July 5, 1938. H. LIEBER 2,122,429

HEARING AID

Filed Aug. 25, 1934 2 Sheets-Sheet 1

Fig. 1.

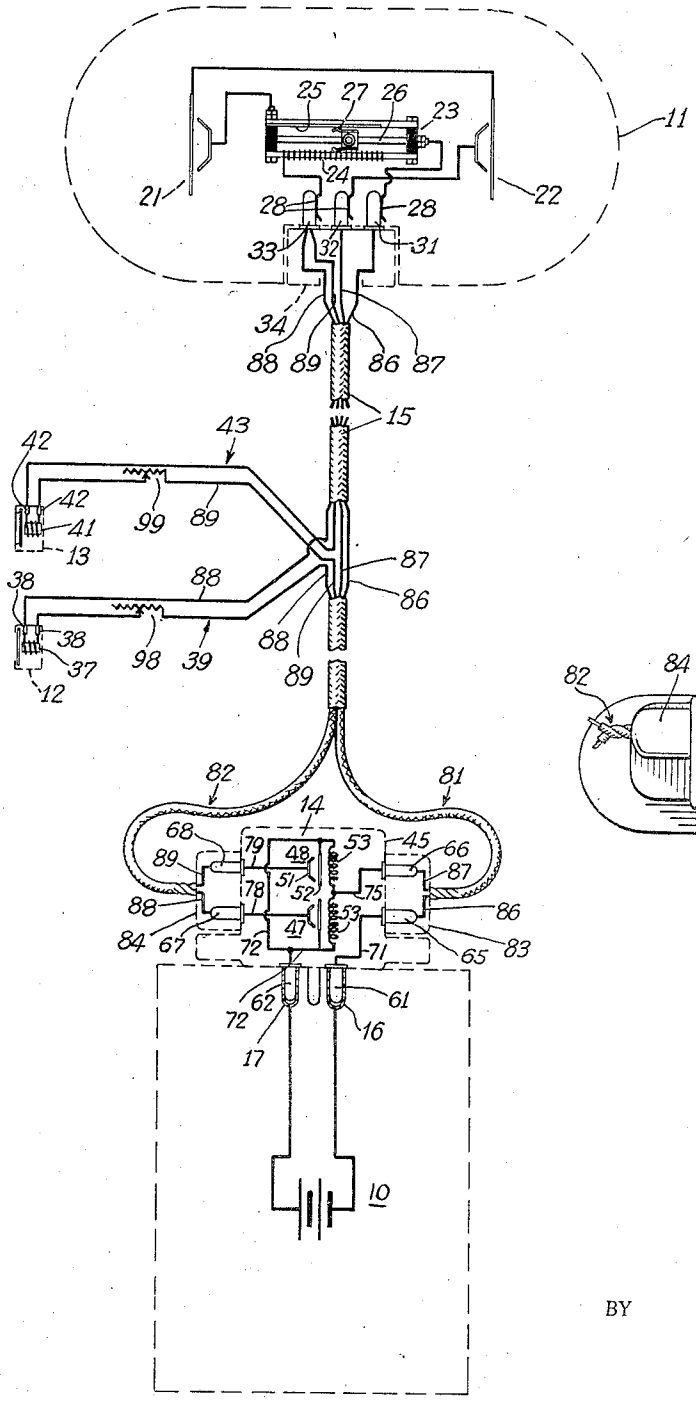
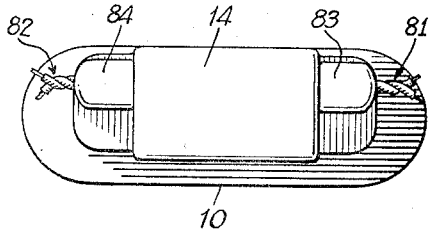


Fig. 2.



INVENTOR.
HUGO LIEBER

BY S M Prieles

ATTORNEY.

July 5, 1938. H. LIEBER 2,122,429

HEARING AID

Filed Aug. 25, 1934 2 Sheets-Sheet 2

Fig. 3.

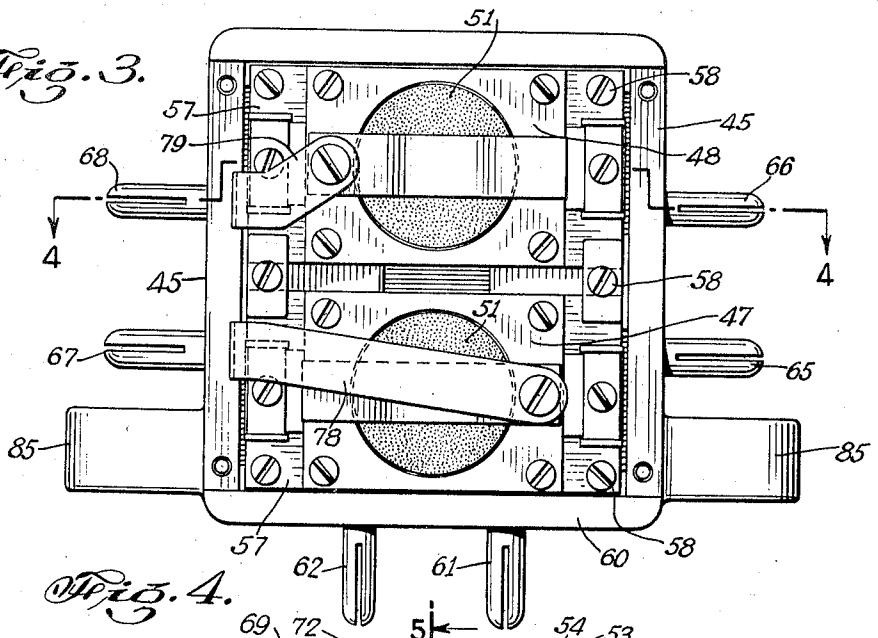


Fig. 4.

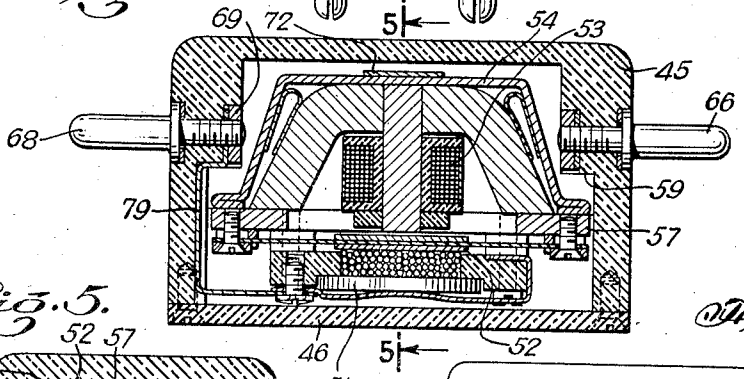


Fig. 5.

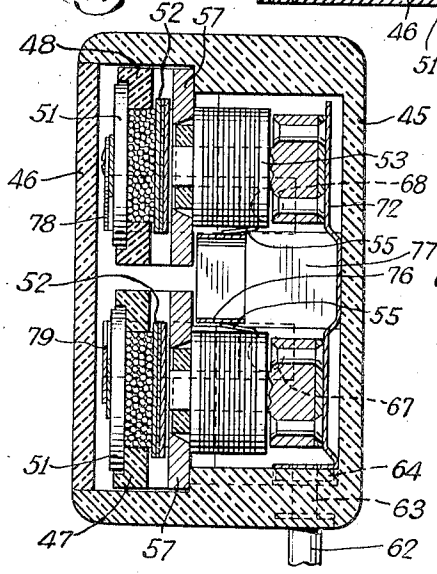
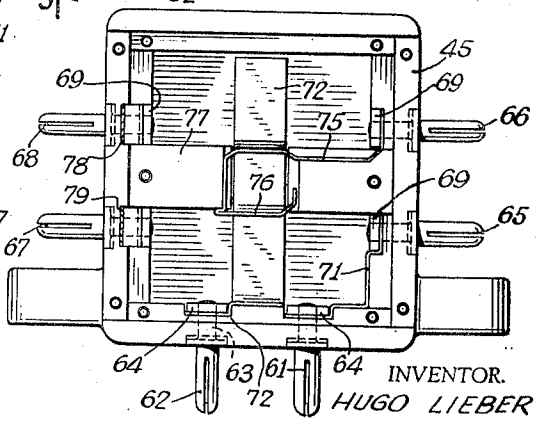


Fig. 6.



INVENTOR.
HUGO LIEBER

BY

S. M. Frieler

ATTORNEY.

Patented July 5, 1938 2,122,429

UNITED STATES PATENT OFFICE

2,122,429

HEARING AID

Hugo Lieber, New York, N. Y., assignor to Lieber Patents Corporation, New York, N. Y., a corporation of New York

Application August 25, 1934, Serial No. 741,487

8 Claims. (Cl. 179—107)

This invention relates to hearing-aids, and it has among its objects an improved wearable hearing-aid device for maintaining the natural hearing ability of air conducted sound of a hard-of-hearing or deafened person while supplying him at the same time with additional hearing sensations by bone conduction in an amount sufficient to enable him to hear speech and music like a normal person without being subjected to strains.

The invention aims also to provide a wearable hearing-aid device having two hearing-inducing receivers for transmitting hearing-inducing sound vibrations to the hearing center of the user through different paths, the two receivers and their operating circuits being so constructed and correlated as to supply simultaneously with optimum sound reception over one path optimum sound reception over the other path.

The foregoing and other objects of the invention will be best understood from the following description of exemplifications thereof, reference being had to the accompanying drawings wherein

Fig. 1 is a view, partially elevational, and partially diagrammatic, illustrating the arrangement of the elements and the circuit diagrams of a hearing-aid embodying my invention;

Fig. 2 is a top view of the amplifier unit and battery of Fig. 1;

Fig. 3 is an enlarged elevational view of an amplifier unit with the front cover removed;

Fig. 4 is a sectional view of the amplifier unit along line 4—4 of Fig. 3;

Fig. 5 is a sectional view of the amplifier unit along line 5—5 of Fig. 4; and

Fig. 6 is an elevational view of the interior of the amplifier casing.

Most of the people with defective hearing consist of persons that during the first part of their lives heard normally and at a later time, after having acquired the characteristics of normal persons, have through sickness or other causes lost their hearing to a lesser or greater degree. After having adjusted their lives as normal persons, they find themselves handicapped by the infirmity and subject to maladjustment.

Hearing-aids giving the deafened persons the ability to hear well and at the same time suitable for concealed inconspicuous wear are of great importance in restoring to them their normal character. For many years past only air-conduction hearing-aids that could be worn concealed have been available for the deafened. Most of the deafened can be only partially aided by air-conduction instruments.

This difficulty has been solved by the invention of inconspicuous bone-conduction hearing-aid receivers. Since the hearing nerves of most deafened persons are intact, sound vibrations imparted by small inconspicuous mechanical bone conduction receivers are able to produce in most of the deafened persons hearing sensations of an effectiveness equivalent to normal hearing, thus entirely overcoming their handicap.

My invention provides a wearable hearing-aid suitable for concealed inconspicuous wear by a deafened person and constructed to maintain in action his remaining normal hearing ability and to simultaneously supply by bone conduction additional hearing sensations to his hearing center enabling him to hear like a normal person.

A hearing-aid device of the foregoing type for inducing a satisfactory amount of hearing sensations in the auditory center of a person and at the same time maintain in action his residual hearing ability is shown in Fig. 1 of the drawings. It comprises a battery unit 10, a transmitter 11, an air conduction receiver 12, a bone conduction receiver 13, an amplifier unit 14, and an interconnecting cord 15. The battery 10 may be in the form of a flat dry cell, or a similar source of supply generally used in portable hearing-aids. On the top of the battery unit are two terminal sleeves 16, 17 of opposite polarity, sleeve 16, for instance, being positive and sleeve 17 negative.

The transmitter unit 11 comprises two microphones 21, 22 comprising carbon diaphragms and carbon buttons holding a plurality of carbon granules to vary the resistance therebetween in accordance with sound vibrations acting on the diaphragm. Mounted within the transmitter unit is a control unit 23 comprising a resistor 24, a stationary contact member 25, a contact rod 26 and a movable contact member 27 slidably mounted on the contact rod, and movable between a position where the movable contact member makes a conducting connection between the resistor 24, contact member 25 and contact rod 26, cutting out the resistor as it is moved in one way, and interrupting the connection between the several elements as it is moved the opposite way. Three plug contacts 28 connected to the resistor 24, the carbon button of one microphone, and the rod 26 are engaged by three plug pins 31, 32, 33 of a plug 34 provided at one end of cord 15. The two microphones 21 and 22 are connected in series between the stationary contact member 25 and the plug terminal 28 engaging the plug pin 32.

The air conduction receiver may be in the

form of a small telephone receiver as disclosed, for instance, in Patent No. 1,913,318, and has an actuating winding 37 which is connected to plug pins 38 at the end of a cord branch 39. The bone conduction receiver 13 is likewise of small size suitable for inconspicuous wear, for instance, as shown in Patent No. 1,940,553, and has an actuating winding 41 which is connected to plug pin terminals 42 at the end of a cord branch 43.

The amplifier unit 14 is shown in detail in Figs. 2 to 6. It comprises a flat, substantially rectangular housing 45 of insulating material, for instance, a phenolic condensation product, and is small in size to fit the space above the battery and permit its concealed wear in conjunction with the battery unit. Back of the removable front wall 46 of the housing are mounted two small microphone amplifier units 47 and 48, which are preferably of the type shown in Reissue Patent No. 19,246.

The two microphone units have each a carbon granule chamber having a carbon electrode 51, a carbon diaphragm electrode 52 movably held opposite the open side of said chamber for varying the resistance path of the carbon granules, and an electromagnetic vibrator having an actuating winding 53 for passing sound-frequency current oscillations supplied thereto by the transmitter 11. The elements of each microphone amplifier 47 and 48 may be assembled into self-contained units as shown in Figs. 5 and 6 and in Reissue Patent No. 19,246. The actuating winding 53 has one end connected to the metallic clamping member 54 thereof, the other end of the winding having on its outer surface a resilient contact strip 55 as shown in Fig. 5. Each amplifier microphone unit has a supporting member 57 by means of which it is attached within the housing by screws 58 threadedly engaging ledges 59 extending from the lateral walls of the housing.

In the bottom wall 60 of the housing are mounted two downwardly extending current supply pins 61, 62 arranged to fit into the sleeves 16, 17 of the battery and establish an electrical as well as a mechanical engagement between the housing 45 and the battery unit. The supply terminal pins 61 and 62 have inward extensions 63 threaded at their ends and held firmly in place by means of nuts 64. Two pairs of similar plug pins 65, 66, 67, 68 are similarly mounted on the opposite side of the housing and held firmly thereon by inward extensions clamped by nuts 69 threaded thereon. The supply pin 61 has secured underneath its holding nut 64 a contact strip 71 of conducting material which runs along the inner wall of the housing and has its end clamped underneath the nut of the contact pin 65 establishing an electrical connection therewith. In a similar way a contact strip 72 of resilient material, such as phosphor bronze, is mounted on the interior side of the rear wall of the housing and has on its lower end a lateral extension which is held clamped underneath the nut 64 of the second supply pin 62.

An additional contact strip 75 of resilient material, having one end held clamped underneath the nut 69 of contact pin 66, has its other end formed into a bent-over rectangularly-shaped contact portion 76 held spaced between two inward housing wall extensions 77 and arranged to make contact with the contact strips 55 provided on the amplifier winding 53 as shown in Fig. 5.

Upon insertion of the two assembled microphone units 47 and 48 into place within the housing as shown in Fig. 3, each unit has its terminals connected as follows: The holding strip 54 of the unit engages the contact strip 72 leading to supply pin terminal 62 and thereby establishes a conducting connection between the carbon diaphragm 52 of the microphone, and of one end of the coil winding 53 with the supply terminal 62; and the flexible contact strips 78, 79, having clamped ends held under the nuts 69 of the contact pins 67, 68, establish conducting connections between these pins and the microphone chamber 51 and thereby establishing conducting connections between the carbon electrodes 51. The housing is then closed and the interior sealed by mounting the cover 46 in place.

The cord 15 has at its lower end two branches 81, 82 terminating in sockets 83, 84, making resilient detachable connections with the terminals 65 to 68 on the opposite sides of the housing, and establishing by its cord leads 86 and 87 of cord branch 81 connections between amplifier housing terminals 65, 66 and transmitter plug pin terminals 31, 32, respectively, and by its cord leads 87 and 88 of cord branch 82 and cord branches 39, 45 connections between amplifier housing terminals 67, 68 and transmitter plug pin terminals 33, the cord leads 67 and 68, including in series the two receiver windings 37, 41, and the rheostats 98, 99. The housing is also provided with blocks 85 underlying the plug sockets 83, 84 to protect them against external strains and permit easy removal of the amplifier unit.

By connecting the several elements of the hearing-aid in the way shown in Fig. 1, a primary and a secondary amplifier circuit is established for each receiver, parts of the circuits including the microphone transmitter 11 with the control unit 23 and the battery being common to the circuits of both receivers.

The primary circuit for both receivers extends from the positive supply pin terminal 61 of the amplifier engaging positive battery terminal 16, through connector 71, amplifier terminal 65, cord lead 86, transmitter terminal 31 in series through the rheostat contact members 26, 27, 25, through the series connected transmitter microphones 21, 22, transmitter terminal 32, cord lead 87, amplifier terminal 66, connector 75, and therefrom along parallel paths through the windings 53 of the two amplifiers and connector 72 to the negative supply pin terminal 62 engaging the negative terminal 17 of the battery.

The secondary circuit for both receivers extends from the positive amplifier supply terminal 16 over the common circuit portion, through connector 71, amplifier terminal 65, cord lead 86, transmitter plug terminal 31, rheostat rod 26, rheostat contact 27, resistor 24, to transmitter plug terminal 33, and therefrom in parallel circuits by way of cord leads 88, 89 through the receiver windings 37, 41, receiver rheostats 98, 99, over cord branch 82, through amplifier terminals 67, 68, connectors 78, 79, the two amplifier microphone chambers, and the common connector 72 to the negative amplifier supply terminal 62.

The two cord branches 39, 43 leading to receivers 12 and 13 are of sufficient length to permit application of the air conduction receiver 12 to the ear on one side of the head of the listener, and of the bone receiver 13 to the mastoid bone back of the ear on the other side of the head of the listener, both receivers being small and inconspicuous and supplied by common battery transmitter and amplifier units which are suitable for concealed wear by the user.

The sound intensity of each receiver circuit

may be independently increased or decreased by adjusting the two independently adjustable receiver rheostats 98, 99 connected in each of the two receiver leads. Once the relation of the sound intensities of the two receivers has been adjusted, the common rheostat 24 may be used to simultaneously increase or decrease the sound intensity of the two receivers while maintaining substantially the same relation between their sound intensities.

There are many deafened persons that hear like normal persons by bone conduction who desire to maintain a small remnant of normal hearing ability in use, although this remnant is insufficient to supply them with satisfactory hearing even when using air-conduction telephone aids. The hearing-aid described above enables such deafened persons to make full use of his remnant hearing ability and at the same time supplies him with enough bone conduction hearing sensations to make him hear like a normal person. By means of this hearing-aid, a person of impaired hearing, whose normal hearing ability cannot be fully restored by an air conduction instrument, can adjust the intensity of the sound that he is desirous to hear to the maximum value that is useful in helping him to hear. He may make this adjustment while the circuit through the bone-conduction receiver includes substantially the full amount of its resistance so as to restrict the hearing sensation to the action of the air-condition receiver. After having adjusted the rheostat of the air-conduction receiver to the maximum value helpful in hearing, but insufficient for satisfactory hearing, he then adjusts the rheostat in the receiver circuit to a point at which he receives additional sound sensations by bone conduction in an amount sufficient to make him hear like a normal person.

The instrument may be adjusted while the user listens to persons close to him and a relatively small sound intensity is sufficient for understanding their speech. The common rheostat which controls the intensity in both circuits may be held in a position at which the ratio of hearing effects produced by the two receivers is made sufficient to hear a nearby person under the full utilization of the natural hearing ability of the user. He can then readily use the instrument to hear persons that are far away, or to use the instrument in a theatre where he needs a greater volume of sound for satisfactory hearing, by cutting out a part or all of the resistance in the common circuit, the ratio of the two currents in the branches of the two receivers being maintained substantially the same at the higher intensities and thereby enabling full utilization of his remaining natural hearing ability throughout the entire range of the instrument.

The exemplification of the invention described above will suggest to those skilled in the art many modifications thereof. It is accordingly desired that the appended claims be given a construction commensurate with the scope of the invention within the art.

The features of the invention described above are susceptible to many modifications that will suggest themselves to those skilled in the art.

I claim:

1. In a wearable hearing-aid device, a microphone transmitter, a first hearing-inducing receiver for inducing hearing through one sound conducting path of the user, a second hearing-inducing receiver for inducing hearing through another sound conducting path of the user having different characteristics than said first sound conducting path, each of said receivers having an actuating winding and a lead including said winding, a battery having two terminals of opposite polarity, a wearable amplifying unit having two supply terminals detachably engaging said battery terminals, said leads and said transmitter being connected to said amplifying unit for simultaneously supplying sound-frequency currents induced by said transmitter to receiver windings of said two receivers, said receivers and the elements included in the circuits of said leads being constructed and correlated to operate with characteristics required in order to impart to the deafened simultaneously with optimum sound reception with said first receiver a correlated optimum sound reception with said second receiver, and means for adjusting the total sound reception imparted to the auditory center of the deafened.

2. In a portable hearing-aid device for a deafened, a microphone transmitter, an air-conduction receiver having an actuating winding and a lead including said winding, a bone-conduction receiver having an actuating winding and a lead including said winding, a battery having two terminals of opposite polarity, a portable amplifying unit having two supply terminals detachably engaging said battery terminals, said leads and said transmitter being connected to said amplifying unit for simultaneously supplying sound-frequency currents induced by said transmitter to said receiver windings, said receivers and the elements connected in the circuits of said leads being constructed and correlated to operate with characteristics required for correlating the outputs of said receivers within the range of audible sounds to impart to the deafened simultaneously with optimum sound reception with said air-conduction receiver a correlated optimum sound reception with said bone-conduction receiver.

3. In a portable hearing-aid device for a deafened, a microphone transmitter, an air-conduction receiver having an actuating winding and a lead including said winding, a bone-conduction receiver having an actuating winding and a lead including said winding, a battery having two terminals of opposite polarity, a portable amplifying unit having two supply terminals detachably engaging said battery terminals, said leads and said transmitter being connected to said amplifying unit for simultaneously supplying sound-frequency currents induced by said transmitter to said receiver windings, means in the circuits of said leads for correlating the outputs of said receivers within the range of audible sounds to impart to the deafened simultaneously with optimum sound reception with said air-conduction receiver a correlated optimum sound reception with said bone-conduction receiver, and means for independently adjusting the total sound reception imparted to the auditory nerve center of the deafened while maintaining a predetermined optimum correlation between the sound receptions imparted by the individual receivers.

4. In a portable hearing-aid device for a deafened, a microphone transmitter, an air-conduction receiver having an actuating winding and a lead including said winding, a bone-conduction receiver having an actuating winding and a lead including said winding, a battery having two terminals of opposite polarity, a portable amplifying unit having two supply terminals detachably engaging said battery terminals, one

of said receiver leads and said transmitter being connected to said amplifier unit for supplying amplified sound-frequency currents induced by said transmitter to the associated receiver, the other of said receiver leads being connected parallel to the input circuit of said amplifier, and means in the circuits of said leads for correlating the outputs of said receivers within the range of audible sounds to impart to the deafened simultaneously with optimum sound reception with said air-conduction receiver a correlated optimum sound reception with said bone-conduction receiver.

5. In a portable hearing-aid device for deafened, a microphone transmitter, an air-conduction receiver having an actuating winding and a lead including said winding, a bone-conduction receiver having an actuating winding, and a lead including said winding, a battery having two terminals of opposite polarity, a portable amplifying unit having two supply terminals detachably engaging said battery terminals, one of said receiver leads and said transmitter being connected to said amplifier unit for supplying amplified sound-frequency currents induced by said transmitter to the associated receiver, the other of said receiver leads being connected parallel to the input circuit of said amplifier, means in the circuits of said leads for correlating the outputs of said receivers within the range of audible sounds to impart to the deafened simultaneously with optimum sound reception with said air-conduction receiver a correlated optimum sound reception with said bone-conduction receiver, and means for independently adjusting the total sound reception imparted to the auditory nerve center of the deafened while maintaining a predetermined optimum correlation between the sound receptions imparted by the individual receivers.

6. In a portable hearing-aid device for a deafened, a microphone transmitter, an air-conduction receiver having an actuating winding and a lead including said winding, a bone-conduction receiver having an actuating winding and a lead including said winding, a battery having two terminals of opposite polarity, and a portable amplifying unit having two supply terminals detachably engaging said battery terminals, said bone-conduction receiver lead and said transmitter being connected to said amplifier unit for supplying amplified sound-frequency currents induced by said transmitter to the associated receiver, said air-conduction receiver lead being connected parallel to the input circuit of said amplifier.

7. In a portable hearing-aid device for a deafened, a microphone transmitter, an air-conduction receiver having an actuating winding and a lead including said winding, a bone-conduction receiver having an actuating winding and a lead including said winding, a battery having two terminals of opposite polarity, a portable amplifying unit having two supply terminals detachably engaging said battery terminals, said bone-conduction receiver lead and said transmitter being connected to said amplifier unit for supplying amplified sound-frequency currents induced by said transmitter to the associated receiver, said air-conduction receiver lead being connected parallel to the input circuit of said amplifier, and means in the circuits of said leads for correlating the outputs of said receivers within the range of audible sounds to impart to the deafened simultaneously with optimum sound reception with said air-conduction receiver a correlated optimum sound reception with said bone-conduction receiver.

8. In a portable hearing-aid device for a deafened, a microphone transmitter, an air conduction receiver having an actuating winding and a lead including said winding, a bone-conduction receiver having an actuating winding and a lead including said winding, a battery having two terminals of opposite polarity, a portable amplifying unit having two supply terminals detachably engaging said battery terminals, said bone-conduction receiver lead and said transmitter being connected to said amplifier unit for supplying amplified sound-frequency currents induced by said transmitter to the associated receiver, said air-conduction receiver lead being connected parallel to the input circuit of said amplifier, means in the circuits of said leads for correlating the outputs of said receivers within the range of audible sounds to impart to the deafened simultaneously with optimum sound reception with said air-conduction receiver a correlated optimum sound reception with said bone-conduction receiver, and means for independently adjusting the total sound reception imparted to the auditory nerve center of the deafened while maintaining a predetermined optimum correlation between the sound receptions imparted by the individual receivers.

HUGO LIEBER.