March 30, 1954 P. REICHERT 2,673,898

WEARABLE HEARING AID HAVING EXTERNAL MICROPHONE WITH PENETRATING PIN CONNECTOR STRUCTURE

Filed June 1, 1951 6 Sheets-Sheet 1

FIG. 1-B.

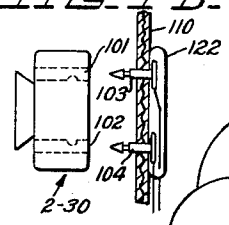


FIG. 1-A.

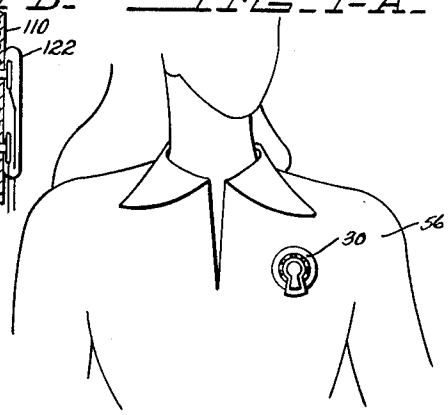


FIG. 1.

INVENTOR.
PHILIP REICHERT

BY

ATTORNEY

March 30, 1954 P. REICHERT 2,673,898

WEARABLE HEARING AID HAVING EXTERNAL MICROPHONE WITH PENETRATING PIN CONNECTOR STRUCTURE

Filed June 1, 1951 6 Sheets-Sheet 2

FIG. 4.

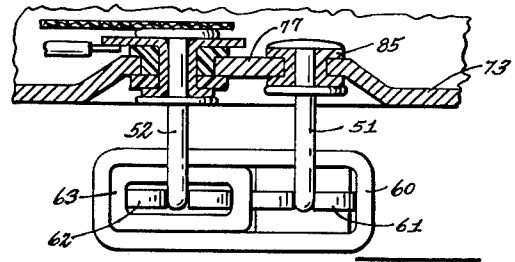


FIG. 2.

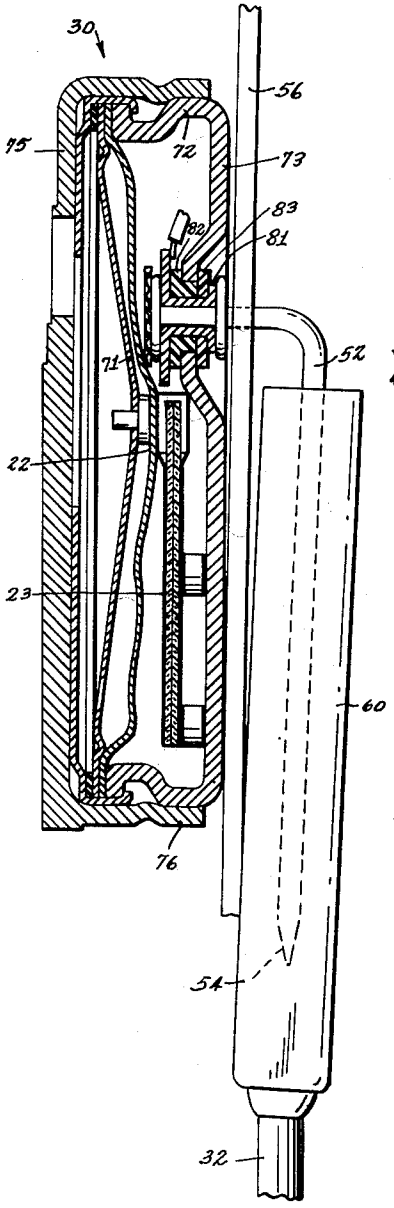
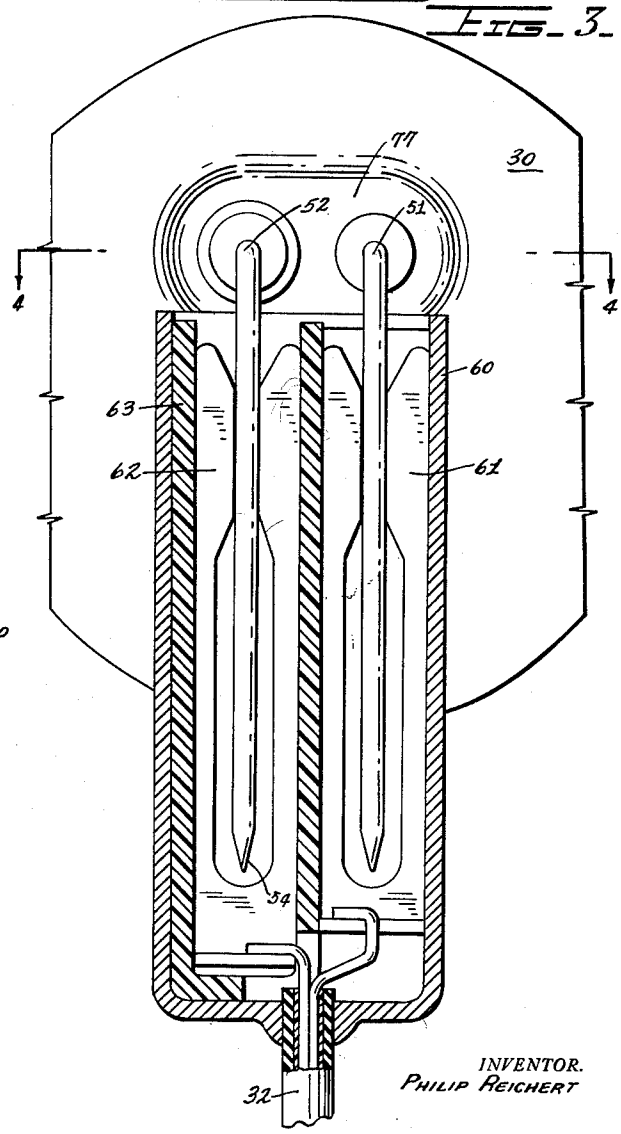


FIG. 3.



INVENTOR.
PHILIP REICHERT

BY

ATTORNEY

March 30, 1954 P. REICHERT 2,673,898

WEARABLE HEARING AID HAVING EXTERNAL MICROPHONE WITH PENETRATING PIN CONNECTOR STRUCTURE

Filed June 1, 1951 6 Sheets-Sheet 3

FIG. 5.

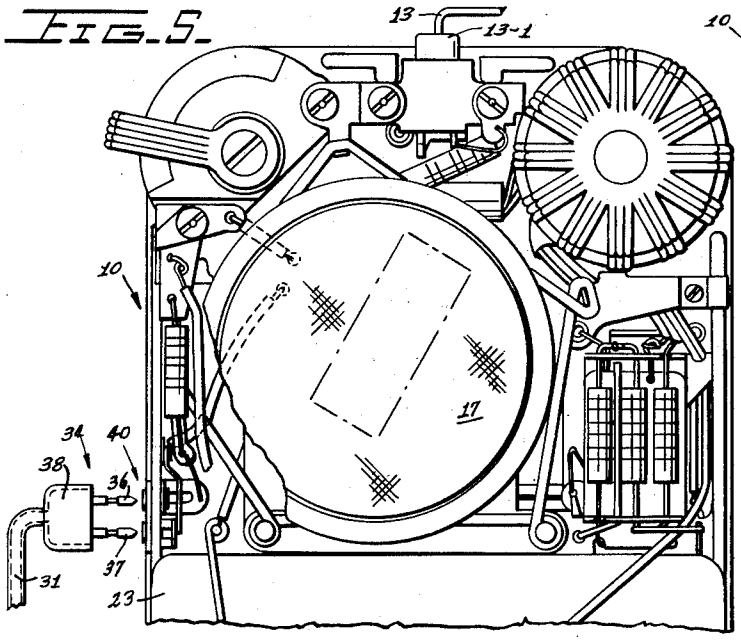


FIG. 6.

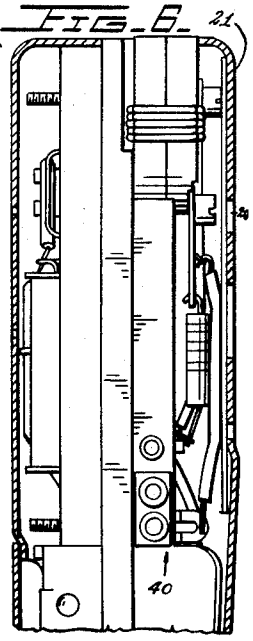


FIG. 2-A.

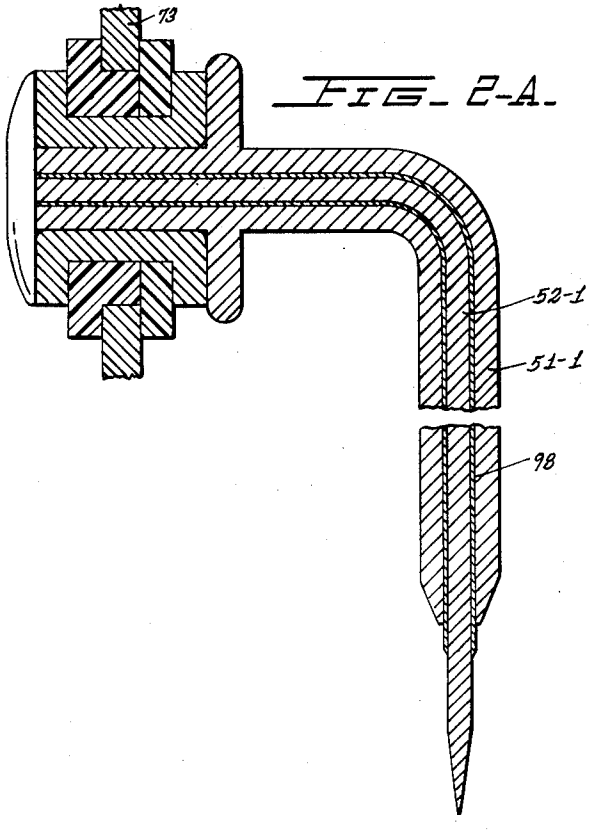
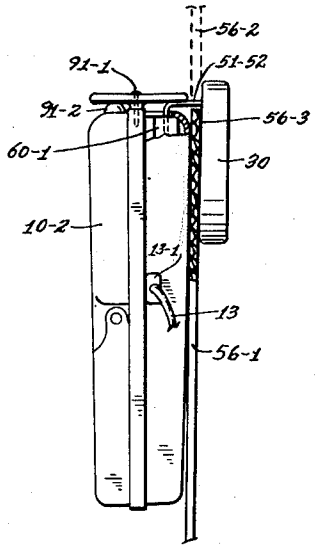


FIG. 6-A.



INVENTOR.
PHILIP REICHERT

BY

ATTORNEY

March 30, 1954 P. REICHERT 2,673,898

WEARABLE HEARING AID HAVING EXTERNAL MICROPHONE WITH PENETRATING PIN CONNECTOR STRUCTURE

Filed June 1, 1951 6 Sheets-Sheet 4

FIG. 7.

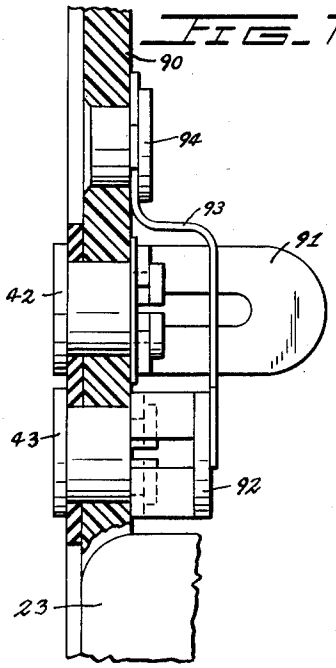


FIG. 8.

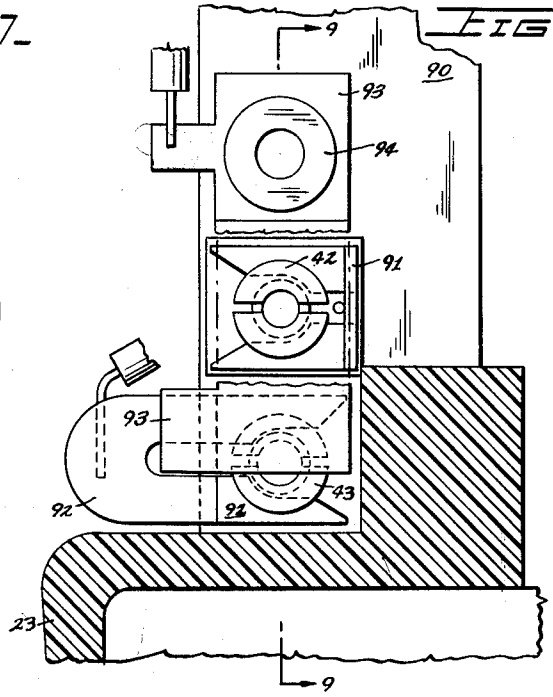


FIG. 9.

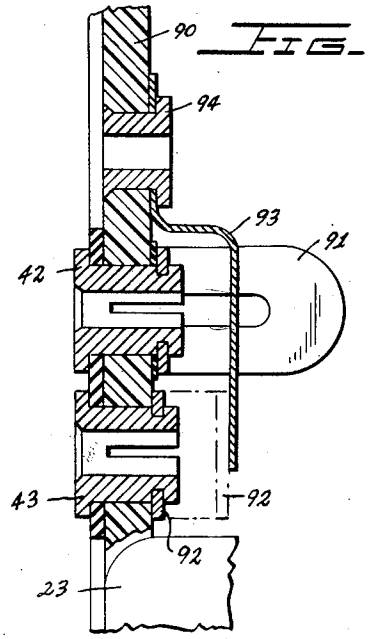
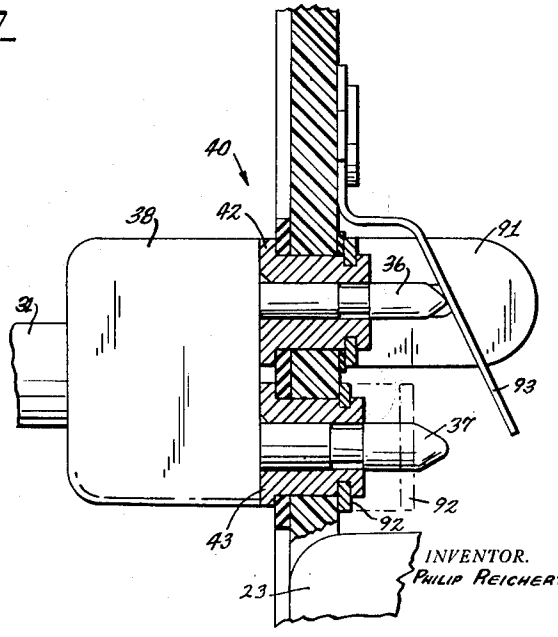


FIG. 10.



INVENTOR.
PHILIP REICHERT

BY

ATTORNEY

March 30, 1954 P. REICHERT 2,673,898

WEARABLE HEARING AID HAVING EXTERNAL MICROPHONE WITH PENETRATING PIN CONNECTOR STRUCTURE

Filed June 1, 1951 6 Sheets-Sheet 5

FIG. 11.

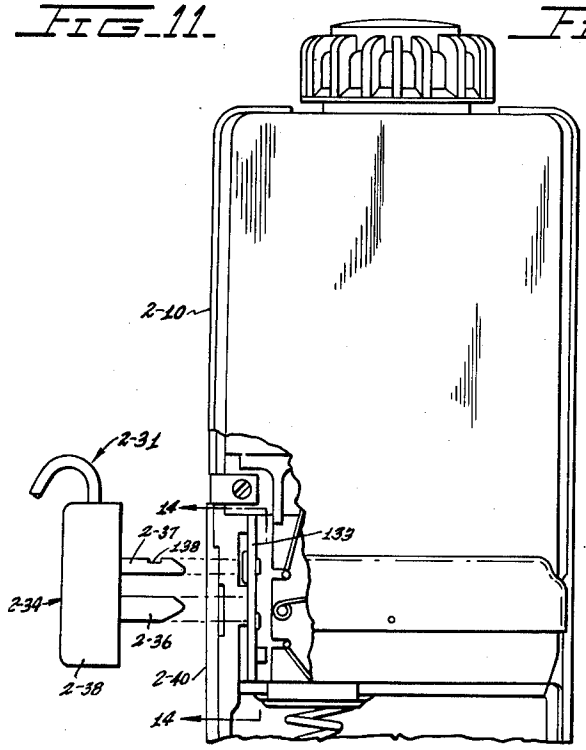


FIG. 12.

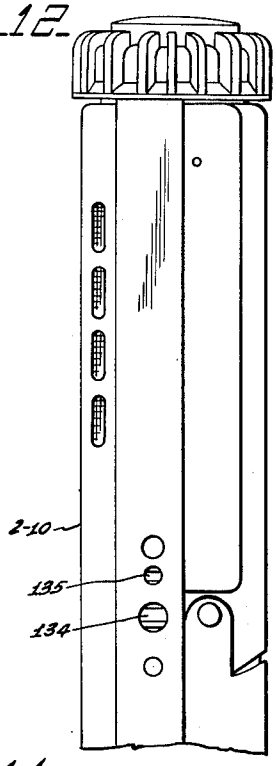


FIG. 13.

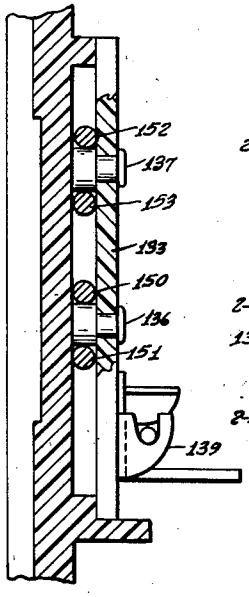
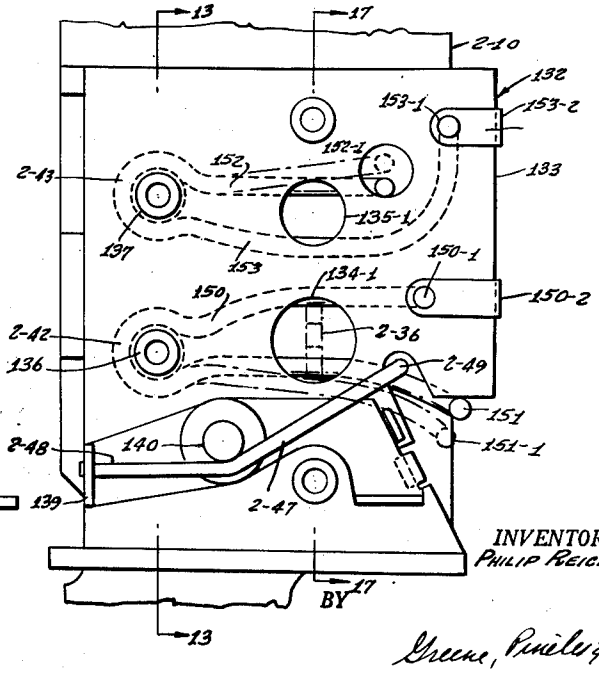


FIG. 14.



INVENTOR.
PHILIP REICHERT

BY

Greene, Peoples & Dunn

ATTORNEYS

March 30, 1954 P. REICHERT 2,673,898

WEARABLE HEARING AID HAVING EXTERNAL MICROPHONE WITH PENETRATING PIN CONNECTOR STRUCTURE

Filed June 1, 1951 6 Sheets-Sheet 6

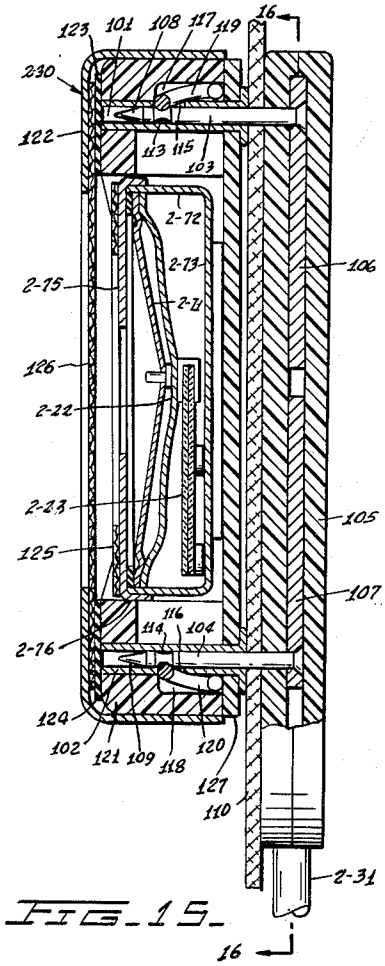


FIG_15_

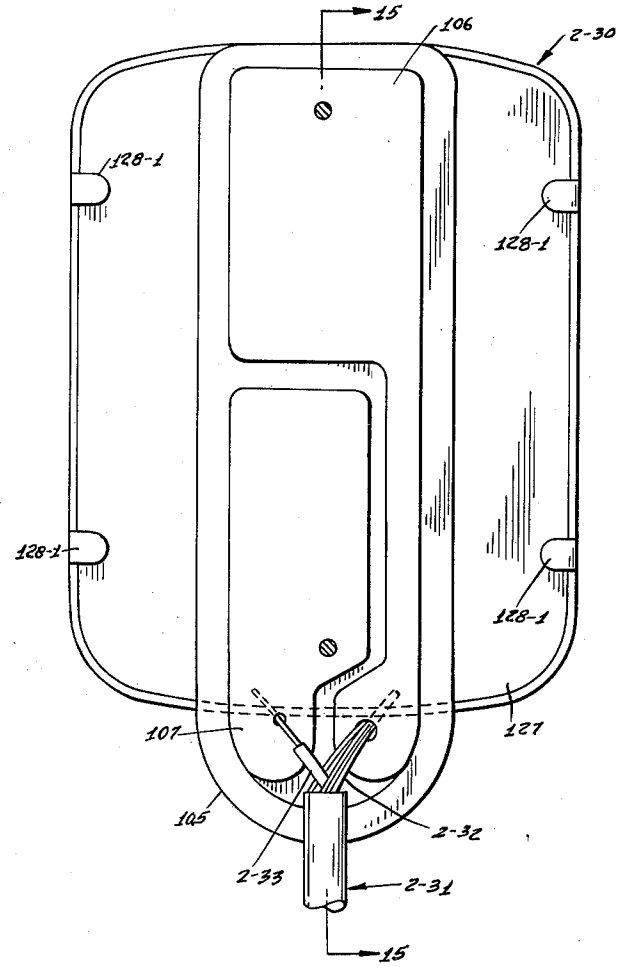


FIG_16_

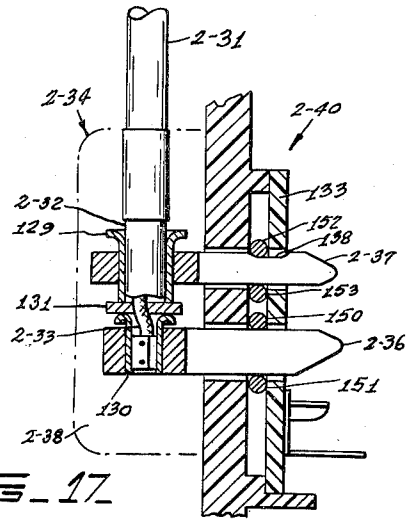


FIG_17_

INVENTOR.
PHILIP REICHERT

BY

Greene, Pieles & Durr
ATTORNEYS

Patented Mar. 30, 1954

2,673,898

UNITED STATES PATENT OFFICE

2,673,898

WEARABLE HEARING AID HAVING EXTERNAL MICROPHONE WITH PENETRATING PIN CONNECTOR STRUCTURE

Philip Reichert, New York, N. Y., assignor to Sonotone Corporation, Elmsford, N. Y., a corporation of New York

Application June 1, 1951, Serial No. 229,386

7 Claims. (Cl. 179—107)

1

This invention relates to microphone arrangements for wearable hearing aids, and more particularly to microphone arrangements for electron tube amplifier hearing aids, all the principal elements of which except for the receiver are usually housed in a flat, small casing worn inconspicuously behind or within the interior part of the garment of a user, although some aspects of the invention are of a broader scope.

This application is a continuation-in-part of application Serial No. 140,692 filed January 26, 1950.

Among the objects of the invention, a hearing aid of the foregoing type having an inconspicuous microphone unit arranged to be worn exposed on the exterior of the user's garment so that it is not affected by clothes-rubbing noises, an electrical circuit connection including a connector pin structure having a garment-penetrating sharply pointed end which may be readily pushed through the garment, serving to connect the externally worn microphone unit to the amplifier worn hidden behind the garment of the user.

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 diagrammatic view of the general arrangement of one form of a wearable hearing aid combined with a microphone arrangement in accordance with the principles of the invention;

Fig. 1–A shows a hard-of-hearing individual wearing the microphone unit of the invention on the exterior of the garment, the hearing aid amplifier hidden under the garment and connected to the microphone by a sharply-pointed garment penetrating connector pin structure of the external microphone;

Fig. 1–B is a diagrammatic view of a variation of the microphone arrangement shown in Fig. 1;

Fig. 2 is a greatly enlarged cross-sectional view of one form of a microphone unit of the invention;

Fig. 2–A is a view similar to Fig. 2 showing a portion of the rear wall of the external microphone unit with a modified form of penetrating connector pin structure;

Fig. 3 is a greatly enlarged rear view of the microphone unit of Fig. 2 with its connector pin structure projecting therefrom into engagement with the terminals of the operating socket structure being shown in cross-section;

Fig. 4 is a cross-sectional view of the rear part of the microphone unit along lines 4—4 of Fig. 3;

2

Fig. 5 is an enlarged front view of an amplifier unit of the hearing aid having a microphone and amplifier elements housed in a flat casing, a part of the front wall of the amplifier casing being broken away to show portions of the interior structure;

Fig. 6 is a cross-sectional view of the amplifier unit of Fig. 5;

Fig. 6–A shows a modified structure for connecting an external microphone to an amplifier;

Fig. 7 is a cross-sectional view of the socket or jack portion of the amplifier casing cooperating with the cord connector plug;

Fig. 8 is a side view of the socket structure of Fig. 7;

Fig. 9 is a cross-sectional view along lines 9—9 of Fig. 8;

Fig. 10 is a view similar to Fig. 9 with the plug connector in position;

Fig. 11 is a greatly enlarged view similar to Fig. 5 of a plug and the upper half of the rear of a modified form of amplifier casing with a portion cut away to show the socket assembly;

Fig. 12 is a greatly enlarged side view of the upper portion of the amplifier casing of Fig. 11 showing openings for reception of a plug carrying the external microphone output.

Fig. 13 is a cross-sectional view of the socket portion of the amplifier casing, along lines 13—13 of Fig. 14;

Fig. 14 is a detail view of the socket structure of the amplifier casing;

Fig. 15 is a cross-sectional view of the external microphone of the type shown in Fig. 1–B having the microphone plug in contact engagement therewith, taken along lines 15—15 of Fig. 16;

Fig. 16 is a greatly enlarged rear view of the external microphone of Fig. 15; and

Fig. 17 is a cross-sectional view of the socket in the amplifier casing and the amplifier plug in contact engagement shown in Figs. 13, 14.

Most of the hard-of-hearing or deafened persons are very sensitive and seek to conceal their impairment. Accordingly, a practical hearing aid must be light, small and compact enough so that it may be worn comfortably and inconspicuously hidden behind a garment portion on the body of the user. In addition, it must be simple and fool-proof in operation and should require little attention so as to free the user from mental and physical strain and annoyance.

It is a general practice to make the hearing aid microphone an essential part of the amplifier unit, and house it directly behind a sound-pervious wall portion of the front wall of the flat

amplifier casing, but since such amplifier unit is as a rule worn behind a garment portion, frictional engagement of the garment with the front wall of the microphone casing produces rubbing noises which are picked up by the microphone and result in the transmission of highly disturbing amplifier clothes-rubbing-noises to the ear of the user.

Since most practical hearing aids operate with a high impedance microphone such as the piezoelectric microphone, it is essential that the connection of the microphone to the input terminals of the amplifier be shielded against pick-up of disturbing noise signals caused by electrical disturbances in the vicinity of the microphone. This is the reason why practically all hearing aids have the microphone unit housed within the amplifier casing close to the input terminals of the amplifier. Where the user desires to avoid cloth-rubbing noises, a shielded connector cord, usually in the form of a coaxial insulated conductor pair, is required to connect it to the amplifier casing worn behind the garment. Since the connector cord must be led to the amplifier unit over an exterior part of the garment, the exposed part of the connector cord causes annoyance to the user because it makes him conspicuous.

As a result, users of hearing aids generally prefer to suffer the annoyance of clothes-rubbing noises rather than wear on the exterior of the garment a microphone unit connected to the amplifier casing through a cord, part of which is exposed on the exterior of the garment. Therefore the only practical way to overcome this difficulty was to wear the microphone on the wrist of the user and lead the cord through the sleeve of the garment to the amplifier casing.

Efforts have been made to overcome the difficulty of exposing a part of the microphone cord on the exterior of the garment, either by providing each garment with a hole through which the microphone cord would be led from behind the microphone to the amplifier behind the garment, or as an alternative to carry the microphone on the wrist and lead the microphone cord through the sleeve to the amplifier casing. Both these alternatives are generally impractical. When a microphone is worn on the hand of the user it transmits annoying sounds to the amplifier each time the hand moves. It is also a source of annoyance to provide each garment of a user with a special cord hole, particularly since this makes it necessary to wear the microphone on the same place on the exterior of the garment in order to cover up the hole in the garment.

According to the invention, the foregoing difficulties are overcome by connecting the externally worn microphone unit to the amplifier casing worn behind the garment—through detachable electrical connector elements including a sharply-pointed garment-penetrating connector pin structure which completes the microphone connection by engaging with a cooperating socket connector structure.

In one form of the invention, the exteriorly exposed microphone unit is provided on its back with the projecting terminal elements in the form of a sharply-pointed garment-penetrating pin structure, thereby making is possible to utilize the pin structure of the microphone for attaching it to the garment, and at the same time provide by the portion of the pin structure which penetrates the garment the electrical connection from the microphone terminals to a terminal socket structure connected to the input terminals of the amplifier unit worn behind the garment of the user. In another form of the invention, the pins extend from a connector element in back of the garment and fit into electrical connector sockets in the microphone.

Fig. 1 shows diagrammatically the general arrangement of one form of a wearable hearing aid based on the principles of the invention. It comprises an amplifier unit generally designated 10, and indicated therein by a dash-dot line enclosing all elements of the usual hearing aid, except for the receiver 12. The dash-line amplifier enclosure of Fig. 1 represents the small, flat amplifier casing shown structurally in Figs. 4 and 5, and which is small enough for inconspicuous wear under the garment of the user.

Referring to Fig. 1, the receiver 12, such as an ear-phone or bone receiver, is shown connected to the output terminals of the amplifier circuit of the hearing aid by two leads of a thin flexible cord 13. Within the flat amplifier casing 10 is housed an electron tube amplifier including a first gain-stage tube 14, a second gain-stage amplifier tube 15, and a power-stage amplifier tube 16. A microphone 17 housed within the amplifier casing 10 (Figs. 4 and 5) impresses its signal output voltage on the control grid of the first gain-tube 14, and an output transformer 18 delivers the amplifier output of power-tube 16 through cord 13 to the receiver 12.

The amplifier tubes 14, 15, 16 are supplied with electric power by a power unit including a tiny A-battery 10–A which supplies heating current to the cathodes of the several tubes, and a tiny B-battery 10–B which supplies electric operating energy to the anode of the plate circuits of the several tubes.

A power supply control unit in the form of a three-position switch generally designated 2—11 has a movable switch member 2—12 provided with actuating member 2—13 accessible on the exterior of the amplifier casing for actuating the switch member 2—12 either in the "on-full" position, or to the "on-cut" position, or to the "off" position indicated in Fig. 1 by correspondingly labeled arrows. In the "on-full" position, the switch member 2—12 completes an energizing circuit to the cathodes of the three tubes, thereby energizing the amplifier. In the "off" position, the switch member 2—12 opens the energizing circuit to the cathodes of the three tubes.

The hearing aid amplifier 10 shown is also provided with an additional volume control structure generally designated 3—11 indicated as an adjustable tap rheostat 6–R connected across the output circuit of the first gain tube 14, and a tap 3—12 connected to the control grid of tube 15, so that by manually shifting the rheostat tap 3—12 by a control member, the user may adjust the sound output to the desired level.

The amplifier also includes the following additional circuit elements arranged in a manner generally similar to that in the co-pending application of R. W. Carlisle et al., Serial No. 129,374, filed November 25, 1949, and assigned to the assignee of the present application. A switch and control tone resistor 1–R connected to the input side of the first gain tube 14; circuit elements 3–R, 4–R, 5–R, 14–R, 2–C, 3–C, 4–C, 11–C connected to the output side, and the screen grid of the first gain tube 14, capacitor 3-C serving as a part of a control circuit selectively

set by the energizing switch 7–C in the "on-cut" position; circuit elements 8–R, 10–R, 6–C and 7–C connected to the output circuit and the screen grid of the second gain tube 15, and to the input circuit of the first gain tube; and circuit elements 11–R, 12–R developing the proper bias voltage for the power tube 16, and the bypass condenser 9–C for the output transformer.

All of the above described elements of the amplifier unit 10, except for the batteries are housed in the upper part of the amplifier casing shown in Figs. 5 and 6, the corresponding parts being shown in Figs. 5 and 6 by similar reference numerals. The microphone unit 17 is carried suspended behind a sound-pervious wall portion 21 of the front wall 22 of the casing 10, which is usually worn hidden behind the garment of the user so that the sound-pervious wall portion 21 faces to the front for picking up sound and generating a corresponding voltage output impressed upon the amplifier. The batteries are usually housed in the battery compartment 23 provided in the bottom part of the flat amplifier casing 10.

As explained above, the user of such a hearing aid wearing the amplifier unit 10 with its microphone behind the garment has to suffer clothes-rubbing noises picked up by the microphone when the garment moves relatively to the front wall 22 of the amplifier casing 10 behind which the microphone 17 is positioned.

The present invention makes it possible for the user to pick up sound by the microphone unit made for instance in the form of a decorative ornament worn on the exterior of the garment, and provides a connection to the microphone unit which does not have any exposed cord portions which tends to embarrass many users.

In accordance with one form of the invention, the electrical circuit connection between the externally worn microphone unit and the amplifier unit worn behind the garment is provided by a detachable electrical connector including a sharply-pointed garment-penetrating connector pin structure arranged to engage a cooperating socket connector structure for completing a circuit connection for the external microphone unit to the amplifier input terminals with the amplifier casing worn behind the garment. The penetrating pin connector may be utilized and arranged to provide direct connection from the externally worn microphone unit to the encased amplifier unit worn directly behind the garment, or it may be made an intermediate part of a cord connection connecting the external microphone unit and the encased amplifier unit, or the like.

Fig. 1 indicates diagrammatically, and Figs. 2 to 4 show structurally, one form of a practical arrangement of an externally worn microphone unit provided with an inconspicious penetrating pin connector structure for connecting the external microphone unit to the input terminals of the encased amplifier unit behind the garment of the user.

An externally mounted microphone unit generally designated 30 (Fig. 1), is shown connected to the input terminals of the amplifier unit through a cord 31 shown in the form of a thin coaxial cord structure having an external cord lead 32 coaxial with and surrounding the inner conductor lead 33 which is insulated therefrom. Any available thin flexible cord leads are suitable for user as cord connection between an external microphone unit 30 and the input terminals of the high gain amplifier unit 10 of the type indicated in Fig. 1. The cord 31 is shown arranged to be connected to the input terminals of the amplifier unit by a plug connector generally designated 34 insertable into a cooperating socket structure 40 exposed along the exterior of the amplifier casing.

The cord connector structure 34 comprises two plug pins 36, 37 insulatingly held by and projecting from a plug member 38, and forming plug terminals for the two relatively insulated cord leads 32, 33 of the connector cord 31. The plug pins 36, 37 are arranged to cooperate with a socket jack structure 40 provided within an exposed wall portion of the amplifier casing 10 and having socket terminal members 42, 43 connected to the input circuit of the first gain tube 14 for supplying the output of the external microphone 30 through the cord leads 32, 33 to the circuit of the first gain tube 14 in lieu of the microphone output of the amplifier 17 enclosed within the amplifier casing 10. The provision of such externally worn microphone makes it unnecessary to provide an internal microphone 17 within the amplifier casing 10, and thus further reduces its size.

In the form of the invention shown in Figs. 1 to 5, the plug and socket terminal elements 36, 37, 42 and 43, are so arranged that when the plug pins 36, 37 are inserted into contact engagement with the socket terminals 42, 43, the circuit connection between the internal microphone 17, housed within the amplifier casing 10 to the first gain tube 14 is broken. To this end the jack 40 of the amplifier casing 10 is provided with switch contact elements 47 which are opened when the plug member 38 with its two plug pins 36, 37 is in the plugged-in position shown in Fig. 1, the switch elements 47 completing the circuit from the internal microphone 17 to the gain tube 14 when the plug member 38 is removed from its plugged-in position. With such arrangement, the user of the hearing aid has available the amplifier unit 10 with its built-in amplifier microphone 17 for use in a conventional way without an external microphone. However, whenever he desires to use the external microphone unit 30, and thereby avoid clothes-rubbing noises, he has merely to plug in the connector plug of the external microphone 30 to the amplifier socket structure 40 for connecting the external microphone unit 30 to the input terminal of the amplifier 10, at the same time disconnecting and short-circuiting the internal amplifier microphone 17.

In the form shown in Figs. 1, 2, 3 and 4, the external microphone is provided with two externally exposed pin-shaped plug pin members 51, 52 exposed on the rear side of the external microphone unit 30. The two plug pin members 51, 52 may be made of stiff spring metal such as beryllium copper and they are provided with sharply pointed pin ends 54, which readily penetrate the garment 56 such as a blouse, coat, overcoat or the like, worn by the user. The user is thus enabled to attach the microphone to the garment by pushing the plug pins 51, 52 which are exposed behind the garment of the user, and without making any visible holes in the garment. This is indicated diagrammatically in Fig. 1, and structurally in Figs. 2 and 4, where the microphone 30 is shown carried on an exterior side of a garment portion 55, the two plug pins 51, 52 of the microphone having been pushed through the thickness of the garment, and extending be-

hind the rear side of the garment portion 56, and holding the microphone unit against the front side of the garment.

The cord 31 is shown provided with a flat socket member 60 housing two terminal socket terminal members 61, 62 arranged for engagement with the pointed plug pins 51, 52, of the microphone unit when the socket member is pushed over them in the manner shown in Figs. 2 to 4, and indicated diagrammatically in Fig. 1. As seen in Figs. 3 and 4, the socket terminal member 62 is held insulated within the socket structure 60, as by an insulating enclosure 63, the socket member 60 being made of metal, such as copper alloy to provide a shield enclosure around the plug connector elements 51, 52, 61, 62. The shielding cord conductor 32 of the cord is mechanically and electrically joined to the metallic socket enclosure member 60, which also serves as a direct support and electrical connection to the spring socket terminal member 61, through which it establishes detachable contact engagement with the low potential or ground terminal member 51 of the external microphone 30.

Figs. 2 to 4 show details of one form of an external microphone unit 30 of the invention, and its internal structure is similar to that described in the co-pending R. W. Carlisle, application Serial No. 86,560 filed April 9, 1949, and assigned to the assignee of the present application. It comprises an outwardly tapering diaphragm 71 having a peripheral edge sealed and held affixed to the flange of the circular rim 72 of the flat rear wall 73 of the microphone casing. The central portion of the conical diaphragm 71 is connected to a vibratory portion 22 of a vibro-electric transducer element 23 shown in the form of a piezoelectric crystal bi-morph structure suitably supported in a vibratory condition on the inner side of the microphone casing wall 73. The front side of the microphone casing 73 is enclosed by a front wall 75 having a rim 76 suitably joined as by crimping to the rim 72 of the rear wall 73. The front wall 75 is provided with openings rendering them sound-pervious and providing acoustic coupling between the diaphragm 71 of the microphone with the surrounding atmosphere for picking up sound, and converting it into corresponding electric output impressed through the cord leads 32, 33 on the amplifier. As indicated in Fig. 1–A, the exterior of the front wall 75 may be suitably ornamented so that the external microphone 30 shall serve as an ornament worn on an exterior part of the user's garment.

The two exposed sharply-pointed plug terminals 51, 52 projecting from the rear side of the external microphone 30 are suitably affixed to its rear wall 73 so that the plug pin 52 which provides the circuit connection to the shielded insulated lead of the cord 31 is insulatingly supported by the casing wall 73. In the form shown, a hollow rivet member 81 of metal has its two end flanges crimped over insulating washers and spacers 82, 83 seated over a hole formed in a recessed wall portion 77 of the microphone casing wall 73. The metallic rivet 81 has secured within its hollow interior an inward projection of the insulated plug pin structure 52 of the microphone, and forms a firm support holding it affixed in its operative position. The inner end of the rivet 81 is suitably connected as by an insulated lead to one of the two conventional terminal leads of the piezoelectric transducer unit 23, the other terminal of the transducer unit 23 being connected to the metallic casing rear wall 73 of the microphone unit. The other pin terminal member 51 of the microphone unit 30 is similarly secured with its inner end within another rivet member 85 held affixed to the recessed wall portion 77 of the microphone rear wall 73.

Figs. 7 to 10 show the structural details of one form of plug and socket connector through which the shielded microphone cord 31 is connected to the input terminals of the amplifier housed within the amplifier casing. Insulating wall portion 90 of the exposed narrow, insulating border frame of the amplifier casing 10 (Figs. 5, 6) has mounted therein two metallic contact terminal sleeves 42, 43, held affixed at the inner end by split metal tabs 91, 92 for retaining them in position and exerting an inward biasing action on the split inner arms of the two contact sleeve members 42, 43 which are shaped to engage and make contact connections with the two plug members 36, 37 of the cord connector plug 38 (see Figs. 5 and 10). The tab member 92 is connected to the high potential input lead of the amplifier, and the tab member 91 is connected to the low potential or ground input lead of the amplifier corresponding to the similar connections of the internal microphone 17. An additional spring contact member made in the form of a metal spring 93 affixed as by a rivet 94 to the insulating wall portion 90 of the frame member, is biased so as to make contact with an underlying bent contact portion 95 of the tab member 92 held extending from the terminal contact sleeve 43. When the cord plug member 38 is inserted into the socket structure 40, the low-potential plug pin 36 will actuate the spring contact member 93 to break its contact connection with the tab 95 of the terminal contact sleeve 43, and thus open the high-potential circuit of the internal microphone to the amplifier. As a result, at the moment when the two plug terminals 36, 37 complete the circuit connection of the external microphone unit 30 to the input terminals of the amplifier, the internal microphone 17 is disconnected from the input circuit and short-circuited. Removal of the plug pin 38 disconnects the external microphone from the amplifier unit and releases the spring contact arm 95 from the position shown in Fig. 10 to the position shown in Fig. 9, in which it completes the circuit connection from the high potential side of the microphone transducer terminal to the high potential input lead of the amplifier.

Fig. 6–A shows another way of combining, in accordance with the invention, an externally worn detachable microphone unit with an amplifier unit worn hidden in the garment of the user. The external microphone unit 30 with the rearwardly extending penetrating contact pin elements 51, 52, may be identical with that described above in connection with Figs. 1 to 6. The amplifier unit 10—2 may likewise be similar to that described in connection with Figs. 1, 5 and 6, except as shown, it may be without the internal microphone unit 17, thus making it possible to correspondingly decrease its size. In addition, the receiver cord 13 with its cord terminal 13—1 is connected to a cord terminal socket—placed not on the top of the microphone unit as in the arrangement of Figs. 5 and 6—but on the side of the microphone unit as shown in Fig. 6-A, corresponding to the socket structure 40 for the external microphone unit described in connection with Figs. 5 and 6. In the upper portion

of the amplifier unit, there is mounted instead a socket structure 60—1 which may be generally similar to that shown at 60 in Figs. 1 to 4, so that the two penetrating contact pin elements 51, 52, of the external microphone unit 30 may be inserted into the socket 30—1 unit of the amplifier unit 10—1, the amplifier unit socket 60—1 having contact terminal elements engaging the contact pins 51, 52 of the microphone unit for connecting them directly to the input terminals of the amplifier shown diagrammatically in Fig. 1.

With the arrangement shown in Fig. 6–A, the external microphone unit 30 forms a unitary structure with the amplifier unit 10—2 mechanically and electrically directly connected thereto. However, the microphone unit may be readily detached from it for pushing the projecting penetrating contact pin elements 51, 52, through a garment, indicated by the garment portions 56—1, 56—2, of Fig. 6–A, whereupon the amplifier unit 60—2 with its socket unit 60—1 are brought into engagement with the amplifier contact pin elements 51, 52, thereby completing the electrical as well as the mechanical connection between the externally worn microphone unit 30, and the amplifier unit 10—2 worn behind the garment. After insertion into the socket 60—1 of the amplifier unit 10—2, the contact pin elements 51, 52 of the external microphone 30 may be locked therein for instance by a swivel latch arm 91—1 pivotally mounted at 91—2 on an adjacent wall portion of the amplifier unit 10—2 so that by turning the latch arm sidewise, the pin elements 51, 52 of the external amplifier unit 30 may be released from or latched within their interfitting contact engagement with the terminal elements of the amplifier socket unit 60—1.

As shown in Fig. 6–A, by providing the amplifier unit 10—2 with a direct electrical and mechanical penetrating contact pin structure connection to the external microphone unit, the two are combined into a unitary structure which makes it possible to place the amplifier unit 10—2 with the external microphone unit 30 detachably affixed thereto directly over an edge 56—3 of a garment portion 56—1, forming part, for instance, of a coat pocket of a garment. With such arrangement, the resilient contact pin connector elements 51, 52, serve as part of a clamp whereby the external microphone 30 overyling the outer surface of the garment portion 56—1 holds the amplifier unit 10—2 clamped to the inner side of the garment portion.

Fig. 2–A shows an external microphone of the invention having a modified form of penetrating connecting pin structure.

The rear wall 73 of the microphone 30, such as described, above, is shown provided with a coaxial connector plug pin structure including an inner conductor pin member 52—1, insulated from a surrounding hollow outer conductor member 51—1, the two conductor members forming the two terminals of opposite polarity through which the microphone unit is connected to the input terminals of the amplifier in a manner described in connection with Fig. 1.

The inner terminal member 52—1 is provided with a sharply pointed penetrating pin, and is insulated along its entire length except for its exposed pointed outer end by an insulating layer 98. The inner ends of the two insulated coaxial pin structure members 51—1, 52—1, are connected to the opposite terminals of the transducer unit 23 of a microphone such as shown in Fig. 2, as described hereinbefore.

The cord socket 60 of Fig. 3 may be readily modified so that when it is placed over the coaxial pin structure of Fig. 6, one socket terminal will make contact with the exposed end portion of the inner insulated pin member 52—1, while the other socket terminal will make contact with the exterior portion of the pin structure 51—1 surrounding the inner pin structure 52—1 extending from the microphone rear wall 73.

Fig. 1–B shows diagrammatically a modified form of an external microphone arrangement of the invention, Figs. 15, 16 showing the structural form thereof. The external microphone 2—30 is provided with socket terminal members 101, 102, instead of with plug connector elements arranged for detachable engagement with pointed plug prong members 103, 104 of an associated microphone plug 122. As shown in Fig. 15, the socket terminal members 101, 102 have the form of metallic sleeves of such diameter and length as to receive plug connector elements 103 and 104, respectively. Plug connector elements 103 and 104 are in the form of pins projecting from base members 106 and 107 in plug enclosure member 105, as best shown in Figs. 15 and 16. Plug enclosure member 105 is molded of any suitable insulating material such as a common synthetic resin. Plug connector elements 103 and 104 may be made of stiff spring metal such as beryllium copper and they are provided with sharply pointed pin-ends 108 and 109 which readily penetrate garment 110 without leaving any visible holes therein. Cord leads 2—32 and 2—33 are connected mechanically and electrically to plug base members 106 and 107 which are held insulated from each other by the insulating enclosure member 105. The base members 106, 107 are of thin sheet metal and they form with the insulating enclosure body a flat unit of only little thickness to prevent bulging of the overlying clothing.

Plug connector elements 103 and 104 have recesses 113 and 114 arranged to be releasably interlocked with portions of interlocking socket spring members 119, 120, respectively. The socket members 101 and 102 have slits 115, 116 into which the interlocking spring members 110, 120 shown in the form of wire springs, are biased.

The external microphone of Figs. 15, 16 is otherwise very similar to that of Fig. 2. The microphone comprises an outwardly tapering diaphragm 2—71 having a peripheral edge seated and held affixed to the rim 2—72 of the flat rear wall 2—72 of the microphone casing. The central portion of the conical diaphragm 2—71 is connected to a vibratory portion 2—22 of a vibroelectric transducer element 2—23 shown in the form of a piezoelectric crystal bi-morph structure suitably supported in a vibratory condition on the inner side of the microphone casing wall 2—73. The rear wall of the microphone casing 2—73 is secured to a front wall 2—75 by means of a front wall rim 2—76 suitably joined, as by crimping, to the rim 2—72 of the rear wall 2—73. The front wall 2—75 is provided with openings rendering them sound-pervious and providing an acoustic coupling between the diaphragm 2—71 of the microphone and the surrounding atmosphere for picking up sound, and converting it into corresponding electric output impressed through the cord leads 2—32 and 2—33 on the amplifier.

The microphone casing 2—73 as well as socket terminal members 101 and 102 is shown mounted

in a housing 121 which may be made of an insulating plastic material. The housing 121 is provided along its front with an exterior rimmed casing wall 122, of metal, for instance, having openings for providing the acoustic coupling between the diaphragm 2—71 and the surrounding atmosphere. The exterior casing 122 may, of course, be given any desired ornamental shape. The front ends of the socket terminal members 101 and 102 are insulated from the casing 122 by insulating sheet portions 123, 124 which are connected over the housing openings, in which the socket terminal members are mounted. A soft fabric cushioning gasket 125 is suitably secured to the front wall 2—75 of the microphone unit to protect it against direct contact with exterior casing 122. The inner side of the sound-pervious external casing wall 122 is covered with a sound-pervious, dust-impervious fabric 126, such as silk or rayon, to keep dust away from the microphone and serve as a damper for sound peaks. The rear of the microphone unit 2—30 has a back cover 127 of insulating material, such as fiber impregnated phenol formaldehyde condensation products, having holes in which the flanged hands of socket terminal members 101, 102 are secured. The back cover 127 is further held affixed to the casing 121 by four ears 128—1 (Fig. 16), of the front casing 122 which are bent over the rear edge of back cover 127.

The externally mounted microphone unit generally designated 2—30 (Fig. 1-B) is connected to the input terminals of the amplifier unit through a cord 2—31 which is similar to that described in connection with the description of Fig. 1.

Figs. 11 to 14 and 17 show a modified form of plug connection between the other end of the cord 2—31 and the amplifier. The cord 2—31 (Fig. 11) is arranged to be connected to the input terminals of the amplifier unit by a plug connector, generally designated 2—34, insertable into a cooperating socket structure, generally designated 2—40, exposed along the exterior of the amplifier casing.

The cord connector structure 2—34 comprises flat, bluntly pointed plug pins 2—36 and 2—37 insulatingly held by and projecting from a plug member 2—38 and forming plug terminals for the two relatively insulated cord leads 2—32, 2—33 of the connector cord 2—31. The plug pins 2—36 and 2—37 are arranged to cooperate with a socket jack structure 2—40 provided within an exposed wall portion of amplifier casing 2—10 (Fig. 12) and having socket terminal members 2—42 and 2—43. The socket terminal members 2—42, 2—43 are connected to the input circuit of the first gain tube 14 of the amplifier for supplying the output of the external microphone 2—30 through the cord leads 2—32 and 2—33 to the circuit of the first gain tube 14 in lieu of the microphone output of the internal microphone 17 enclosed within the amplifier casing 2—10. The amplifier circuit may be identical with that shown schematically in Fig. 1.

Referring to Figs. 11, 17, the plug connector has an insulating cover 2—38 insulatingly molded about the electrical and mechanical connections of cord leads 2—32 and 2—33 of coaxial cord 2—31 to plug pins 2—36 and 2—37, respectively. The embedded ends of the plug pins 2—36 and 2—37 are curved to form seats in which are clamped metallic eyelets 129 and 130 which are clamped to the coil lead ends, and insulating washer 131 separating the two eyelets 129, 130.

Figs. 12 to 14 show the microphone input socket assembly of the amplifier unit of Fig. 1. Adjacent the interior of the narrow border wall 2—40 of the casing 2—10 (Figs. 11, 12) is mounted terminal plate 133, which is made of a stiff insulating material, such as resin impregnated fiber. The casing border wall 2—40 is provided with suitable openings, 134, 135 (Fig. 12) to receive plug pins 2—36, 2—37. Terminal plate 133 is provided with openings 134—1, 135—1 which register with plug pin openings 134, 135 in casing 2—10 for receiving the inner ends of the plug pins 2—36, 2—37.

Terminal plate 133 is also provided with looped socket terminal members 2—42, 2—43 which are affixed thereto by means of rivets 136, 137 which also serve as contacts for leads to first gain tube 14 and to ground, respectively. Socket terminal members 2—42, 2—43 are shown made of spring wire and each includes two arms 150, 151 and 152, 153, respectively. Arms 153 and 150 are secured to terminal plate 133 at their bent ends 153—1, 150—1, respectively, by metallic brackets 153—2, 150—2, respectively, (Fig. 14). The other arms 151, 152 of socket terminal members 2—42, 2—43, respectively, are spring biased to the positions shown in Fig. 14 so that they may flex away from their fixed arms by plug pins 2—36, 2—37, inserted therebetween. Arms 150, 151 and 152, 153 of socket terminal members 2—42, 2—43 are so disposed and biased to pass directly behind socket openings 134—1, 135—1 in terminal plate 133, and to establish contact engagement with portions of the two plug pins 2—36, 2—37 of the cord plug 2—34 in its coupled position (Fig. 17). It will be noted that, as shown in Figs. 11 and 17, plug pin 2—36 is of greater width than is plug pin 2—37. Openings 134, 135 and 134—1, 135—1 are similarly polarized and correspond in size so as to prevent inserting plug 2—34 into socket 132 in reverse position.

As shown in Figs. 13, 14, the terminal plate 133 is also provided with switch element 2—47 having a fixed end 2—48 which is secured to metal bracket 139 of the terminal plate. The switch element 2—47 remains in fixed electrical contact engagement with terminal post 140 through which it is connected to the internal microphone 17. The flexible contact spring arm 151 of the plug socket is spring biased to remain in releasable contact engagement with the fixed switch arm 2—47 as long as the cord plug pins are disengaged from the socket.

In the form shown in Figs. 11–14 and Fig. 17, the plug and socket terminal elements 2—36, 2—37 and 2—42, 2—43 are so arranged that when the plug pins 2—36 and 2—37 are inserted into contact engagement with socket terminals 2—42, 2—43, the circuit connection between the internal microphone 17 housed within the amplifier casing 10 and the first gain stage tube 14 is broken.

When plug 2—34 is inserted into contact engagement with socket 132, plug pin 2—36 forces the spring contact arm 151 downwardly into position shown at 151—1 (Fig. 14) and out of contact with switch element 2—47 thereby breaking the connection of the internal microphone 17 while contact spring 150 completes the connection to the external microphone 2—30. At the same time, plug pin 2—37 forces spring contact arm 152 upwardly with the position shown at 152—1 (Fig. 14).

When plug pins 2—36, 2—37 are inserted into contact engagement with socket spring terminal members 2—42, 2—43 (Figs. 17, 13, 14), the stationary spring arms 153 and 150 together with

adjacent flexible spring contact arms 151, 152 serve to guide the plug pins into contact engagement therewith, respectively. Recess 138 in plug pin 2—37 engages arm 152 so that plug 2—38 is releasably held in the closed contact position.

With such an arrangement, the user of the hearing aid has available the amplifier unit with its built-in amplifier microphone 17 for use in a conventional way without an external microphone. However, when the user desires to use the external microphone unit 2—30, and thereby avoid clothes-rubbing noises, he has merely to plug in the connector plug of exteral microphone 30 to the amplifier socket structure 132 for connecting the external microphone unit 2—30 to the input terminal of the amplifier, at the same time disconnecting circuit for the internal microphone 17.

Various other modifications of the invention will suggest themselves to those skilled in the art. It is accordingly desired that in construing the breadth of the appended claims, they shall not be limited to the specific details shown and described in connection with the exemplifications of the invention.

I claim:

1. In a hearing aid including an inconspicuously small amplifier casing enclosing substantially all elements of an electron tube amplifier, and designed for cooperation with a separate microphone unit embodying a sound transducer structure arranged to be connected to the input terminals of said amplifier, and in combination therewith one set of metallic connector elements embodying at least one mechanically stiff metallic connector pin structure provided with a relatively sharply pointed pin-end shaped to penetrate the thickness of a garment and a cooperating set of metallic connector elements constituting a contactor structure arranged for detachably receiving said pin structure and mechanically retaining said cooperating set of connector elements in a position wherein said two sets of metallic connector elements complete electric circuit connections between the transducer structure of the separate microphone unit and the input terminals of said amplifier whereby said microphone unit may be worn on the exterior of a garment and connected to said amplifier by insertion of the connector pin structure through the thickness of the garment into said contactor structure.

2. In a hearing aid including an inconspicuously small amplifier casing enclosing substantially all elements of an electron tube amplifier together with an associated internal microphone and electric power source and designed for cooperation with a separate microphone unit embodying a sound transducer structure arranged to be connected to the input terminals of said amplifier, and in combination therewith, one set of connector elements embodying at least one mechanically stiff metallic connector pin structure provided with a relatively sharply pointed pin-end shaped to penetrate the thickness of a garment and a cooperating set of metallic connector elements constituting a contactor structure arranged for detachably receiving said pin structure and mechanically maintaining said cooperating set of metallic connector elements in a position wherein said two sets of metallic connector elements complete electric circuit connections between the transducer structure of the separate microphone unit and the input terminals of said amplifier whereby said microphone unit may be worn on the exterior of a garment and connected to said amplifier by insertion of the connector pin structure through the thickness of the garment into said contactor structure, said amplifier casing also embodying disabling elements operative to disable said internal microphone when said separate microphone unit is connected through said circuit connections to said amplifier, said disabling elements including means operative to restore the operativeness of said internal microphone when said circuit connections are broken.

3. In a hearing aid as claimed in claim 1, one of said connector elements forming part of said separate microphone unit.

4. In a hearing aid as claimed in claim 2, one of said connector elements forming part of said microphone unit, the set of connector elements embodying said connector pin structure having two projecting electrically relatively insulated metallic connector pins each with a sharply pointed pin-end and a cooperating contactor structure having two relatively insulated metallic portions engaging said two metallic connector pins.

5. In a hearing aid as claimed in claim 1, one of said two sets of metallic amplifier connector elements being a part of and carried by said amplifier casing whereby said separate microphone unit is directly carried through said contact pin structure by said amplifier casing.

6. In a hearing aid as claimed in claim 2, said one set of metallic amplifier connector elements being a part of and carried by said amplifier casing whereby said separate microphone unit is directly carried through said contact pin structure by said amplifier unit.

7. In a device of the class described, a cup-like casing, a microphone within said casing, an anchoring pin extending through the closed end of said casing and projecting laterally outwardly therefrom, said anchoring pin being formed from electrical conducting material and being pointed at its outer end to facilitate penetration of the garment of the wearer, electrical conduit means within said casing connecting said microphone to said anchoring pin, and female connector socket means adapted to make connection with and enclose the pointed end of said anchoring pin on the opposite side of the garment of the wearer, said anchoring pin being provided with an angular outer end portion which extends in a direction substantially parallel to the plane of the bottom wall of said casing.

PHILIP REICHERT.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
313,726	Haid	Mar. 10, 1885
466,725	Miltimore	Jan. 5, 1892
1,318,874	Houghiemstra	Oct. 14, 1919
1,666,729	Bick et al.	Apr. 17, 1928
1,689,692	Sell	Oct. 30, 1928
1,709,747	Sell	Apr. 16, 1929
1,826,797	Leach et al.	Oct. 13, 1931
2,182,865	Franzblau	Dec. 12, 1939
2,321,370	Dubilier	Jan. 8, 1943
2,582,287	Shaper	Jan. 15, 1952