

ELECTROACOUSTIC TRANSDUCER

The present invention relates generally to electroacoustic transducers and more particularly to an electroacoustic transducer such as an earphone or the like which is worn over or inserted into an auditory opening.

US patent number 4736435 discloses a so-called inner-ear type earphone which is inserted into an auditory opening. Figure 1 of the accompanying drawings shows an example of such an inner-ear type earphone.

Referring to figure 1, it will be seen that a driver unit 15 is accommodated within a housing 16. The driver unit 15 is an electroacoustic transducer element and is formed of a diaphragm, a magnetic circuit or the like, though not shown. An external connection cord 17 is extended from the driver unit 15 and is supported by a cord supporting member 18. The cord supporting member 18 is elongated from the housing 16.

As shown in figure 2, the housing 16 is made moulding a synthetic resin and is formed in such a size that it can be inserted into a cavum concha a which is a concave portion of the auricle a. When the housing 16 is inserted into the cavum concha b, at least two points of the outer peripheral surface of the housing 16 are supported by the tragus c and the antitragus d which form a part of the auricle a.

The rear peripheral portion of the housing 16, which is opposed to the outside of the auricle a when the housing 16 is inserted into the cavum concha b, is formed as a tapered, inclined portion 19. The inclination angle of the inclined portion 19 is selected so that the inclined portion 19 substantially corresponds to the curved, rising surface of the cavum concha b.

The cord supporting member 18 extended from the housing 16 is downwardly elongated from the lower end of a

rear side edge wall 20 of the housing 16 in substantially parallel to the rear side edge wall 20. When the housing 16 is inserted into the cavum concha b, the cord supporting member 18 comes into contact with a point P3 on the outer surface of a lobe e at the position lower than points P1 and P2 of the tops of the tragus c and the antitragus d. The points P1 and P2 are the supporting points to support the housing 16.

A ring 21 is made of flexible and resilient material and is engaged with a connection portion in which the driver unit 15 and the housing 16 are connected. Referring back to figure 1, it will be seen that a protecting plate 22 is located at the front wall of the diaphragm of the driver unit 15. The protecting plate 22 is made of a material such as a metal net or the like having high sound transmission coefficient.

With the inner-ear type earphone as shown in figure 1, the housing 16 is inserted into the cavum concha b in a three-point supporting fashion so that it can be positively held at one portion of the auricle a without pressing the auditory opening.

In order that any user may wear the inner-ear type earphone shown in the example of figure 1 regardless of the size of the ear, in particular, the size of the cavum concha b, this earphone is made in size so as to be inserted into the smallest ear size.

Accordingly, the earphone is too small for the cavum concha of people with larger ears. Thus, when the earphone is inserted into the auditory opening of a large ear, its closure property is poor and the low frequency response is reduced and hence good acoustic characteristic is not expected.

It is an object of the present invention to provide an improved electroacoustic transducer which can remove the above mentioned defects encountered with the

prior art electroacoustic transducer.

According to an aspect of the present invention, there is provided an electroacoustic transducer comprising:

(a) a housing incorporating therein an
5 electroacoustic transducer element, said housing being formed such that it can be inserted into a concave portion of the human auricle; and

(b) a ring member having resiliency sufficient so that it is attached to the outer peripheral portion of said
10 housing, said ring member being formed such that its thickness is increased in one direction from the centre of the housing; and

(c) means for connecting the transducer element to an electrical audio signal source external to the
15 auricle.

These and other features and advantages of the present invention will be apparent in the following detailed description of preferred embodiments of the invention when read in conjunction with the accompanying drawings, in which
20 like reference numerals identify the same or similar parts in the several views. In the drawings:-

Figure 1 is a cross-sectional side view of an example of a prior art earphone;

Figure 2 is a pictorial representation of the
25 condition that the earphone shown in figure 1 is inserted into a cavum concha upon use;

Figure 3 is a plan view of an embodiment of an earphone according to the present invention;

Figure 4 is a partly cut-away, rear view of the
30 earphone shown in figure 3;

Figure 5 is a plan view of a ring member used in the earphone of the invention shown in figure 3;

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Figure 6 is a perspective view of the ring member shown in figure 5;

5 Figure 7 is a pictorial representation of the condition that the earphone shown in figure 3 is inserted into the cavum concha upon use;—

Figure 8 is a plan view of another embodiment of—

an earphone according to the present invention;

Figure 9 is a partly cut-away, rear view of the earphone shown in figure 8;

Figure 10 is a plan view of a ring member used in the earphone shown in figure 8; and

Figure 11 is a perspective view of the ring member shown in figure 10.

An embodiment of an electroacoustic transducer such as an earphone according to the present invention will now be described with reference to figures 3 and 4. In figures 3 and 4, like parts corresponding to those of figures 1 and 2 are marked with the same references and therefore need not be described in detail.

Referring to figures 3 and 4, it will be seen that a ring member 1 having resiliency is engaged with a connection portion where the housing 16 and the driver unit 15 are connected.

The ring member 1 is formed such that as shown in figures 5 and 6 the centres of the inner and outer circles thereof are displaced from each other. In other words, the ring member 1 is formed to increase its thickness in one direction from the centre of the housing. This ring member 1 is formed of a base ring portion 2 on an inner peripheral side and a resilient ring portion 3 on an outer peripheral side which are moulded by the resin moulding process such as a so-called two colour moulding process or dichromatic moulding.

The base ring portion 2 is formed by moulding a resin material having a sufficient hardness, for example, polycarbonate. The base ring portion 2 is comprised of a ring-shaped base portion 2a and three leg portions 2b each extending longitudinally and having a radially inwardly directed protrusion 2c at its tip end. The resilient ring portion 3 is made by moulding a material high in resiliency such as silicon or the like. The resilient ring portion 3

is made hollow except its portions corresponding to the leg portions 2b of the base ring portion 2.

When the ring member 1 constructed as described above is engaged with the connection portion between the housing 16 and the driver unit 15, the base portion 2a of the base ring portion 2 is faced to the protecting plate 22 side. In this case, the base portion 2a is engaged with the protecting plate 22 and the protrusions 2c are engaged with a flange portion 16a of the housing 16. The ring member 1 is arranged to increase its thickness in the direction of the antitragus d side. Figures 3 and 4 illustrate the earphone which is inserted into the auditory opening of the left-hand side ear. If the earphone of the invention is formed as an earphone for a right-hand side ear, then the ring member 1 is arranged to increase its thickness in the reverse direction, though not shown.

Upon use, the earphone thus made is inserted into the cavum concha b as shown in figure 7. The auricle opening is not located at the centre of the cavum concha b and is displaced to the tragus c side. Therefore, the increased thickness of the resilient ring member 1 is selected so that when the earphone is inserted into the cavum concha b, the diaphragm of the driver unit 15 is opposed to the auditory opening.

According to this embodiment, the resilient ring member 1 is arranged so that its thickness increases toward the antitragus d side so that when the user wears the earphone, the resilient ring portion 3 of the ring member 1 is resiliently deformed so as to be fitted to the shape of the cavum concha b. Thus, the resilient ring portion 3 is resiliently deformed in accordance with the shape of the cavum concha b, resulting in the closed property being increased. Consequently, the reduction of the low frequency response is avoided, hence an excellent acoustic characteristic can be obtained.

Another embodiment of an earphone according to the present invention will be described hereinafter with reference to figures 8 and 9. In figures 8 and 9, like parts corresponding to those of figure 1 are marked with the same references and therefore need not be described in detail.

Referring to figures 8 and 9, it will be seen that a resilient ring member 10 is engaged with the connection portion where the housing 16 and the driver unit 15 are connected.

As shown in figures 10 and 11, the resilient ring member 10 is formed such that the centres of the inner circle and the outer circle are displaced from each other. In other words, when the centre of the outer circle is displaced from that of the inner circle, so that the ring member 10 is allowed to increase its thickness in one direction from the centre. The ring member 10 is formed of a base ring portion 12 at the inner peripheral side and a resilient ring portion 13 of the outer peripheral side according to the resin moulding process, for example, the dichromatic moulding process.

The base ring portion 12 is formed by moulding a material having a suitable hardness, for example, acrylonitrile butadiene styrene copolymer (ABS) resin. The base ring portion 12 is formed as a cylindrical shape having a circular edge portion 12a. The resilient ring portion 13 is formed by moulding a material high in resiliency such as urethane or the like.

The above mentioned ring member 10 is engaged with the connection portion between the housing 16 and the driver unit 15 in such a manner that the circular edge portion 12a of the base ring portion 12 faces to the side of the protecting plate 22. In this case, the edge portion 12 is engaged to the protecting plate 22. The ring member 10 is arranged such that its swollen portion is positioned toward

the antitragus d. Figures 8 and 9 show the earphone which is inserted into the cavum concha of the left-hand side ear. The earphone, which is suitably inserted into the cavum concha of the right-hand side ear, though not shown, is so arranged that the thicker portion of the ring member 10 is positioned in the reverse direction to that shown in figure 8.

Upon use, the earphone according to the second embodiment of the present invention is inserted into the cavum concha b similarly to the first embodiment shown in figure 7. In this embodiment, the increased thickness of the ring member 10 is selected similarly to the first embodiment.

According to this embodiment, the resilient ring member 10 is arranged to increase in thickness toward the antitragus d side so that when the user wears the earphone, the resilient ring portion 13 of the ring member 10 is resiliently deformed and the ring member 10 is properly fitted into the cavum concha b. Thus, the closed property of the earphone can be increased and similar action and effect to those of the above mentioned first embodiment can be achieved.

While both the ring members 1 and 10 are formed such that the centres of the inner circle and the outer circle are displaced from each other as described above, the outer form of the ring members is not limited to being circular and instead may be an ellipse and other forms. In short, the ring member 10 has to increase its thickness in one direction from the centre of the housing 16.

According to the present invention, as described above, since the resilient ring member is arranged to increase its thickness in one direction from the centre of the housing and this ring member is attached to the outer peripheral portion of the housing, upon use, the resilient ring portion of the ring member is resiliently deformed and

can be properly fitted into the cavum concha. Thus, the closed property can be increased, and loss of low frequency response is avoided. Therefore, it is possible to obtain excellent acoustic characteristic.

5 It should be understood that the above description is presented by way of example on the preferred embodiments of the invention and it will be apparent that many modifications and variations thereof could be effected by one with ordinary skill in the art without departing from
10 the scope of the invention as defined in the appended claims.



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CLAIMS

1. An electroacoustic transducer comprising:

(a) a housing incorporating therein an
5 electroacoustic transducer element, said housing being
formed such that it can be inserted into a concave portion
of the human auricle; and

(b) a ring member having resiliency sufficient so
that it is attached to the outer peripheral portion of said
10 housing, said ring member being formed such that its
thickness is increased in one direction from the centre of
the housing; and

(c) means for connecting the transducer element
to an electrical audio signal source external to the
15 auricle.

2. An electroacoustic transducer according to claim
1, in which said ring member is attached to said housing
such that when said electroacoustic transducer is inserted
20 into said concave portion of the auricle, said ring member
is allowed to increase its thickness toward the antitragus
side of the ear.

3. An electroacoustic transducer according to claim 1
25 or 2, in which said ring member is formed such that when
said electroacoustic transducer is inserted into said
concave portion of the auricle, a diaphragm of said
electroacoustic transducer element is opposed to the ear
passage.

4. An electroacoustic transducer according to claim
1, 2 or 3, in which said ring member is formed of a base
ring portion and a resilient ring portion made of a material
more resilient than that forming said base ring portion.

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5. An electroacoustic transducer according to claim 4, in which said base ring portion is provided with a plurality of leg portions each having a protrusion engageable with a flange portion of said housing and said resilient ring portion is hollow except its portions corresponding to said leg portions.

6. An electroacoustic transducer according to claim 4 or 5, in which said base ring portion is provided with an edge portion which is engaged with a sound emanating surface side of said electroacoustic transducer element incorporated within said housing.

7. An electroacoustic transducer according to claim 6, in which said resilient ring portion is made of urethane resin.

8. An electroacoustic transducer according to claim 4, 5, 6 or 7, in which said ring member is formed of said base ring portion and said resilient ring portion by means of a resin moulding process.

9. An electroacoustic transducer constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in figures 3 to 7 or figures 8 to 11 of the accompanying drawings.
