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EUROPEAN PATENT APPLICATION

21 Application number: **90301311.8**

51 Int. Cl.⁵: **H04R 1/10**

22 Date of filing: **07.02.90**

30 Priority: **13.02.89 US 309736**

43 Date of publication of application:
22.08.90 Bulletin 90/34

84 Designated Contracting States:
DE FR GB IT

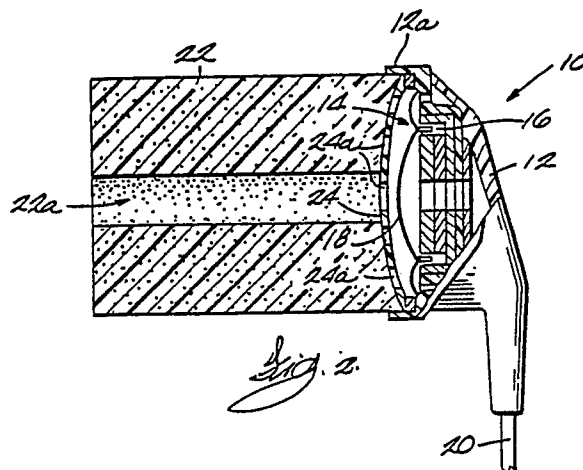
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54 **Earphone having resilient insertion device.**

57 An earphone, which is constructed of a housing (12), and a transducer (14) comprising a magnetic circuit (16) received in the housing and a diaphragm (18) magnetically coupled to the magnetic circuit. The diaphragm has a diameter substantially equal to the housing. A resilient support member (22) is attached in relation to the housing and aligned with the diaphragm. In use, the resilient member is compressed, inserted into the user's auditory meatus and allowed to re-expand so as to provide a high fidelity sonic connection between the diaphragm of the earphone and the user's eardrum. In one embodiment a protector plate is attached to the housing and covers the diaphragm. The support member is then affixed to the protector plate. The support member is generally cylindrical in shape, having a longitudinal axis oriented generally normal to the diaphragm. The support member includes an axial opening which runs substantially the length of the member.



EARPHONE HAVING RESILIENT INSERTION DEVICE

Background of the Invention

This invention relates to electro-acoustic transducers, and in particular to such transducers designed to be placed close to the eardrum, and to a resilient support device for maintaining their position relative to the eardrum.

Earphones and headphones are generally well known in the art. Both earphones and headphones have electromagnetic transducers, whether dynamic or static, for producing sound from electrical signals. Generally the distinction has been that an earphone includes a transducer held in the ear, possibly with a strap over the auricle, or outer ear, to hold the transducer in place generally at the ear. Headphones, on the other hand, have a transducer attached at one or both ends of a strap that fits on top of the wearer's head in such a position that the transducers are positioned generally at the ears. The disadvantages of headphones, with their uncomfortable weight applied to the top of the head and the sometimes undesirable effect the headband can have on a woman's hairstyle, are well known.

As to the earphones, they have the distinct advantage that the transducer is held close to the user's eardrum, and the closer the transducer can be held to the eardrum, the better the sound fidelity will be. Originally earphones were held in place by a pipe that was inserted into the auditory meatus of the wearer, and sized so as to fit snugly therein, possibly aided by the strap over the auricle referred to above. Such an earphone is shown in U.S. Patent No. 4,403,120 to Yoshimi, and described at Fig. 1(d) therein as "Prior Art". Since the pipe was generally made of a hard material, it could easily become uncomfortable if used for more than a few minutes.

Hence in later designs the pipe was done away with, and replaced by a flat protector plate with holes for allowing the escape of the sound waves generally toward the ear. Later designs, such as those set forth in U.S. Patent No. 4,429,194 to Kamon and in U.S. Patent No. 4,736,435 to Yokoyama, are directed toward supporting the transducer as close as possible to the eardrum on one or more portions of the auricle.

In Akiyama, U.S. Patent No. 4,133,984, there is shown an earphone for a hearing aid in which a pipe, similar to the pipe of earlier earphones, is inserted into the auditory meatus, and is surrounded by an expandable bladder. The bladder is expanded by means of a pump for transferring a fluid from a reservoir outside the meatus. However, this apparatus is entirely too complex, and likely expensive,

for common, non-medical usage such as listening to music for pleasure.

In Gardner, U.S. Patent No. 3,811,437, an earplug is used to position a pipe, again similar to the pipe of earlier headphones, partially within the user's auditory meatus. However, this structure is not suitable for high fidelity sound reproduction because it positions the transducer too far from the user's eardrum, assumedly at the opposite end of the disclosed pipe, remote from the user's ear.

This invention relates to improvements to the apparatus described above and to solutions to the problems raised thereby.

Summary of the Invention

The invention includes an earphone, which is constructed of a housing, and a transducer comprising a magnetic circuit received in the housing and a diaphragm magnetically coupled to the magnetic circuit. The diaphragm has a diameter substantially equal to the housing. A resilient support member is attached in relation to the housing and aligned with the diaphragm. In use, the resilient member is compressed, inserted into the user's auditory meatus and allowed to re-expand so as to provide a high fidelity sonic connection between the diaphragm of the earphone and the user's eardrum. In one construction a protector plate is attached to the housing and covers the diaphragm. The support member is then affixed to the protector plate. The support member is generally cylindrical in shape, having a longitudinal axis oriented generally normal to the diaphragm. The support member includes an axial opening which runs substantially the length of the member. Hence this construction satisfies the object of positioning the transducer as close as possible to the user's eardrum, and securely maintaining that position.

Other objects and advantages of the invention will become apparent hereinafter.

Description of the Drawing

Fig. 1 is an isometric view of an earphone constructed according to a preferred embodiment of the invention.

Fig. 2 is an axial cross-sectional view of the earphone shown in Fig. 1, taken along line 2-2.

Fig. 3 is a lateral cross-sectional view of the earphone shown in Fig. 1, taken along line 3-3.

Fig. 4 is a side view of the earphone constructed according to the invention, having its resilient

ient member compressed prior to insertion into the user's auditory meatus.

Fig. 5 is a side elevational view, partially in section, of a user wearing the earphone after it has re-expanded inside the user's auditory meatus.

Description of the Preferred Embodiment

Referring now to Figs. 1, 2 and 3, there is shown an earphone assembly 10 constructed according to a preferred embodiment of the invention. This earphone assembly 10 includes an earphone housing 12, carrying therein a transducer 14. This transducer 14 includes a magnetic circuit 16, and a diaphragm 18 driven by the magnetic circuit. The transducer 14 produces sound in a generally conventional manner in accordance with a signal received in the magnetic circuit 16, generally via a cord or wire 20.

As indicated above, support of a transducer in proper relation to the user's ear has been a problem in the past. In order to provide proper support of the transducer 14 in the present invention, the earphone assembly 10 includes a support member 22. This support member 22 is attached in relation to the housing 12 in such a manner that the support member extends outwardly, away from the housing. The support member 22 is generally cylindrical in shape, with an axis generally normal to the diaphragm 18.

The support member 22 may be attached in relation to the housing 12 by any suitable attachment means. In the embodiment shown in Fig. 2, a protector plate 24 is provided to cover and protect the transducer 14. Sound passage openings 24a are provided in the protector plate 24 to allow the sound generated by the transducer 14 to escape and proceed into the user's ear. As shown in Fig. 2, the support member 22 is attached to the protector plate 24 by any suitable attachment means, such as adhesive or sonic welding. Further attachment support of the support member to the housing 12 may be provided by an annular flange 12a at the outermost edge of the front face of the housing, projecting generally parallel to the axial direction of the cylindrical support member 22. The inside diameter of the flange 12a is sized so as to just fit over the outer diameter of the support member 22. Again, the support member may be adhered to the flange 12a by any suitable means such as adhesive or sonic welding.

An axially oriented opening 22a may be formed in support member 22. Such an opening 22a, allowing the sound generated by the transducer 14 to escape and reach the user's ear, runs generally the entire length of the support member 22.

In the preferred embodiment, support member 22 is composed of a foamed plasticized polymeric

material having a sufficiently high concentration of plasticizer to provide the member with a reduced rate of recovery from compression, such as the material disclosed in U.S. Patent No. 3,811,437. That is, the support member 22 is compressible and sized, in its un-compressed state, larger than the user's auditory meatus. Because of its physical properties, once compressed, the member returns to its original, expanded state only slowly.

The use of the assembly 10 according to the present invention can be seen by reference to Figs. 4 and 5. Rather than support the housing on the user's auricle 26, as is the case with the prior art, the user first compresses the support member 22 transversely, as shown in Fig. 4, so that the diameter is smaller than the user's auditory meatus 28 (Fig. 5). Then, before the support member 22 can return to its original, un-compressed diameter, the user inserts it into his auditory meatus 28, where it continues to expand until it contacts the interior of the meatus. Hence the apparatus and method of the present invention provide good positioning of the transducer 14 at the entrance of the user's auditory meatus, substantially improving the sound fidelity heard by the user.

While the apparatus hereinbefore described is effectively adapted to fulfill the aforesaid objects, it is to be understood that the invention is not intended to be limited to the specific preferred embodiment of an earphone having a resilient insertion device set forth above. Rather, it is to be taken as including all reasonable equivalents within the scope of the following claims.

Claims

The embodiments of the invention in which an exclusive property or privilege is claimed are as follows:

1. An earphone comprising:

a housing;
a magnetic circuit received in said housing;
a diaphragm magnetically coupled to said magnetic circuit and with a diameter substantially equal to said housing; and
a resilient support member attached in relation to said housing and aligned with said diaphragm, for compression, insertion into an auditory meatus and re-expansion so as to provide a high fidelity sonic connection between said diaphragm and a eardrum.

2. An earphone as recited in claim 1 further comprising a protector plate attached to said housing and covering said diaphragm, said support member being affixed to said protector plate.

3. An earphone as recited in claim 1 or claim 2 wherein said support member is cylindrical in

shape, having a longitudinal axis oriented generally normal to said diaphragm.

4. An earphone as recited in claim 3 wherein said support member includes an axial opening which runs substantially the length of said member. 5

5. A method of attaching a transducer to a user's ear, said transducer comprising a magnetic circuit and a diaphragm magnetically coupled to said magnetic circuit, said method comprising: enclosing said transducer in a housing, said housing having a diameter substantially equal to said diaphragm, and said housing having openings for allowing sound waves generated by said diaphragm to escape; 10
attaching one end of a cylindrical, resilient support member to said housing, over at least some of said openings, such that said member extends outward away from said housing, said member having a predetermined non-compressed diameter; 15
compressing the diameter of said member so that said diameter is smaller than the user's auditory meatus; and 20
inserting said member into said auditory meatus before said member re-expands to its non-compressed diameter. 25

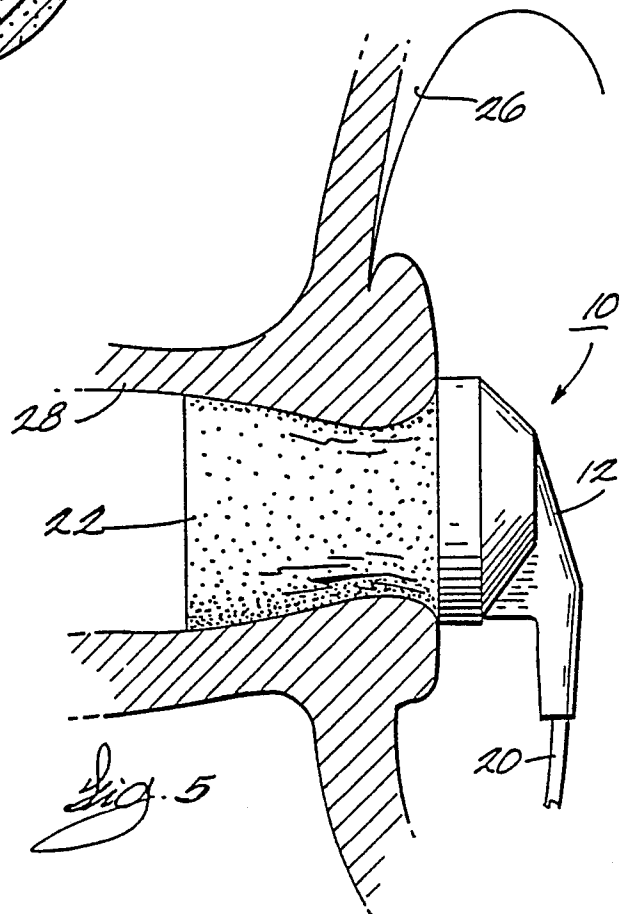
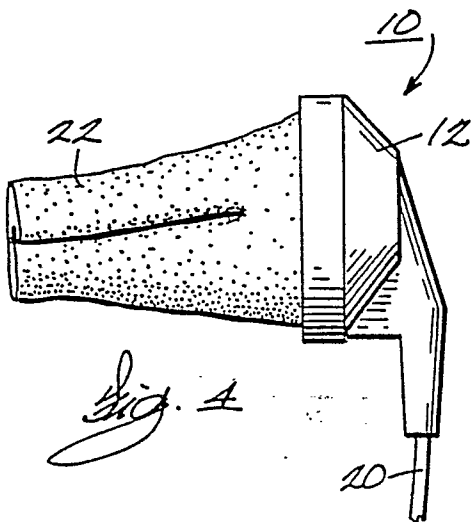
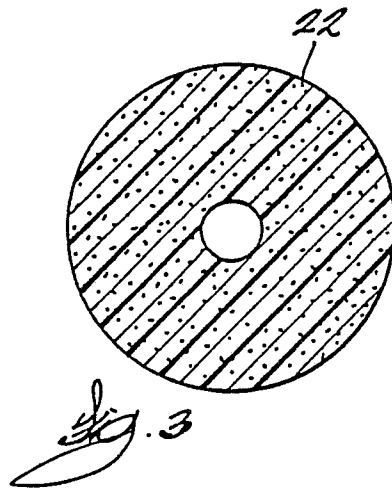
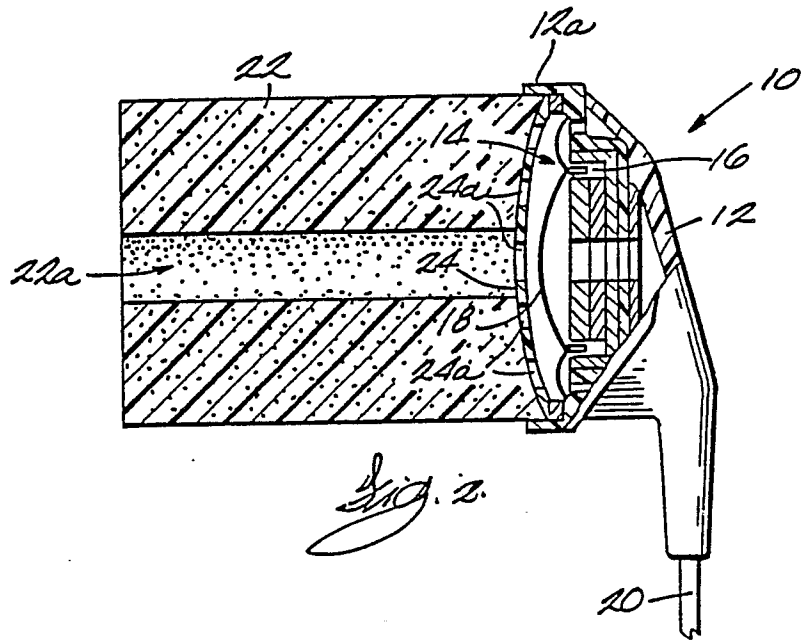
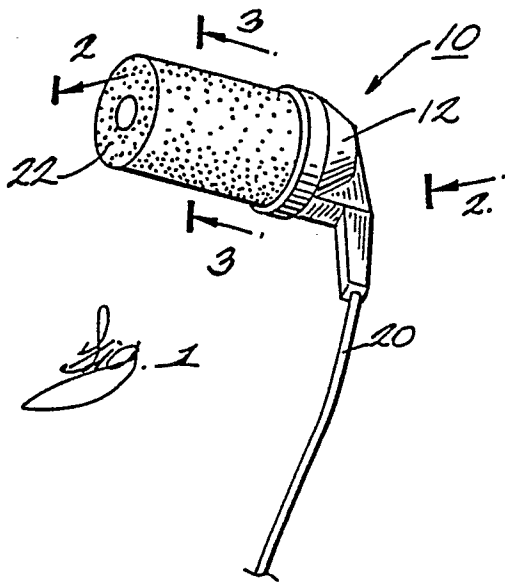
6. A method as recited in claim 5 wherein said support member, when not compressed, is larger than said auditory meatus.

7. A method as recited in claim 5 further comprising the step of forming an axial opening for the entire length of said support member prior to said compressing step. 30

8. An earphone comprising: a housing; 35
a magnetic circuit received in said housing; a diaphragm magnetically coupled to said magnetic circuit and with a diameter substantially equal to said housing; 40
a protector plate attached to said housing and covering said diaphragm; and
resilient support means connected at one end to said protector plate and projecting outward therefrom, for compression, insertion into an auditory meatus and re-expansion so as to provide a high fidelity sonic connection between said diaphragm and a eardrum. 45

9. An earphone as recited in claim 8 wherein said support means comprises a cylindrical expansion member, having a longitudinal axis oriented generally normal to said protector plate. 50

10. An earphone as recited in claim 9 wherein said expansion member includes an axial opening which runs substantially the length of said expansion member. 55





DOCUMENTS CONSIDERED TO BE RELEVANT			EP 90301311.8
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	<u>DE - A1 - 3 102 722</u> (AKG) * Abstract; page 7, line 28 - page 8, line 5; claim 1; Fig. 6 *	1-7	H 04 R 1/10
A	--	8-10	
A	<u>AT - B - 369 214</u> (AKG) * Abstract; page 2, line 41 - page 3, line 4; claims 1,2; Fig. 3 * -----	1-4	
			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
			H 04 R
The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 26-04-1990	Examiner GRÖSSING
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	