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An ear microphone for insertion in the ear in connection with portable telephones or radios.

The present invention relates to an ear microphone comprising a microphone unit mounted in a holder, said unit receiving speech sounds transmitted by tissue from the wearer, the microphone unit being insensitive to airborne sound signals. The novel features of the invention is stated after mentioning the prior art.

The known ear microphones receiving and transmitting via tissue differ from the present invention as follows:

DK 159190. The disclosed earplug is designed for arrangement in the auditory meatus thereby requiring individual adjustment. The arrangement in the inner ear causes various drawbacks that in addition to the individual adjustment are an uncomfortable feeling of pressure in the auditory meatus, sweat in the ear, pollution by cerumen, loss of sense of sound localization when one auditory meatus is blocked etc. The earplug is deliberately designed to suppress sound (noise) coming from the outside. The microphone must be sensitive to airborne sound signals as the signals arrive at the microphone through internal ducts from the area of the plug the exterior of which is provided with recesses to absorb the sound signals from the soft tissue in the auditory meatus.

GB-A-2 197 158. This ear telephone is also designed for being plugged into the auditory meatus. Possibly, the vibration transducer is a piezoelectric element. The design seems to imply that the whole holder is set to vibration, and since the holder is relatively heavy, the consequence must necessarily be that the sound transmission must be of a lowpass nature.

DK 135480. The holder is designed to cover the whole ear and consequently, it cannot be worn discreet-



ly. The microphone is a pressure-gradient microphone that has to be in contact with the jawbone in front of the ear. This can only be obtained by strapping the microphone on to the head.

DE 4019529 A1. This ear microphone too, is receiving and transmitting the sound via the jawbone in front of the ear, and likewise a clamp across the head is required.

EP-B-0 092 822. This device is also designed for being pressed into the auditory meatus - like GB-A-2 197 158.

The object of this invention is to avoid the mentioned drawbacks of the known ear microphones. This is achieved by an ear microphone according to the introductory part of claim 1, the microphone being characterized by what is stated in the characterizing part of claim 1. Thus, it is obtained that when the holder can be positioned in the outer ear outside the auditory meatus, individual adjustment is avoided, easy insertion into the ear is achieved and the holder is not being smeared with cerumen. Furthermore, a better comfort is obtained, and an inconvenient feeling of pressure in the auditory meatus as well as sweat in a plugged auditory meatus is avoided. Moreover, outer sounds are not necessarily totally shut off.

Next, the background and idea of the invention will be explained. When people talk, vibrations in the throat and vocal cords are generated. These vibrations propagate through the bony and liquid-filled tissue. Especially the jawbone which passes near the front part of the outer ear produces a strong transmission and transfers considerably more "teeth sounds" than if the signal was collected in the throat.

For an ear microphone to be used for full duplex, sufficient separation between input and output must be present in order to avoid self-resonance.



In order to increase the separation in the ear microphone, the sensitivity to vibrations can be increased, and the sensitivity to acoustic sounds can be decreased. Thus, a microphone being unable to hear anything is desirable. At the same time, this results in the advantage of suppression of the surrounding noise.

A microphone having a tight rubbery coating is very sensitive to movements of the coating. The air pressure produced underneath the coating cannot escape for which reason a strong sound pressure is produced on the microphone membrane. This principle can be further optimized cf. fig. 3a.

If the area of the coating ($h \times w$) is large compared to the volume ($t \times h \times w$), the sensitivity can be geared. The sound pressure is proportional to

$$\frac{\text{area} \times \text{movement}}{\text{volume}} = \frac{(h \times w \times \Delta t)}{(h \times w \times t)}$$

This relation is useful only to low source impedance action on the rubber coating, e.g. direct skin contact and not air. Further, the relatively large mass compared to air of the rubber coating attenuates about 25 dB of airborne sound.

The microphone of the ear microphone is a standard microphone, the sound pressure sensitive face (wall) of which is substantially hermetically covered by a coating of flexible material. In use, the coating is in vibration transmitting contact with the tissue. This coating renders the microphone substantially insensitive to airborne sound and due to the soft material, the ear microphone becomes pleasant to wear.

Therefore, the ear microphone can be used in noisy surroundings without transferring any appreciable noise to the microphone which receives the vocal sound by direct transfer through the bottom of the ear at tragus.



The ear microphone is provided with low-frequency cutoff. Due to the tissue transmitted sound spectrum in which low-frequency content is dominating, it is advantageous having the low-frequency dominance removed already in the receiving phase as this low-frequency dominance may cause overamplification in the electrical system.

The ear microphone may be used in a full duplex ear communication unit by having a softly suspended electro-acoustic sound generator mounted in a side of the holder facing the auditory meatus.

Thus, the ear microphone may be used for e.g. portable telephones in cars under which circumstances it is desirable that the user during the conversation can have both hands free to manoeuvre the car.

Similarly, the ear microphone may advantageously be used for simplex radiophones, e.g. by the police and fire brigade, wherein the unit in the ear may be worn hidden under the helmet or face guard without being inconvenient during the work.

In the ear microphone, a relatively heavy vibration absorbing insert reducing vibrations from the electro-acoustic sound generator to the microphone may be mounted in an area of the holder between the sound generator and the microphone unit.

The present invention will now be explained with reference to the accompanying drawing, wherein

fig. 1 shows the ear microphone 2 positioned in the left ear,

fig. 1a the ear microphone 2 removed from the ear,

fig. 2 the position of the units in the ear microphone 2,

fig. 2a the position of the microphone coating 10 in the ear microphone 2,

fig. 3 the microphone 4 seen from the side with spacing foam 11 and microphone attenuation coating 10



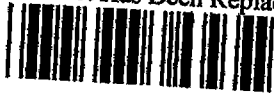
fig. 3a microphone 4 with microphone attenuation coating 10 glued thereto, and

fig. 4 the design concept of the ear microphone.

Fig. 1 shows the position of ear microphone 2 in the outer ear with the microphone 4 in contact with the bottom of tragus. If applied to the right ear, an ear microphone 2 in a mirror-inverted embodiment is used.

The position of the individual units in the ear microphone 2 appears from fig. 2, wherein the feeder cable 3 connects microphone unit 4 and sound generator 7 to the external unit. A heavy oscillation reducing insert 9 is embedded between microphone 4 and sound generator 7. The sound generator 7 is embedded in a thin layer of attenuation foam 8.

Fig. 3a shows the microphone 4 covered with sound transparent foam 11 and rubber 10 glued thereto for attenuation of airborne sound.



CLAIMS

1. An ear microphone comprising a microphone unit (4) mounted in a holder (2) for reception of speech sounds transmitted by tissue from the wearer, the microphone unit being insensitive to airborne sound signals, characterized in that the holder (2) is designed for arrangement in its entirety in the outer ear outside the auditory meatus, and the microphone unit (4) being mounted in vibration transmitting tissue contact in a part of the edge of the holder (2) facing the bottom of tragus.

2. An ear microphone as claimed in 1, characterized in that the sound pressure sensitive face (wall) of the microphone unit (4) is substantially hermetically covered by a coating (10) of a flexible material which in use is in vibration transmitting contact with the tissue.

3. An ear microphone as claimed in 2, characterized in that said coating (10) is made of a rubber elastic material.

4. An ear microphone as claimed in 1, 2 or 3, characterized in that said microphone (4) is positioned inside the holder (2) and is connected with a sound duct, said sound duct being substantially hermetically connected with said coating (10).

5. An ear microphone as claimed in 1 through 4, characterized in that said microphone unit (4) has a low-frequency cutoff.

6. An ear microphone as claimed in 1, characterized in that said microphone unit (4) is an accelerometer.

7. An ear microphone as claimed in one of the preceding claims to use in a full duplex ear communication unit, characterized in that said microphone has a softly suspended (8) electroacoustic sound generator (7) mounted in a side of the holder (2) facing the auditory meatus.



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8. An ear microphone as claimed in 6, characterized in that a vibration absorbing insert (9) is mounted in an area of the holder (2) between the sound generator (7) and the microphone unit (4).

9. An ear microphone as claimed in 6, characterized in that the entire holder is made substantially of a heavy vibration absorbing material having a density greater than 2 g/cm³, e.g. metal.

10. An ear microphone as claimed in 1 through 9, characterized in that said microphone comprises means for allowing the feeder cable (3) to be replaced by a wireless transmission.



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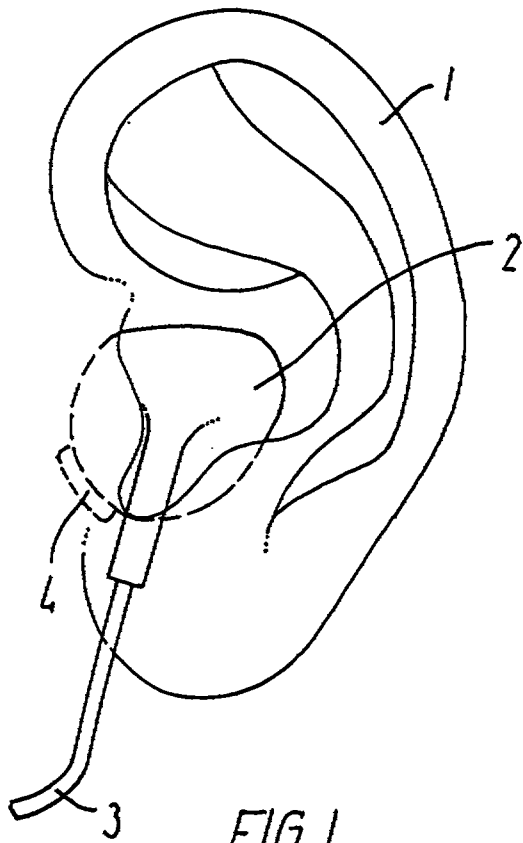


FIG. 1

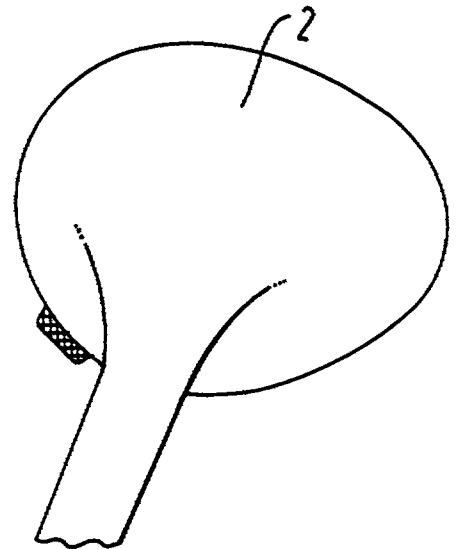


FIG. 1a

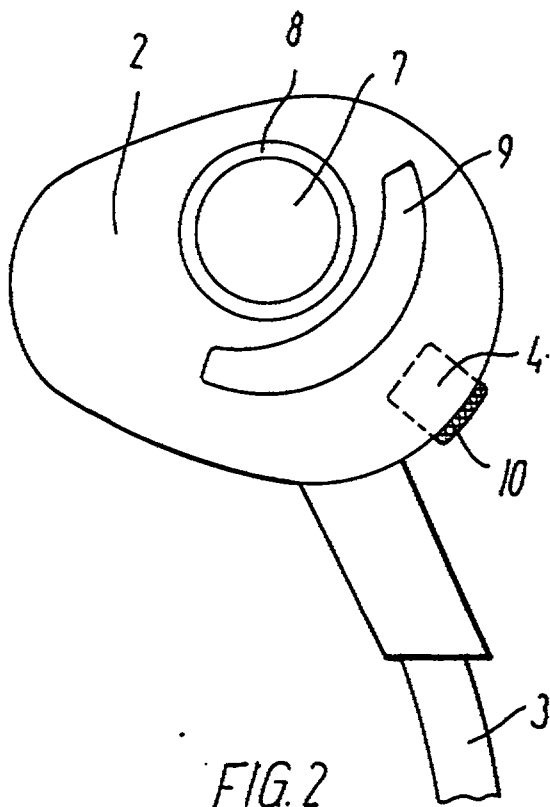


FIG. 2

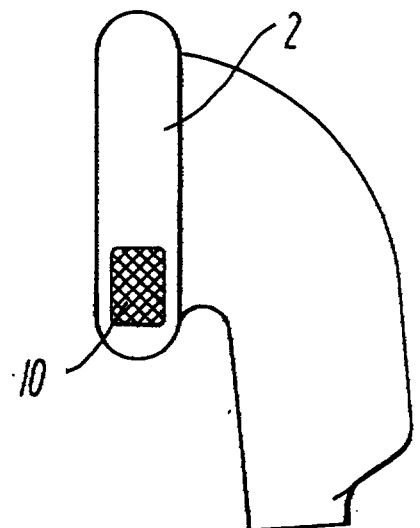


FIG. 2a

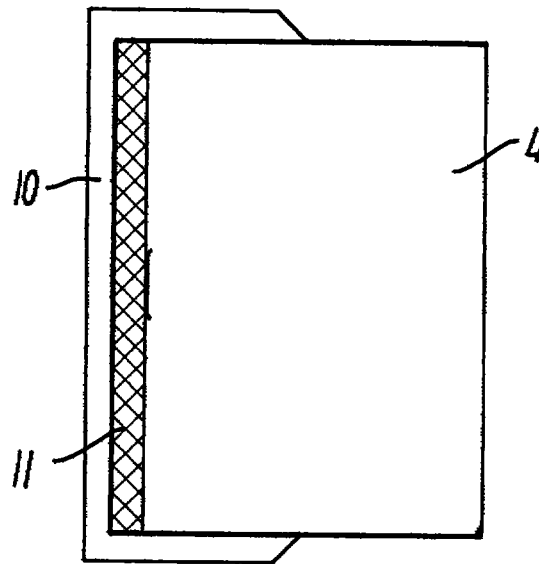


FIG. 3

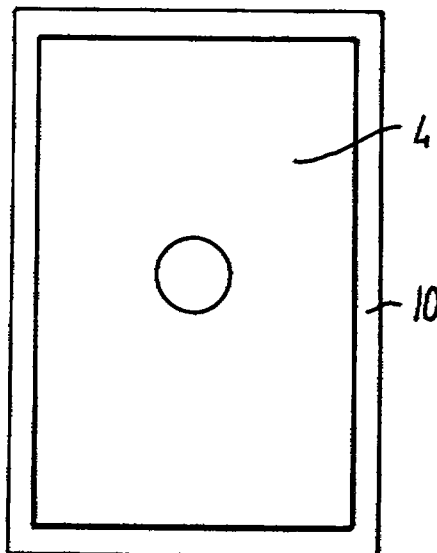


FIG. 3a

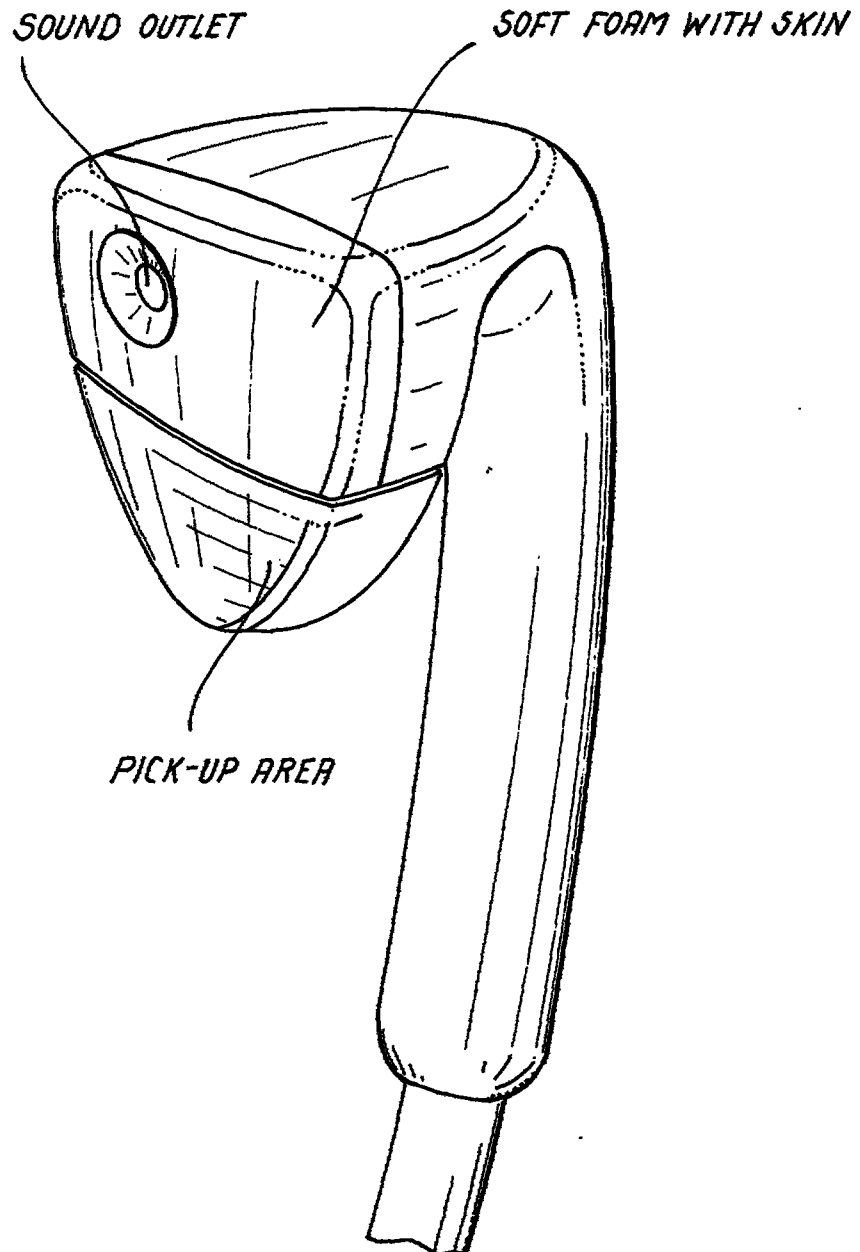


FIG. 4

ABSTRACT

An ear microphone for insertion in the ear in connection with portable telephones or radios.

An ear microphone (2) for insertion in the ear (1) in connection with portable telephones or radios.

An ear microphone (2) for insertion in the outer ear (1) comprises e.g. a microphone (4) and a sound generator (7) designed to avoid a hand operated phone.

The ear microphone (2) is based on tissue transmitted sound transferred directly from vocal cords to microphone (4) by contact in the ear (1) of the rubber coating (10) of the microphone (4) against tragus.

Microphone (4) comprises attenuation of low-frequency sound, and microphone (4) provided with rubber coating (10) has a minimal sensitivity to airborne sound, whereby use in noisy surroundings is enabled.

Arrangement of the ear microphone (2) in the outer ear (1) prevents those inconveniences caused by use of constructions based on arrangement in the inner ear.

(Please note that Figure 4 should accompany the abstract when published)

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ABSTRACT

An ear microphone for insertion in the ear in connection with portable telephones or radios.

An ear microphone (2) for insertion in the ear (1) in connection with portable telephones or radios.

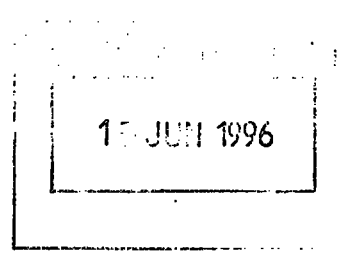
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Arrangement of the ear microphone (2) in the outer ear (1) prevents those inconveniences caused by use of constructions based on arrangement in the inner ear.

(Please note that Figure 4 should accompany the abstract when published)



✓ 1. Title
 ✓ 2. Invention
 ✓ 3. Drawing(s) : page 1 to page 8
 ✓ 4. Claim(s) : page 1 to page 3/4
 ✓ 5. Abstract : page 1 to page 1

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Substitute sheet - 10 July 1998

DATE OF RECEIPT 10/7/98

AN EAR MICROPHONE FOR INSERTION IN THE EAR IN CONNECTION WITH PORTABLE TELEPHONES OR RADIOS

Description

The present invention relates to an ear microphone comprising a microphone unit mounted in a holder for reception of speech sounds transmitted by tissue from the wearer, the microphone unit being insensitive to air-borne sound signals.

DK-B-159190 discloses an earplug designed for arrangement in the auditory meatus thereby requiring individual adjustment. The arrangement in the inner ear causes various drawbacks that in addition to the individual adjustment are an uncomfortable feeling of pressure in the auditory meatus, sweat in the ear, pollution by cerumen, loss of sense of sound localization when one auditory meatus is blocked etc. The earplug is deliberately designed to suppress sound (noise) coming from the outside. The microphone must be sensitive to air-borne sound signals as the signals arrive at the microphone through internal ducts from the area of the plug the exterior of which is provided with recesses to absorb the sound signals from the soft tissue in the auditory meatus.

From GB-A-2 197 158 an ear telephone is known which is designed for being plugged into the auditory meatus. Possibly, the vibration transducer is a piezoelectric element. The design seems to imply that the whole holder is set to vibration, and since the holder is relatively heavy, the consequence must necessarily be that the sound transmission must be of a lowpass nature.

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DK-B-135480 discloses a holder designed to cover the whole ear and consequently, it cannot be worn discreetly. The microphone is a pressure-gradient microphone that has to be in contact with the jawbone in front of the ear. This can only be obtained by strapping the microphone on to the head.

DE 4019529 A1 discloses an ear microphone receiving and transmitting the sound via the jawbone in front of the ear, and likewise a clamp across the head is required.

EP-B-0 092 822 discloses a device also designed for being pressed into the auditory meatus - like GB-A-2 197 158.

The object of this invention is to avoid the above-mentioned drawbacks of the known ear microphones.

This is achieved by an ear microphone characterized in that the holder is designed for arrangement in its entirety in the outer ear outside the auditory meatus, and the microphone unit being mounted in vibration transmitting tissue contact in a part of the edge of the holder facing the bottom of tragus.

Thus, it is obtained that when the holder can be positioned in the outer ear outside the auditory meatus, individual adjustment is avoided, easy insertion into the ear is achieved and the holder is not being smeared with cerumen. Furthermore, a better comfort is obtained, and an inconvenient feeling of pressure in the auditory meatus as well as sweat in a plugged auditory meatus is

avoided. Moreover, outer sounds are not necessarily totally shut off.

When people talk, vibrations in the throat and vocal cords are generated. These vibrations propagate through the bony and liquid-filled tissue. Especially the jawbone which passes near the front part of the outer ear produces a strong transmission and transfers considerably more "teeth sounds" than if the signal was collected in the throat.

For an ear microphone to be used for full duplex, sufficient separation between input and output must be present in order to avoid self-resonance.

In order to increase the separation in the ear microphone, the sensitivity to vibrations can be increased, and the sensitivity to acoustic sounds can be decreased. Thus, a microphone being unable to hear anything is desirable. At the same time, this results in the advantage of suppression of the surrounding noise.

A microphone having a tight rubbery coating is very sensitive to movements of the coating. The air pressure produced underneath the coating cannot escape for which reason a strong sound pressure is produced on the microphone membrane.

If the area of the coating ($h \times w$) is large compared to the volume ($t \times h \times w$), the sensitivity can be geared. The sound pressure is proportional to

$$\frac{\text{area} \times \text{movement}}{\text{volume}} = \frac{(h \times w \times \Delta l)}{(h \times w \times t)}$$

This relation is useful only to low source impedance action on the rubber coating, e.g. direct skin contact and not air. Further, the relatively large mass compared to air of the rubber coating attenuates about 25 dB of airborne sound.

The microphone of the ear microphone is a standard microphone unit, the sound pressure sensitive face (wall) of which is substantially hermetically covered by a coating of flexible material. In use, the coating is in vibration transmitting contact with the tissue. This coating renders the microphone substantially insensitive to airborne sound and due to the soft material, the ear microphone becomes pleasant to wear.

Therefore, the ear microphone can be used in noisy surroundings without transferring any appreciable noise to the microphone which receives the vocal sound by direct transfer through the bottom of the ear at tragus.

The ear microphone is preferably provided with low-frequency cutoff. Due to the tissue transmitted sound spectrum in which low-frequency content is dominating, it is advantageous having the low-frequency dominance removed already in the receiving phase as this low-frequency dominance may cause overamplification in the electrical system.

The ear microphone may be used in a full duplex ear communication unit by having a softly suspended electroacoustic sound generator mounted in a side of the holder facing the auditory meatus.

Thus, the ear microphone may be used for e.g. portable telephones in cars under which circumstances it is desirable that the user during the conversation can have both hands free to manoeuvre the car.

Similarly, the ear microphone may advantageously be used for simplex radiophones, e.g. by the police and fire brigade, wherein the unit in the ear may be worn hidden under the helmet or face guard without being inconvenient during the work.

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In the ear microphone, a relatively heavy vibration absorbing insert reducing vibrations from the electroacoustic sound generator to the microphone may be mounted in an area of the holder between the sound generator and the microphone unit.

The present invention will now be explained with reference to the accompanying drawing, wherein

fig. 1 shows the ear microphone positioned in the left ear,

fig. 1a the ear microphone removed from the ear,

fig. 2 the position of the units in the ear microphone,

fig. 2a the position of a microphone coating in the ear microphone,

fig. 3 the microphone unit seen from the side with spacing foam and microphone attenuation coating

fig. 3a the microphone unit with microphone attenuation coating glued thereto, and

fig. 4 the design concept of the ear microphone.

Fig. 1 shows the position of an ear microphone in the outer ear with a microphone unit 4 in contact with the bottom of tragus. The microphone unit 4 is mounted in a holder 2. If applied to the right ear, an ear microphone in a mirror-inverted embodiment is used. The microphone unit may e.g. be an accelerometer.

The position of the individual units in the ear microphone appears from fig. 2, wherein a feeder cable 3 connects microphone unit 4 and a sound generator 7 to an external unit. The feeder cable 3 can be replaced by the use of wireless transmission. A heavy oscillation reducing insert 9 is embedded between microphone unit 4 and

sound generator 7. The sound generator 7 is embedded in a thin layer of attenuation foam 8.

Fig. 3 shows the microphone unit 4 covered with sound transparent foam 11 and rubber 10 glued thereto for attenuation of airborne sound.

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Claims

1. An ear microphone comprising a microphone unit (4) mounted in a holder (2) for reception of speech sounds transmitted by tissue from the wearer, the microphone unit being insensitive to airborne sound signals, characterized in that the holder (2) is designed for arrangement in its entirety in the outer ear outside the auditory meatus, and the microphone unit (4) being mounted in vibration transmitting tissue contact in a part of the edge of the holder (2) facing the bottom of tragus.
2. An ear microphone as claimed in 1, characterized in that the sound pressure sensitive face of the microphone unit (4) is substantially hermetically covered by a coating (10) of a flexible material which in use is in vibration transmitting contact with the tissue.
3. An ear microphone as claimed in 2, characterized in that said coating (10) is made of a rubber elastic material.
4. An ear microphone as claimed in 1, 2 or 3, characterized in that said microphone unit (4) is positioned inside the holder (2) and is connected with a sound duct, said sound duct being substantially hermetically connected with said coating (10).



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5. An ear microphone as claimed in 1 through 4, characterized in that said microphone unit (4) has a low-frequency cutoff.
6. An ear microphone as claimed in 1, characterized in that said microphone unit (4) is an accelerometer.
7. An ear microphone as claimed in one of the preceding claims for use in a full duplex ear communication unit, characterized in that said microphone has a softly suspended (8) electroacoustic sound generator (7) mounted in a side of the holder (2) facing the auditory meatus.
8. An ear microphone as claimed in 7, characterized in that a vibration absorbing insert (9) is mounted in an area of the holder (2) between the sound generator (7) and the microphone unit (4).
9. An ear microphone as claimed in 1 through 7, characterized in that the entire holder is made substantially of a heavy vibration absorbing material having a density greater than 2 g/cm^3 , e.g. metal.
10. An ear microphone as claimed in 1 through 9, characterized in that said microphone comprises means for allowing the feeder cable (3) to be replaced by a wireless transmission.



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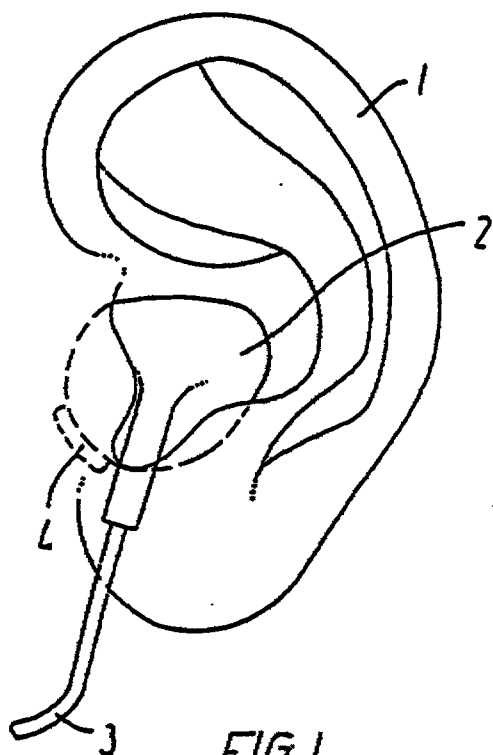


FIG. 1

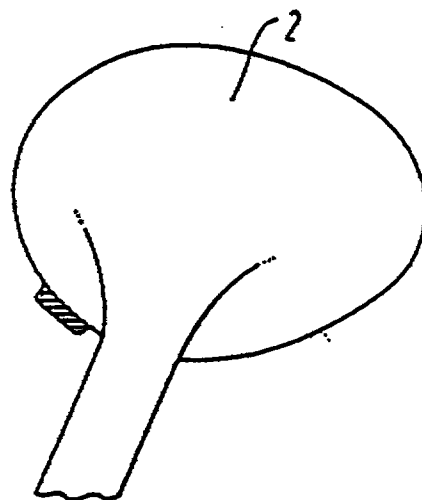


FIG. 1a

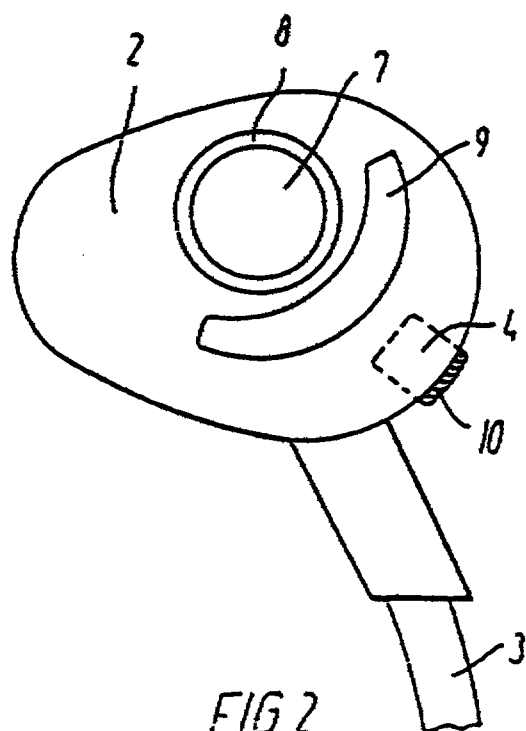


FIG. 2

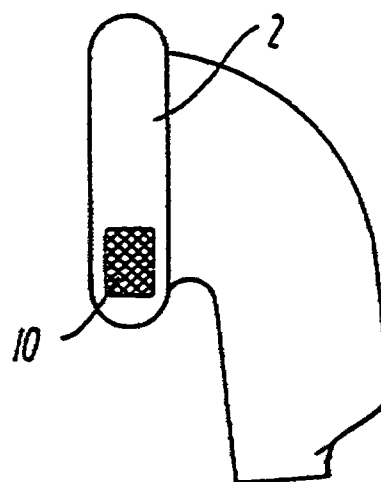


FIG. 2a

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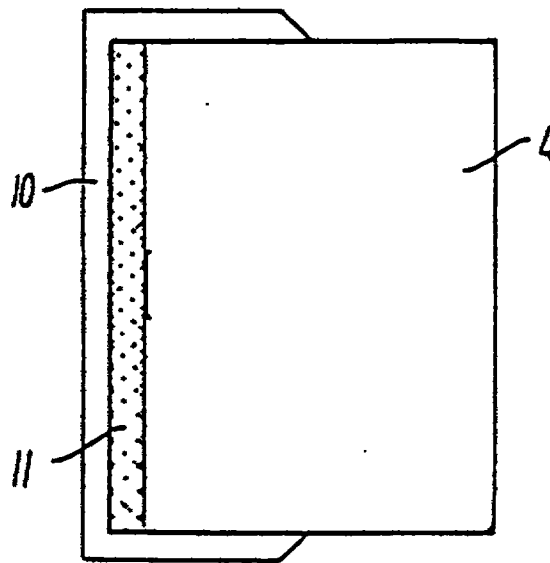


FIG. 3

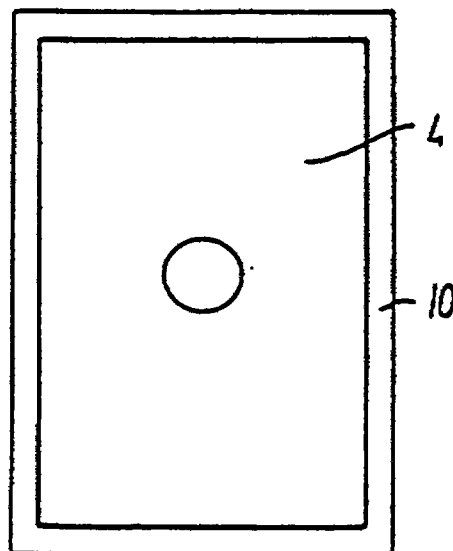


FIG. 3a

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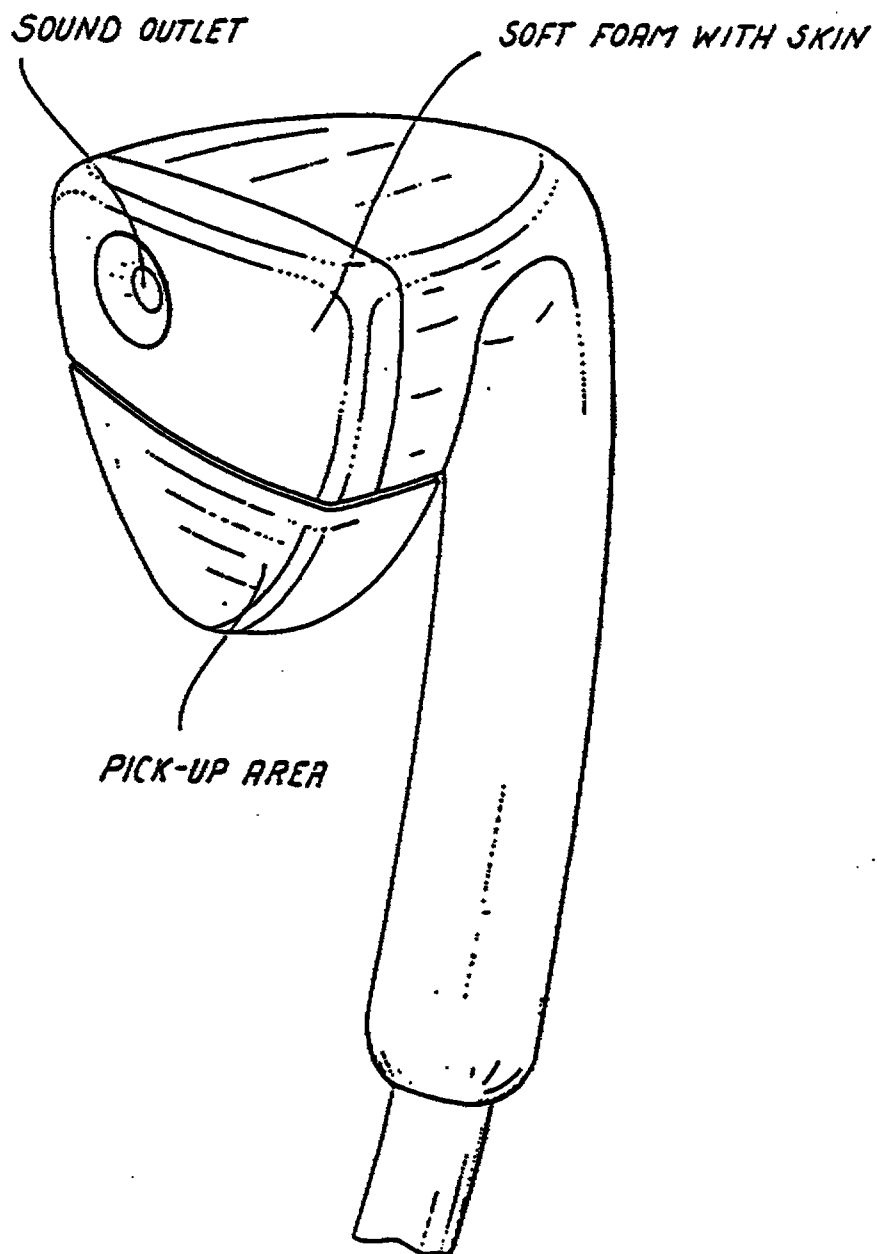


FIG. 4

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