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Description

Hearing devices are used to compensate for the diminished hearing capacity of patients. Hearing devices consist of one or more microphones, an electronic
5 circuit, which comprises at least one analogue or digital amplifier, and one or more loudspeakers as well as an energy source for supplying these components.

During practical use hearing devices are constantly exposed to the influences of
10 liquids and dirt. These influences may have different causes: on the one hand patient perspiration and earwax formation, on the other hand environmental influences such as dust or the effect of water when swimming or participating in other types of water sport for instance, or if the patient carelessly drops the hearing device into a vessel filled with water or other liquids.

15

To prevent damage to or destruction of the hearing device as a result of water ingress and thus electrical short-circuits frequently associated therewith, hearing devices have until now been designed to be water-tight so that water ingress cannot take place. The disadvantage of this is for instance that compli-
20 cated membrane arrangements are needed in the region of the microphone and loudspeaker in order to seal these regions while allowing the transmission of sound waves from/to outside the hearing device, as in the publication DE 11 2006 000 463 T5 for example.

25 It is thus an object of the present invention to specify a hearing device in which it is possible to dispense with a water-tight design.

This object is achieved in accordance with the invention by a hearing device, which has the following: At least one first electroacoustic transducer for recei-
30 ving sound waves and converting said sound waves to electrical signals, an electronic circuit for processing the electrical signals that is sealed against liquids by means of coating and/or encapsulation, at least one second electroacoustic transducer for converting electrical signals supplied by the circuit to

sound waves and an electrical energy source sealed against liquids by means of coating and/or encapsulation.

5 The electroacoustic transducers here are made of materials which convert a change of shape to an electrical field or an electrical current flow or an electrical voltage (or vice versa) and which are insensitive to liquids, in particular water, salt water and slight acids.

10 In this way all components of the hearing device, i.e. the at least two transducers (e.g. microphone and loudspeaker), the electronic circuit, which is used for signal processing and signal amplification, and the energy source (e.g. battery or accumulator) are insensitive per se to the influence of water in each instance and this does not depend on the housing. In particular the housing does not need to be embodied in a water-tight fashion and corresponding complicated
15 measures can advantageously be dispensed with.

Provision is made in one exemplary embodiment to design the housing such that liquid, in particular water, reaching the interior of the housing, can drain off. This ensures on the one hand that liquid which has unintentionally reached the
20 interior of the housing can drain off and on the other hand enables the hearing device to be rinsed with water or other liquids and to be cleaned in this way.

Single or multilayer piezoelectret films and/or piezoelectric transducers, for instance flexural vibrators or thickness vibrators, are particularly suited to the design of the electroacoustic transducers.
25

Exemplary embodiments of the present invention are described in more detail below with reference to 3 figures, in which:

30 Figure 1 shows a schematic representation of the block diagram of a hearing device;

Figure 2 shows a schematic representation of an embodiment of an electroacoustic transducer for use in conjunction with a hearing device; and

Figure 3 shows a further embodiment of an electroacoustic transducer for use in
5 conjunction with a hearing device.

Figure 1 shows a schematic representation of the block diagram of a hearing device 100 with a first electroacoustic transducer and/or microphone 110 for receiving an acoustic input signal (sound waves) and converting said acoustic input signal to an electrical signal, a signal processing unit 120 and a second
10 electroacoustic transducer or earpiece 130 for converting an electrical signal output by the signal processing unit 120 to an acoustic output signal.

A programmable control unit 140 can optionally be provided, which controls the
15 signal processing unit 120 and contains executable programs as well as setting parameters for the signal processing unit 120. These programs and parameters are used to adjust the behaviour of the signal processing unit 120 (and thus the behaviour of the hearing device 100) to different hearing losses as well as to different hearing situations. The signal processing unit 120 and control unit 140
20 can naturally be combined in a common electronic system (not shown).

An electrical energy source 150 is used to supply electrical energy.

According to the present invention, the electronic circuit(s) 120, 140 and the
25 energy source 150 are protected against the effect of liquids by means of coating and/or encapsulation. Liquids which have penetrated into the hearing device 100, such as water, therefore cannot damage these components 120, 140, 150, since the liquids are held back by the coating and/or encapsulation compound and are not able to wet the components 120, 140, 150. Exposed conductor paths, which connect the electronic circuit(s) 120, 140 and the energy
30 source 150 to one another are preferably likewise protected against the effect of liquids by means of coating and/or encapsulation.

In conjunction with such a design, the use of an accumulator as an energy source 150 is particularly advantageous if this is combined with wireless charging devices (not shown), the technology of which is well-known. Alternatively high-yield batteries can also be used, the service life of which should then correspond approximately to the overall service life of the hearing device 100.

A water-resistant embodiment is preferred for the electroacoustic transducers 110, 130, i.e. a design which, as a result of its structure and/or the materials used, cannot be damaged by contact with liquids, so that a seal is not required.

10 To this end materials can preferably be used, which convert a change of shape to an electrical field or an electrical current flow or an electrical voltage (or vice versa) and which are insensitive to liquids.

Figure 2 shows a schematic representation of a first embodiment of an electroacoustic transducer. A piezoelectret film 220 is applied to a housing section 210. Piezoelectret films are electrically polarised plastic films (electrets) which contain many flat bubbles 230 in their interiors. Polarised charges are present on the boundary surfaces of these bubbles, so that many small capacitors are produced. The resilience of the air (or another gas) in the bubbles is essentially

20 lower than the resilience of the film, so that the film can be expanded and compressed in respect of its thickness. When used as a sensor or a microphone, a voltage can then be tapped off in response to an acoustic signal 250 on the surfaces of the film by means of electrodes 240. Conversely a voltage applied to the electrodes 240 then results in the thickness of the film changing, so that an

25 acoustic signal can be generated with corresponding actuation. With an electroacoustic transducer according to Figure 2, it is possible advantageously to dispense with a complicated mechanical system and, with a suitable embodiment, also to dispense with a return volume.

30 An electroacoustic transducer made of piezoelectret film is thus in principle suitable both as a microphone 110 and also as an earpiece 130. With the exception of the electrodes 240, such a film transducer does not present any components which can be attacked by (non-corrosive or slightly corrosive) li-

quids, so that a water-resistant electroacoustic transducer 110, 130 is present after suitably coating the electrodes, which is not impaired by, and can also not be damaged by, contact with liquids and therefore does not have to be sealed. Indeed, it is possible to rinse the transducer with water inter alia and the transducer once again functions normally after drying. Such a transducer also functions in the wet state but this may result in frequency distortions and efficiency losses. Such a transducer is also largely insensitive to mechanical stresses.

Alternatively conventional piezoelectric transducers can also be used as electroacoustic transducers 110, 130. These are likewise water-resistant but have the disadvantage that they operate less efficiently and at the same time exhibit a higher sensitivity to mechanical stress and structure-borne sound. Examples of such piezoelectric transducers are flexural vibrators and thickness vibrators.

A microphone 110 constructed using piezoelectret film in accordance with Figure 2 also has the advantage, in addition to the insensitivity to water already explained in detail, that it is insensitive to structure-borne sound. In some instances a larger surface needs to be provided compared with conventional microphones, in order to achieve adequate acoustic sensitivity.

If piezoelectric flexural vibrators are used as the microphone 110 in accordance with an alternative exemplary embodiment, it may be advantageous to provide two microphones of this type at a distance from one another, in order to be able to compensate for the effect of structure-borne sound on the microphones and to isolate the air-borne sound as the signal of interest.

The housing (not shown) of a microphone 110 preferably has two openings, so that the microphone 110 can be rinsed through without any problem and can easily be dried again in particular after - desired or undesired - contact with liquid. A microphone with such a housing has a directional characteristic, which, by corresponding design of the housing, can advantageously be used for the preferred detection of acoustic signals from a preferred direction.

Figure 3 shows a schematic representation of an embodiment of an electro-acoustic transducer on the basis of a piezoelectret film for use as an earpiece 130 of a hearing device. The transducer has a piezoelectret film, which essentially has the shape of a hollow cylindrical segment and which is either held in
5 this shape by a housing (not shown) or by its own mechanical properties. Terminals 320 are used to supply electrical signals, which are then converted by the film earpiece to acoustic signals. Such an earpiece is primarily suitable for use in the auditory canal of the hearing device wearer.

10 With the above-mentioned measures and components it is readily possible to construct a hearing device, the housing (not shown) of which does not have to be embodied as water-tight. Instead an open housing can be configured, so that the hearing device as a whole is lighter, more economical and in particular also easy to clean. In addition pressure equalisation does not present any problems
15 in an open design, in contrast to closed and sealed systems where it represents a considerable problem.

Patentkrav

1. Høreapparat (100), som omfatter mindst en første elektroakustisk transducer (110) til modtagelse af lydbølger og omdannelse af disse til elektriske signaler, en ved hjælp af pålægning af lag og/eller ved påstøbning, over for væsker tætnet elektronisk kobling (120, 140) til bearbejdning af de elektriske signaler, mindst en anden elektroakustisk transducer (130) til transformation af fra koblingen afgivne elektriske signaler til lydbølger, og en elektrisk energikilder (150), som er tætnet mod væsker ved hjælp af nogle påstøbninger, og hvor
- 10 - den første elektroakustiske transducer (110) er opbygget af et materiale, som kan omsætte en formændring til et elektrisk felt eller en elektrisk strøm eller en elektrisk spænding, og som er ufølsomt over for væsker, især vand, saltvand og lette syrer; og
- 15 - den anden elektroakustiske transducer (130) er opbygget af et materiale, som kan omdanne et elektrisk felt eller en elektrisk strøm eller en elektrisk spænding til en formændring, og som er ufølsomt over for væsker, især vand, saltvand og lette syrer.
- 20 2. Høreapparat ifølge krav 1, og hvor en elektroakustisk transducer (110, 130) har et eller flere lag piezoelektret-folie.
3. Høreapparat ifølge et af de foregående krav, og hvor mindst en af de elektroakustiske transducere (110, 130) er en vibrator, der kan udføre bøjningssvinger eller svingninger i tykkelsen.
- 25 4. Høreapparat ifølge et af de foregående krav, og som yderligere har et hus, som i det mindste har én, fortrinsvis to åbninger, som er således dimensionerede, at væsker, især vand, som er nået ind i det indre af huset, kan flyde bort.
- 30 5. Høreapparat ifølge et af de foregående krav, og hvor den anden elektroakustiske transducer (130) indeholder et transducermateriale, som tilnærmelsesvis er udformet som en cylinder eller et hulcylindersegment.

FIG 1

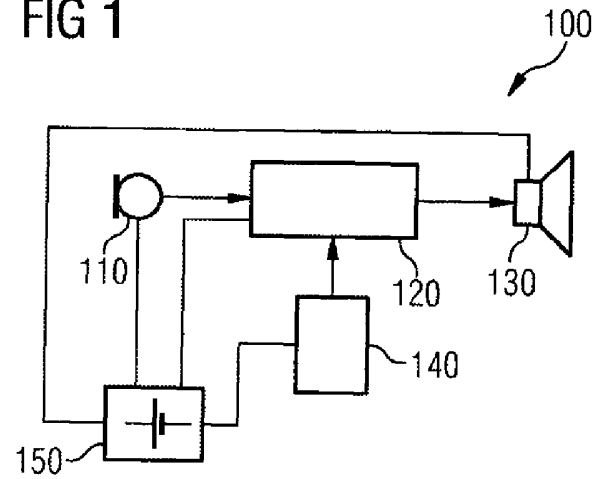


FIG 2

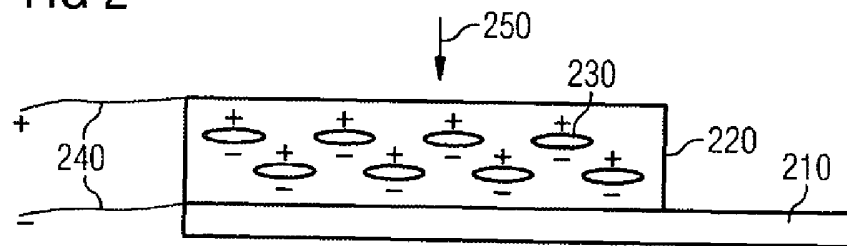


FIG 3

