

The invention relates to miniature hearing aids, more particularly a hearing aid which is to be worn behind the ear, according to the preamble of claim 1. Such devices are substantially known from US-PS 43 54 065.

In the case of behind-the-ear hearing aids, among which there also number devices which are provided as a replacement for the angular portion at the end of a spectacle frame, it is known that there is little space to accommodate therein the parts of the device which are important to the operation. As the size of the transducers, regulating units and current source can scarcely be varied in terms of their need for installation space, there are even attempts to shape the amplifier in a favourable manner. According to the above-mentioned US-PS, for example, the parts of the amplifier for miniature hearing aids have been provided on several plates and these have been connected with each other by way of flexible intermediate pieces. An amplifier is thus obtained, which amplifier can be folded together and requires little space. In this connection, however, special measures also demanding space have to be provided in order to give mounting support for the parts which are moveable relative to each other.

Further configuration possibilities of amplifiers are described, for example, in DE-A 27 24 399 and in the paper "Starr-flexible Leiterplatten" (Rigid-flexible printed circuit boards), in "FUNKSCHAU", No. 1, January 1982, page 58, Munich, Federal Republic of Germany. The printed circuit boards of these amplifiers are formed with flexible layers (foils) which are integrated into the rigid printed circuit boards and, as a cable replacement, electrically connect the individual rigid plates. Although such printed circuit boards are being used increasingly in hearing aids, a few disadvantages have to be suffered thereby. The special flexibility of the printed circuit board necessitates expensive mounting supports in the hearing aid housing. This in turn renders difficult the installation of the printed circuit board and reduces the interior space in the housing present for other components.

The set object of the invention is to dispense with the mounting support of folded amplifier parts in a miniature hearing aid of the kind mentioned initially and still to obtain a large surface area for the provision of the components. This object is achieved according to the invention by means of the measures specified in the characterising part of claim 1. Advantageous developments are the subject matter of the subclaims.

The invention is based on the fact that with a bent structure which is available more particularly in

the case of behind-the-ear hearing aids for the installation of the amplifier, more can be achieved if a multi-layer amplifier system is used. The bent surface can be used in a better way as a result of the arrangement of several amplifier layers. The arrangement of the amplifier can, for this purpose, also be further divided up into several assemblies, between which bending zones are left free of components. In the layer system, the assemblies can lie on an intermediate layer which also bridges over the bending zones between the groups.

By means of the use of an amplifier built up in the multi-layer system according to the invention, no folding and no mounting support of the folded parts in respect of each other are required so that a simplification of the structure is achieved.

With use of a three-layer system, components can be accommodated in the two outer layers and the intermediate layer, as a so-called neutral layer, can just be provided with strip conductors. This has the advantage that the bending zones of the amplifier are laid in regions which carry no components and are therefore less brittle so that they break less easily than the actual carriers of the amplifier components. Moreover, by means of the layer construction sufficient surface area is obtained in order to form parts of the amplifier in the form of chips as well, i.e. to use components which only have soldering points and therefore demand more surface area than conventional components provided with soldering posts, yet which are essentially cheaper to have and to process.

The parts of an amplifier for a behind-the-ear hearing aid can, as tests have shown, be accommodated on three assemblies in, in each case, two component layers. The central assembly of the assemblies lying side by side can contain an adjusting system which contains an induction take-up spool in addition to adjusting regulating units for acting upon the transmitted range of frequencies and upon the dynamics. This has proved to be favourable because in the case of the bent arrangement of the amplifier, for this assembly lying in the central region of the arrangement a situation is found which renders possible access to the adjusting regulating units for which an opening with a sealing flap can be provided in the wall of the device housing.

An arrangement consisting of three assemblies can contain at both ends parts of a connecting intermediate layer which project out over the three assemblies. In this connection, connecting lines can be led on this layer, on the one hand, to contacts of the supply current source or to a sound level regulating unit and, on the other hand, to an on and off switch and to the transducers.

Further details and advantages of the invention are explained further in the following with the aid of the exemplary embodiments represented in the Figures.

5 Figure 1 shows a perspective diagram of a behind-the-ear hearing aid which is fitted with an amplifier formed according to the invention;

Figure 2 shows the arrangement of the device on the ear;

10 Figure 3 shows a side view, in part broken open;

Figure 4 shows a side view of the amplifier used in the previously mentioned device;

Figure 5 shows the plan view of its upper layer;

Figure 6 shows the plan view of its intermediate layer and

15 Figure 7 shows the view from below of the amplifier according to Figure 4.

In Figure 1 the housing of a behind-the-ear hearing aid, which is composed of a shell 2 and a shell 3, is denoted with 1. Located at the upper end of the housing 1 there is a support hook 4 and at the opposite lower end there is a container 5 for a current source. This container 5 is sealed with a lid 6 which can be swung out towards the inside of the bent housing. Towards the outside, there lies on the container 5 a sound level regulating unit 7 which can be identified by its small adjusting wheel 8.

20 The outer arc of the shell 3 has, substantially in its centre, a sealing flap 9 and, between the latter and the upper end, a switch 10. Connected to the end of the support hook 4, through which there passes a sound conduction channel, there is a tube 11 which opens into an elastic ear olive 12 which serves to connect the device to the auditory canal of its user.

25 The device is, as is evident from Figure 2, worn on the ear 15 such that it lies with its inner arc adjacent the rear side of the ear root. It is held fast on the upper ear projection with the hook 4. As is evident from Figure 3, sound can reach a microphone 18 through an opening 17 on the face 16. In said microphone the sound is converted into electrical signals. In an amplifier 19 which lies in the central part of the housing 1 these signals can then be increased in terms of their intensity with the aid of the adjusted frequency transmission curve and finally supplied to a receiver 20. From there the sound received from the amplified signals, by way of a line 21, the support hook 4, the tube 11 and the ear olive 12, reach the hearing system of the user of the hearing aid. The amplifier 19 is supplied with energy from a current source accommodated in the space 5.

30 The actual control of the sound level reaching the ear is effected at the small regulating unit wheel 8. The adjustment of this small wheel can be seen by the position of a burl 25 which is coloured differently

from its surroundings and, as this burl 25 protrudes over the surface of the small regulating unit wheel 8, can also be felt.

5 The amplifier 19 is affected at its regulating units 26 and 27, which can be varied in terms of their effect by way of adjusting turning elements 28 and 29, also in terms of its effectiveness with regard to the frequency transmission curve, i.e. the accepted frequency distribution and the effect of very high
10 sound intensities, by an adjustable PC (peak clipping).

The switch 10 is, as is evident from Figure 3, secured to a plate 30 in adapted mounting supports 31 and 32. It serves to switch the device on and off and to switch on the signal take-up by means of microphone
15 18 or an induction take-up spool 34 which is connected together with the regulating units 26 and 27 to form a structural unit.

The amplifier 19 is built up on a flexible foil 40 which carries on its large surfaces copper conductor layers 42 and 43, which have the form of printed
20 circuits. Following the strip conductors of the layer 43, towards the underside, there is an adhesive layer 45 which carries rigid mounting support plates 46 to 49 of which those which are denoted with 47 to 49 are covered on their side remote from the adhesive layer 45
25 with a copper strip conductor layer 50 to 52, onto which then components 53 which are formed as chips are soldered at the points 53.1.

Towards the other side components, which are soldered in the usual manner with their connection
30 posts on the foil 40, follow the strip conductors of the layer 42. These are substantially capacitors 54, an integrated switching circuit 54.2, the sound level regulator 7 with its regulating unit connection 8.1 and
35 the switch 10 as well the taps 55 and 56 which, for the purposes of connection of a current source, extend to the battery holder 6.

It is evident in Figure 6 that the conductive occupancy 43 of the foil 40 is broken up into strip
40 conductors 57, which present solderings 10.1 of the switch 10 and the solderings of the components 54 denoted with 54.1 and also the solderings 8.2 of the sound level regulating unit 7.

There remain between the plates 46 to 49 bending
45 zones 60 to 63. From the views of the amplifier 19 (Figures 5 to 7) points can also be seen for the securement of the amplifier 19 in the housing 1. These are the break-through 37.1 of the screw 37 (Figure 3) and lateral recesses 38.1 and 38.2 for the screws, of
50 which the one, which is denoted with 38, is visible in Figure 3. It covers the second screw which lies behind this along the other side of the housing 1. Moreover, the amplifier 19 is suspended by means of openings 32.1 and 32.2 on the rear mounting support of the switch 10

formed by the pins 32 (Figure 3).

- 5 The position of the amplifier 19 in the housing 1 is drawn in Figure 3. Its structure extends from the switch 10 as far as the sound level regulating unit 7. The bent adaptation of the amplifier 19 to the form of the housing 1 thereby follows as a result of bent-off portions at the bending zones 60 to 63.

Claims

1. Miniature hearing aid with input transducer (18), amplifier (19) and operating elements (7, 10, 28, 29) and also current source and output transducer (20),
5 in which at least one part of the amplifier is provided on assembly surfaces (46 to 49) which are connected with each other in an articulated manner and the articulated connections (60 to 63) have a flexible base which is provided with electrically conductive tracks,
10 characterised in that the amplifier is developed as a multi-layer system which comprises at least three layers (42, 43, 50 to 52), of which the two outer layers (42, 50 to 52) carry components, lie on a so-called neutral intermediate layer (43) which is
15 provided with strip conductors (57), and are subdivided into assemblies at several opposing points and in that the mechanical strength of the intermediate layer permits a deformation of the arrangement.
2. Miniature hearing aid according to claim 1,
20 characterised in that components in the form of chips (53) are soldered onto strip conductors (50 to 52) at least in one of the two outer layers of a three-layer system amplifier.
3. Miniature hearing aid according to claim 1,
25 characterised in that of the outer layers one contains only conventional components and the other contains only chips.
4. Miniature hearing aid according to claim 1,
30 characterised in that the intermediate layer (43) reaches beyond the assemblies and has at the one end strip conductors (57) as far as a switch (10), whilst at the other end strip conductors reach as far as solderings (8.2) of a sound level regulating unit (7).
5. Miniature hearing aid according to claim 1,
35 characterised in that in the case of subdivision into three assemblies the central one thereof is provided with a combination of at least two regulating units (26, 27) and an induction take-up spool (34).
6. Miniature hearing aid according to claim 1,
40 characterised in that the strip conductors (57) of the intermediate layer (43) are parts of a printed circuit, said parts cooperating with the components contained in the assemblies.
7. Miniature hearing aid according to claim 1,
45 characterised in that the articulated connections (60 to 63) are developed as bending zones which carry no components.
8. Miniature hearing aid according to claim 1,
50 characterised in that the hearing aid has a housing (1) to be worn behind the ear with a bent structure and in that the amplifier (19) reproduces this bent structure.

