sound receiving characteristics of the hearing aid incorporating the principles of my invention are shown. It is readily apparent that interferring sounds emanating from behind the user are substantially reduced in relation to the single or double side facing microphone arrangements. Thus sounds emanating from directly ahead of the user, i.e. 0°, are more easily discriminated from rear originating sounds. Moreover, the side shadow effect relative to sounds emanating from the aided side is proportionately substantially reduced. Such reduction is achieved without necessitating the use of an additional second microphone or complex electrical coupling circuitry.

It should be noted that since the sound receiving aperture **58** is located in the end of the lens carrying frame **10**, it is spaced a substantial distance from the head of the user. Also the microphone **38** itself is spaced a substantial distance from

the sound receiving aperture **58** and is connected to the latter by the conduit **52** which is of a relatively small diameter. Such construction results in a substantial reduction of the possibility of perspiration entry into the microphone.

It should be understood that the embodiment of the invention which has been described is merely illustrative of one of the applications of the principles of the invention. Numerous modifications may be made by those skilled in the art without departing from the true spirit and scope of the invention.

What is claimed is:

1. A spectacle mounted hearing aid construction comprising the combination of

a lens carrying frame adapted to be worn on the front face of the user, said lens carrying frame being independent of any electrical components of the hearing aid,

an elongated temple earpiece member attached to each side of the lens carrying frame for supporting the frame on the head of the user,

at least one of said temple earpiece members carrying a complete hearing aid circuit including a microphone, a receiver, an amplifier and an electrical power source,

said microphone being positioned within said earpiece member adjacent an ear of the user in spaced relationship with said frame,

at least one of said temple earpiece members carrying a complete hearing aid circuit including a microphone, a receiver, an amplifier and an electrical power source,

said microphone being positioned within said earpiece member adjacent an ear of the user in spaced relationship with said frame,

a hollow elongated sound conduit carried by and extending longitudinally over a substantial portion of the length of said earpiece member, one end of said conduit communicating with the input to said microphone and the other end of said conduit terminating in an aperture at the front end of said temple earpiece member opening in a direction forward of and in substantially the same direction that the head of the user is facing,

said lens carrying frame having an aperture in axial alignment with the aperture at the front end of said temple earpiece member to provide a substantially continuous sound conducting passage through said frame and earpiece member to the microphone when said spectacle mounted hearing aid is in operative position on the user's head.

2. A spectacle mounted hearing aid construction in accordance with claim **1** wherein the dimensions of the earpiece member sound conduit are preselected for optimizing the frequency response of the hearing aid in a predetermined range of frequencies.

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