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A sound recording system.

An artificial head (2) assembly has mounted therewithin a pair of microphones (10) each having the plane of its diaphragm (14) parallel to the axis (12) of the ear channel (8). The cavity (6) of the head (2) is rendered substantially anechoic by inclusion of sound-absorbing material (20, 22) therein. The arrangement provides a microphone colouration-free polar response for acoustic recording.

The present invention relates to a sound recording system including an artificial head having a channel which communicates at one end with an outer-ear structure and at the other end with a cavity within the artificial head, the system also including a microphone mounted within the head, which microphone has an acoustically active diaphragm.

So-called artificial head recording is described in "An electronic dummy for acoustical testing" by E.L. Torich et al., Journal of Audio Engineering Society 16 (4), pp 397-402 1968). The head itself generally has simplified structural and external ear features which are representative of the mean adult population. The head also has an acoustically matched microphone pair mounted in the sides of the head. The philosophy behind artificial-head recording is that sound to be recorded by each microphone within the head must first pass through the associated ear structure and thus is acoustically "shaped" in a manner analogous to the human hearing process.

United States Patent No. US-A-5,031,216 discloses an alternative, simpler arrangement in which the microphones (said to possess a unilateral pickup effect) are mounted in replicas of the outer-ears. The position in which the microphones are mounted is generally that which corresponds to the position of the pinna openings in a human head.

There exist, however, various shortcomings with these prior art arrangements. Firstly, with respect to the latter, the microphones are mounted such that they face outward from the head with the microphone surface flush with the opening of the pinna. Such a mounting arrangement suffers from problems associated with the intrinsic directionality of the microphones themselves. This is because all microphones have differing frequency response characteristics for sounds which are incident from different directions. It is generally possible to attain a relatively flat frequency response when the sound source is on-axis with respect to the microphone; but when the sound source is off-axis, say 45° off-axis, then the high-frequency sensitivity of the microphone is considerably reduced because the sound pressure waves approach obliquely and must therefore diffract around and into the diaphragm cavity of the microphone. Shorter wavelengths do not achieve this as efficiently as the longer wavelengths.

Secondly, in respect of the former, it is possible for sound energy which has passed through and entered the ear to be reflected back out therethrough by the walls of the cavity in the dummy-head. This sound energy may then impinge upon some of the external ear surfaces and cause further parasitic resonances and undesirable secondary reflections back into the ear, or into the microphone.

It is thus an object of the present invention to at least alleviate the aforementioned shortcomings by providing a recording system as defined in the open-

ing paragraph characterised in that: the microphone is mounted adjacent the channel such that the plane of the diaphragm is substantially parallel to the axis of the channel; and the cavity includes sound-absorbent material for providing a substantially anechoic said cavity. Thus by orienting the microphone in such a manner, a colouration-free (or constant-colouration) microphone configuration may be achieved having a uniform polar response in the horizontal plane. Furthermore substantially all the sound which passes through the ear may either be detected by the microphone, or absorbed.

Preferably a portion of a surface of the channel opposite the diaphragm is tapered, in a direction from the outer-ear structure to the cavity, the taper being away from the microphone such that any sound in this portion tending to reflect between the microphone and the said surface of the channel is directed toward the cavity. This aims to avoid the formation of a parasitic resonance region adjacent the microphone.

Advantageously the sound-absorbent material is arranged to substantially fill the cavity and may comprise a plurality of materials of differing acoustic absorbencies and/or reflectances. Alternatively the sound-absorbent material may comprise a plurality of acoustic baffles substantially lining the inside of the cavity.

The microphone may be mounted inside the cavity.

The present invention will now be described, by way of example only and with reference to the accompanying drawings, of which:

Figure 1 illustrates schematically a conventional microphone mounting arrangement in a dummy-head;

Figure 2 illustrates schematically a microphone mounting arrangement according to the present invention;

Figures 3 and 4 illustrates schematically alternative anechoic cavities in accordance with the present invention, and;

Figures 5a and 5b show alternative embodiments of the present invention.

Referring firstly to figure 1 a conventional artificial head 2 has an outer-ear structure 4 communicating with a cavity 6 inside the head 2 via a channel 8.

A cylinder microphone 10 is mounted within the cavity 6 and oriented such that the axis of the cylinder microphone 10 is co-axial with the axis of the channel 8. In this manner, the diaphragm 14 of the microphone lies orthogonal to the axis 12 of the channel 8.

Although such a cylinder microphone 10 is claimed to be "omni-directional", having a bright on-axis response (that is an enhanced high-frequency response with respect to the remainder of the audio band within which it operates), there is a reduced off-axis sensitivity at high frequencies. It has been found, for example, that for such a microphone, the response

at 10 kHz is around 4dB reduced at 45° incidence compared to an on-axis incidence.

Furthermore the microphone 10 orientation shown in figure 1, due to it being mounted within the head so as to be a termination to the channel 8, provides a semi-closed cavity in this region. This semi-closed cavity has an inherent resonance frequency which is undesirable during recording operations and is especially so because the diaphragm 14 itself acts as the terminating wall of this semi-closed cavity and therefore absorbs a great deal of the sound energy present.

Referring now to figure 2 it can be seen how the invention aims to obviate the problems associated with reduced off-axis response. The microphone 10 is mounted within the cavity 6 adjacent the channel 8 but turned through 90° with respect to Figure 1 such that the plane of the diaphragm 14 is now substantially parallel to, rather than orthogonal as in Figure 1, the axis 12 of the channel 8. The cavity 6 contains sound-absorbing material such as rock-wool. This orientation provides a "colouration-free" microphone configuration for sound sources in, say, the horizontal plane, when the head 2 is held in an upright position. So if a sound source is moved around the microphone in a complete circle in this horizontal plane, then there are no significant changes to the spectral content of the corresponding signal caused by the microphone 10 itself, the only spectral changes are those attributable to the acoustic modification caused by the artificial head and outer-ear devices.

This is understood by appreciating that, in the configuration illustrated in Figure 2, all sound sources (not shown) in the horizontal plane always subtend the same angle with respect to the plane of diaphragm 14, namely 90°. Thus a substantially uniform polar response is achieved.

Considering now figure 3, which incorporates the microphone 10 orientation as illustrated in Figure 2, it can be seen that the head 2 cavity 6 no longer contains a single sound-absorbent material, rather the cavity 6 is compartmentalized such that it comprises a central sound-absorbing partition 16 which prevents internal acoustic crosstalk to the other ear (not shown because only half of the whole artificial head has been illustrated for clarity), an absorbing lining in this example, rubber 18 to inhibit resonances of the head moulding, an absorber layer of, in this case, rock-wool 20 having a large acoustic absorption coefficient for example 0.75 at 1 kHz and a further absorbing layer, here polyester fibre 22 having a very small acoustic reflection coefficient for example 0.95 at 1 kHz. The overall effect of these absorbing materials is to provide a substantially anechoic cavity 6 such that no stray energy is therewithin which could interfere with the diaphragm 14 once sound has entered the ear 4, passed through the channel 8 and been sensed by the microphone 10.

It will also be observed from figure 3 that a part 24 of the surface, the channel 8 opposite the diaphragm 14 tapers away from the diaphragm 14 in a direction through the channel 8 from the ear 4 toward the cavity 6. By ensuring that the surface part 24 is angled such that it is not parallel to the plane of the diaphragm 14, then a parasitic resonance cavity in the vicinity of the microphone 10 is avoided. The surface part 24 must, however, be angled so as to reflect any stray or residual sound back into the substantially anechoic cavity 6.

Referring now to Figure 4, an alternative structure for the substantially anechoic cavity 6 to that of Figure 3 is illustrated. Here it can be seen that the absorbing layers 20 and 22 have been replaced by a plurality of acoustic baffles, in this case wedges 26 of rock-wool. The wedges 26 are arranged to substantially line the entire inner surface of the cavity 6. It will be appreciated that such wedges provide good acoustic absorption and so render the cavity 6 substantially anechoic. Furthermore inclusion of the rubber 18 is desirable in figure 4, although not essential.

Figure 5 illustrates embodiments of the present invention wherein the cranial and facial features of the artificial head 2 have been removed and a pair of ear 4/microphone 6 assemblies are each mounted in a casing unit 25. In these figures the ear 4 communicates with the cavity 6 via the channel 8 in the same manner as described herebefore. Figure 5a illustrates the detail of one of the microphones 10 which, in pairs (figure 5b), find particular application in live-recording situations, because the presence of the entire (and physically large) head 2 may be unacceptable. A clip 28 provides the mounting facility.

Figure 5b illustrates the practical configuration of a pair of the Figure 5a assemblies mounted onto a bar 30 and spaced apart such that the channels 8 are separated by a distance D which can be chosen to be the mean human inter-aural separation (~19 cm). The whole assembly is held on a stand 32.

Those skilled in the art will appreciate that there are always practical limitations in the efficiency of the anechoic cavity 6 of the artificial head 2. Consequently there will be a slight deviation from the ideal, flat, on-axis frequency response of the microphone 10/channel 8/cavity 6 combination (but without the outer-ear structure 4 in place). Furthermore because the microphone 10 is placed, in accordance with the present invention, in an off-axis mode, the high-frequency performance will be reduced compared with its on-axis characteristics. Both of these aspects, however, can be corrected by spectral modification of the signals produced by the microphone 10 (so called equalisation), either immediately or during subsequent processing of the recorded material. In any event the concepts of equalisation are known to those skilled in the art and are not germane to the present invention and so will not be discussed herein.

It will be understood that in the foregoing, the limitation that the cavity 6 be "substantially" anechoic is intended to cover the practical case that, by equalisation techniques, any reflectances which do occur in the cavity 6 may be ignored by processing equipment, yet acknowledging that no perfectly anechoic cavity can actually exist.

Similarly, the limitations placed on the diaphragm 16 being "substantially" parallel to the axis 12 of channel 8 are such that deviations from precisely parallel adjustment for which any processing may compensate are tolerable. However beyond, say $\pm 30^\circ$ off this parallel alignment, the polar response of the microphone 10 when mounted within the artificial head 2 in accordance with the present invention becomes too distorted to achieve the desirable effects provided by the present invention.

Claims

1. A sound recording system including an artificial head having a channel which communicates at one end with an outer-ear and structure at the other end with a cavity within the artificial head, the system also including a microphone mounted within the head and which microphone has an acoustically active diaphragm, the system characterised in that:

the microphone is mounted adjacent the channel such that the plane of the diaphragm is substantially parallel to the axis of the channel;

and the cavity includes sound-absorbent material for providing a substantially anechoic said cavity.

2. A sound recording system according to Claim 1 wherein a portion of a surface of the channel opposite the diaphragm is tapered, in a direction from the outer-ear structure to the cavity, the taper being away from the microphone such that any sound in this portion tending to reflect between the microphone and the said surface of the channel is directed toward the cavity.

3. A sound recording system according to either of Claim 1 or Claim 2 wherein the sound-absorbent material is arranged to substantially fill the cavity.

4. A sound recording system according to Claim 3 wherein the sound-absorbent material comprises a plurality of materials each of differing acoustic absorbency and/or reflectance.

5. A sound recording system according to either Claim 1 or Claim 2 wherein the sound-absorbent material comprises a plurality of acoustic baffles substantially lining the inside of the cavity.

6. A sound recording system according to any one of the preceding claims wherein the microphone is mounted within the cavity.

7. A sound recording system including: a channel which communicates at one end with an outer-ear structure and at the other end with a cavity, the system also including a microphone mounted adjacent the channel; which microphone has an acoustically active diaphragm arranged such that the plane of the diaphragm is substantially parallel to the axis of the channel; the channel having a portion of the surface thereof opposite the diaphragm tapered, in a direction from the outer-ear structure to the cavity, the taper being away from the microphone such that any sound in this portion tending to reflect between the microphone and the said surface of the channel is directed toward the cavity; and wherein the cavity includes sound-absorbent material for providing a substantially anechoic said cavity.

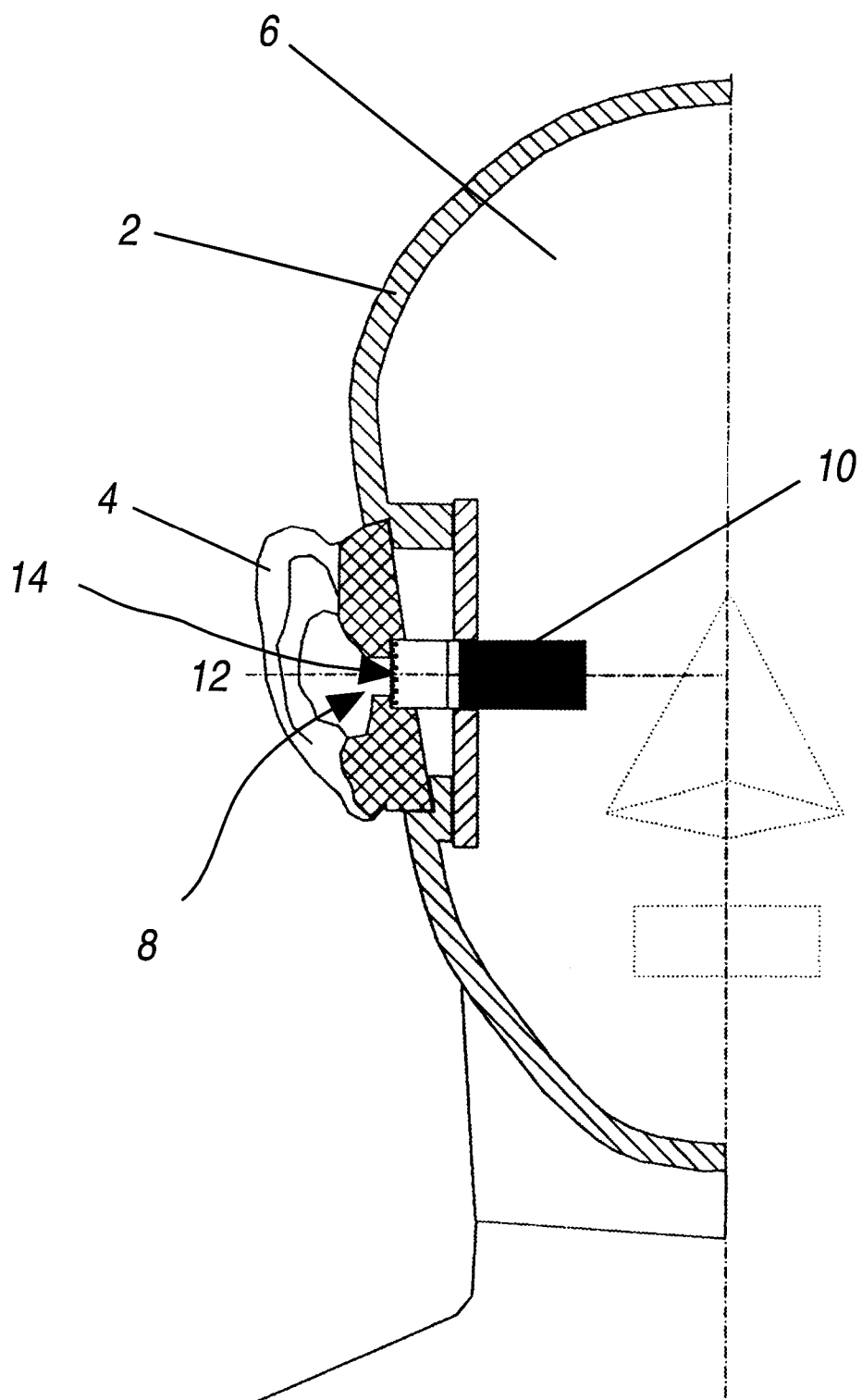


Fig.1.

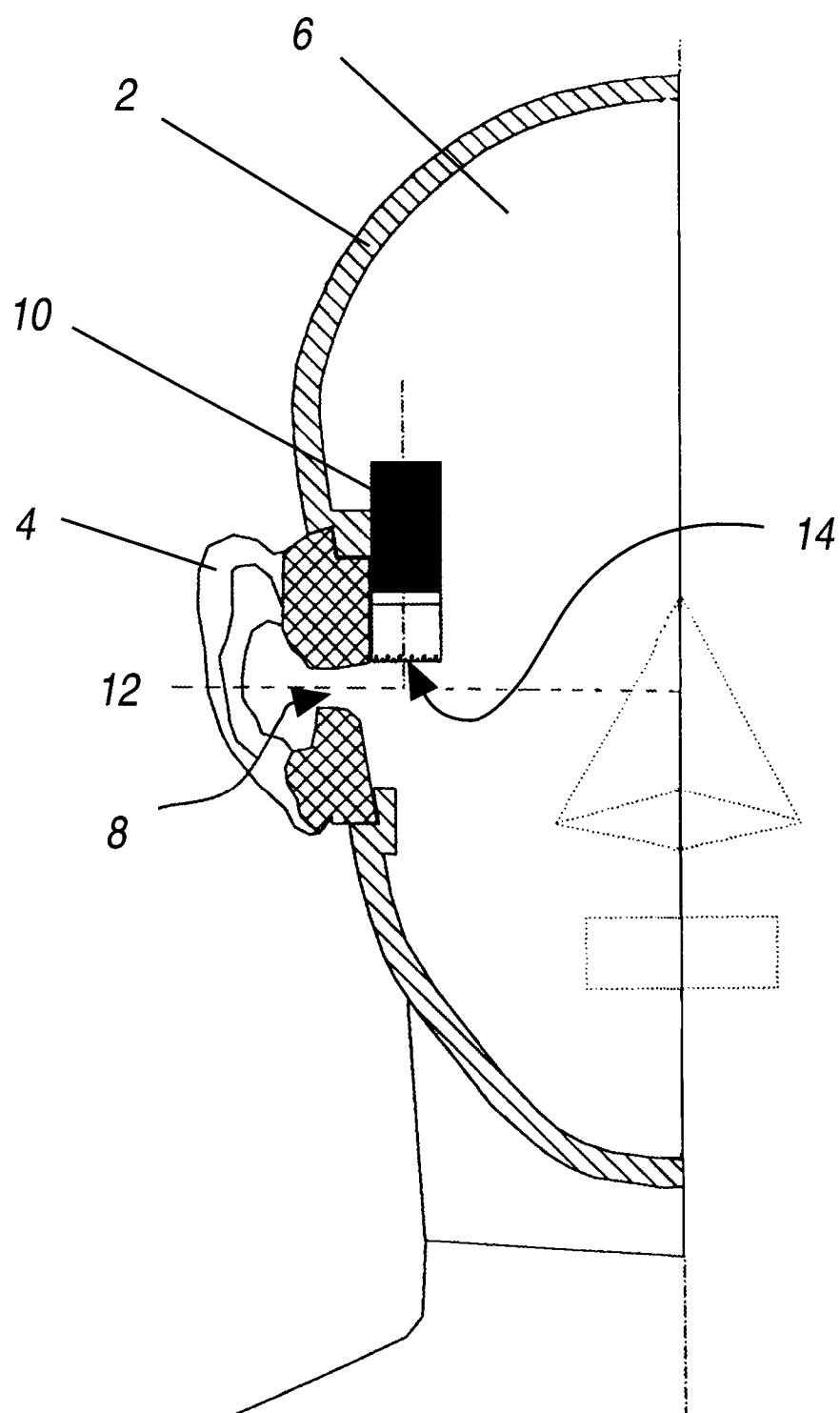


Fig.2.

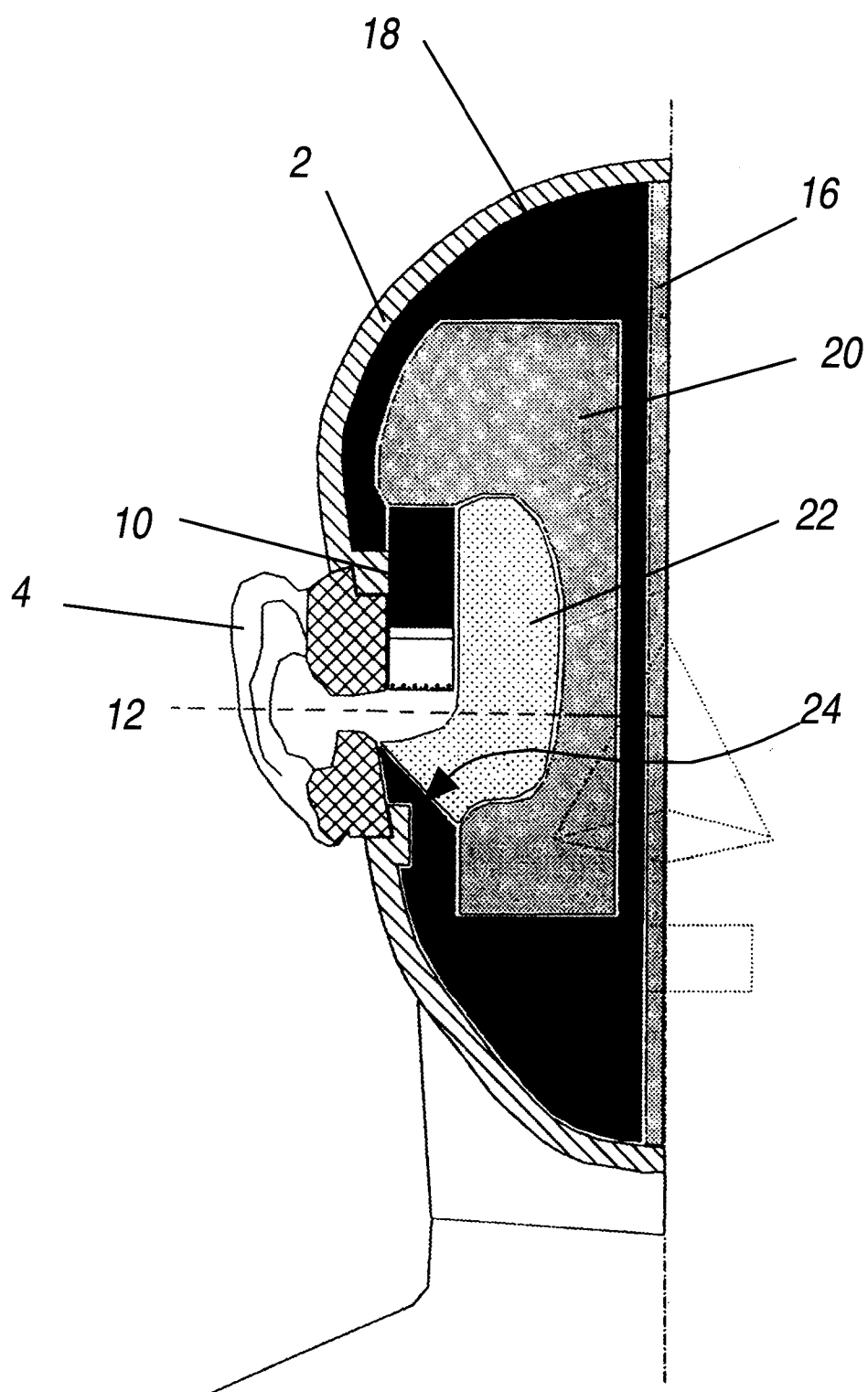


Fig.3.

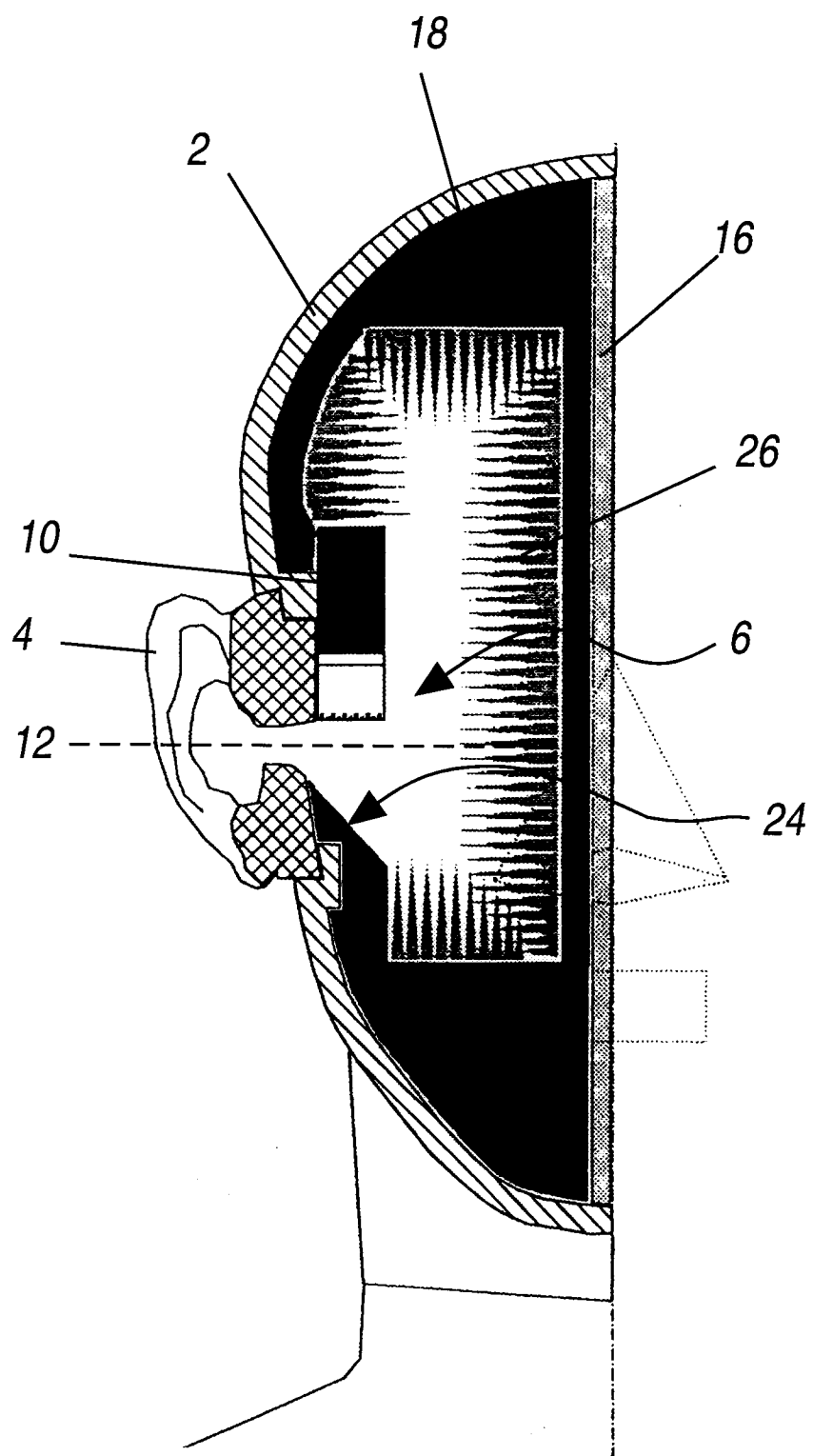


Fig.4.

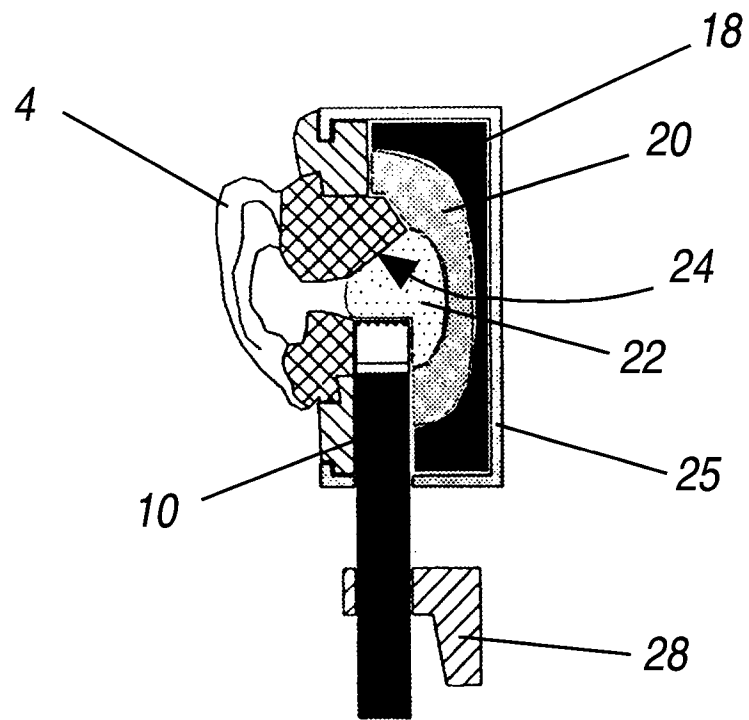


Fig.5a.

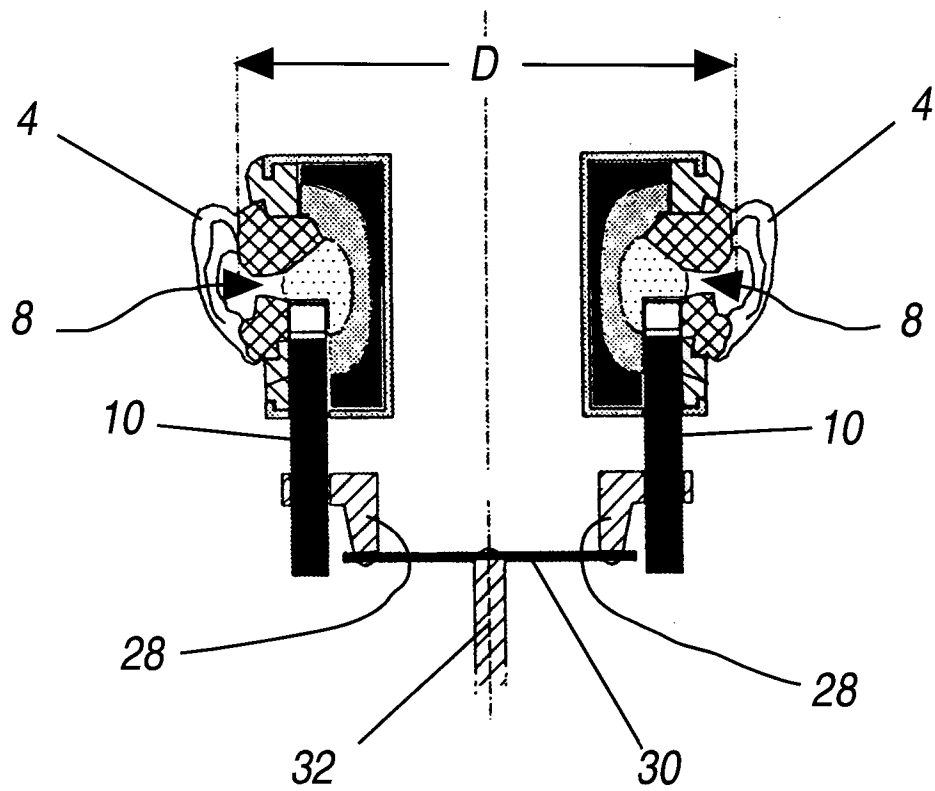


Fig.5b.

Figs.5.



European Patent
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EUROPEAN SEARCH REPORT

Application Number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 94305196.1
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 6)
A	EP - A - 0 050 100 (ZUCCARELLT) * Totality *	1,7	H 04 R 5/027
A	US - A - 4 741 035 (K. GENUTT) * Description *	1,7	
A	AT - B - 388 636 (AKG) * Claims *	1,7	
A	AT - B - 386 504 (AKG) * Totality *	1,7	
A	DE - A - 3 619 950 (INST. F. RUNDFUNKTECHNIK) * Fig. 1 *	1,7	
A	EP - A - 0 056 479 (G. NEUMANN GMBH) * Totality *	1,7	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 6)
			H 04 R 5/00 H 04 S 1/00
The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 03-11-1994	Examiner ZUGAREK
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			

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