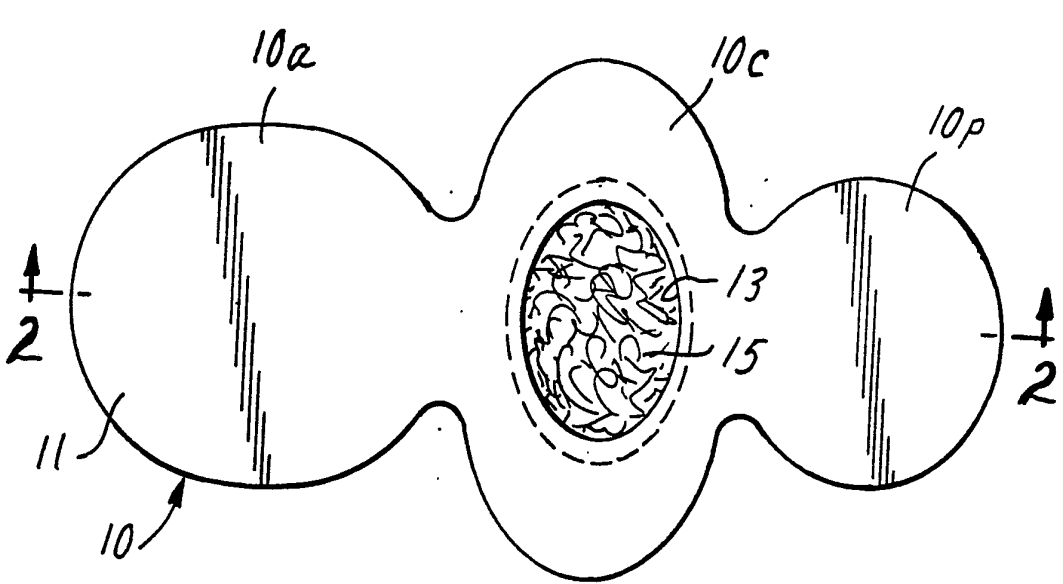


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b>  <b>H04R 25/02</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 93/12626</b>  <b>(43) International Publication Date:</b> 24 June 1993 (24.06.93)
<p><b>(21) International Application Number:</b> PCT/US92/10231</p> <p><b>(22) International Filing Date:</b> 27 November 1992 (27.11.92)</p> <p><b>(30) Priority data:</b> 803,576                      9 December 1991 (09.12.91)    US</p> <p><b>(71)(72) Applicant and Inventor:</b> OLIVEIRA, Robert, J. [US/US]; 200 Crestview Drive, Maplewood, MN 55119 (US).</p> <p><b>(74) Agent:</b> BRINK, Richard, E.; 4738 Bouleau Road, White Bear Lake, MN 55110-3355 (US).</p> <p><b>(81) Designated States:</b> AU, BR, CA, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p>		<p><b>Published</b> <i>With international search report.</i></p>
<p><b>(54) Title:</b> CERUMEN FILTER FOR HEARING AIDS</p> <div style="text-align: center;">  </div> <p><b>(57) Abstract</b></p> <p>A readily installed and replaced disposable wax guard that is affixed over the sound outlet port of an "in the ear" hearing aid and adhered to the adjacent sides of the aid. The portion that overlies the sound outlet port is porous to sound and receptive to cerumen.</p>		

*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NL	Netherlands
BE	Belgium	GN	Guinea	NO	Norway
BF	Burkina Faso	GR	Greece	NZ	New Zealand
BG	Bulgaria	HU	Hungary	PL	Poland
BJ	Benin	IE	Ireland	PT	Portugal
BR	Brazil	IT	Italy	RO	Romania
CA	Canada	JP	Japan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SK	Slovak Republic
CI	Côte d'Ivoire	LJ	Liechtenstein	SN	Senegal
CM	Cameroon	LK	Sri Lanka	SU	Soviet Union
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	MC	Monaco	TG	Togo
DE	Germany	MG	Madagascar	UA	Ukraine
DK	Denmark	ML	Mali	US	United States of America
ES	Spain	MN	Mongolia	VN	Viet Nam
FI	Finland				

## CERUMEN FILTER FOR HEARING AIDS

Background of the Invention

This invention relates to preventing cerumen, or ear wax, from interfering with the operation of sound transmission devices, especially "in the ear" hearing aids, and is particularly concerned with a novel filter for achieving that result.

The human outer ear comprises the visible external ear, or pinna, and a dynamic S-shaped canal that has a generally oval cross section and is about an inch (2.5 cm) long. Cerumen is secreted by the walls of the canal in the outer half inch (1.2 cm) or so and gradually moved outward; some believe that this outward movement is brought about by cilia in the walls, but more likely it is caused by the natural action of the ear canal. When a hearing aid is inserted into the outer 1/4 inch (about 0.6 cm) of the canal, it becomes susceptible to cerumen, which mixes with sloughed off skin and often fouls the hearing aid's sound delivery tube, thereby reducing its efficiency.

When the sound delivery tube of a hearing aid clogs with cerumen and reduces the effectiveness of sound transmission, the wearer of a hearing aid typically turns up the volume control. This in turn results in two undesirable conditions. Not only does the hearing aid battery wear out more quickly with certain types of circuit, but the likelihood of embarrassing and frequently painful feedback howl also increases. Most importantly, cerumen in the sound tube of the hearing aid is the basis for large numbers of costly hearing aid repairs.

There have been numerous attempts to modify hearing aids to avoid the problems discussed in the preceding paragraphs. Thus, for example, U.S. Pats. No. 4,870,689 and 4,972,488 disclose a tubular passage having a series of baffles that define a "tortuous path" that the wax must travel before reaching the sound tube. U.S. Pat. No. 4,800,982 describes a hearing aid through which solvent may be pumped to remove wax buildup. U.S. Pat. No.

4,953,215 describes a hearing aid in which a domed membrane having a small central opening is provided, wax being said to accumulate in a ring around the base of the membrane.

Still others have attempted to devise some type of filter to prevent ear wax from reaching the sound delivery tube. For example, U.S. Pats. No. 3,414,685 and 4,984,277 discuss various prior art wax filters, noting the apparent difficulty in replacing them after they are soiled. In each case, the patentees' approach to the problem is to provide a one-piece plastic part that has numerous openings around the periphery and snaps around the sound delivery tube opening. A somewhat similar device is shown in U.S. Pat. No. 4,553,627, where a snap-on wax guard has a cross passage through its head that intersects an axial passage in its stem; ear wax is removed by pushing a tool through the cross passage. Still others have mechanically mounted screens or other filters beyond the sound delivery tube opening, but removal and replacement has been difficult, especially since persons wearing hearing aids are often advanced in years and unable either to see clearly enough or to perform fine physical actions well enough to replace the filters.

#### Brief Summary

The present invention provides a novel disposable wax guard for sound transmission devices that are inserted into the ear canal, especially "in the ear" hearing aids. It is simple to install, easy to remove, and convenient to replace, even for older persons. The guard is inexpensive and requires no tools for installation or removal. In many instances, the wax guard of the invention not only assists in retaining the sound transmission device in place in the ear canal but also improves the seal between the hearing aid and the dynamic ear canal. Although the use of the invention with such sound transmission devices as stethoscopes, miniaturized portable telephones, etc., is envisioned, for convenience, the major part of the description that follows will be addressed to "in the ear" hearing aids.

An "in the ear" hearing aid comprises a housing containing a microphone, a battery, an amplifier, and a speaker, the housing fitting within a user's ear canal. A sound-transmitting tube extends from the speaker to an outlet port at the portion of the housing closest to the ear drum. The present invention provides a readily installed and replaced disposable wax guard for mounting over the outlet port of the hearing aid to prevent cerumen from fouling it. This wax guard comprises a thin, strong carrier membrane adapted to be temporarily adhered over the portion of the hearing aid nearest to the ear drum, fixed in position over the outlet port, the portion of the guard overlying the outlet port being porous to sound and receptive to cerumen and the accompanying dermal detritus from the lining of the ear canal before it can foul the sound outlet port of the hearing aid. In another aspect, the invention provides a method of modifying a conventional "in the ear" hearing aid to render it resistant to cerumen. In still another aspect, the invention provides a method of forming an improved seal between the hearing aid and the dynamic ear canal. In a further aspect, the invention provides improved retention of small earpieces in the dynamic ear canal.

#### Brief Description of the Drawing

Understanding of the invention will be enhanced by referring to the accompanying drawing, in which like numbers refer to like parts in the several views, and in which:

FIG. 1 is a greatly enlarged plan view of one embodiment of the wax guard of the invention;

FIG. 2 is a cross-section of the wax guard of FIG. 1, taken along section line 2 - 2, looking in the direction of the arrows;

FIG. 3 is a view in perspective of a currently preferred embodiment of the invention;

FIG. 4 is a cross-sectional view of the wax guard of FIG. 3, taken along section lines 4-4, looking in the direction of the arrows;

FIG. 5 is a plan view of the lower adhesive-coated surface of the wax guard of FIG. 3;

FIG. 6 is an enlarged and simplified drawing of a human ear, showing an "in the ear" hearing aid mounted in the ear canal, with a wax guard of the invention in place;

FIG. 7 is a greatly enlarged plan view showing three wax guards of the type shown in FIG. 3 (the exact dimensions differing among the three), positioned on a release liner, with a folded release liner protecting each of the lobes of each wax guard; and

FIG. 8 is a cross-sectional view of the assembly shown in FIG. 7, taken along section line 8 - 8, looking in the direction of the arrows.

#### Detailed Description

Turning first to FIGs. 1 and 2, wax guard 10 comprises thin, strong, flexible carrier membrane 11 having attaching lobes 10a, 10p, and central lobe 10c, hole 13 being located approximately in the center of lobe 10c. One side of carrier membrane 11 is provided with a layer of normally tacky and pressure-sensitive adhesive 14, which serves to affix wax guard 10 to a hearing aid, with hole 13 positioned over the sound outlet port of the hearing aid. A nonwoven mat 15 of fine fibers is held in place by adhesive 14 in the area circumjacent to hole 13. If desired, hole 13 may be covered with a mesh fabric to help retain mat 15 in place.

Carrier membrane 11 is conveniently made from a white rayon acetate taffeta woven backing, combined with a layer of pressure-sensitive adhesive 14, the mild rugosity of the backing imparting a desirable frictional property when wax guards of the invention are used as subsequently described. One adhesive-coated product suitable for use in practice of the invention is available from Minnesota Mining and Manufacturing Company (3M) under the catalog designation "1538-L Woven Medical Tape on Liner." The adhesive on this product is a hypoallergenic acrylate, making it especially suitable for practicing the present invention.

Nonwoven mat 15 is desirably formed from a melt-blown mat of extremely fine oleophilic polypropylene fibers. Alternatively, the mat could be an appropriately sized disc formed from a web of oleophilic open cell foam.

5 Turning next to FIGs. 3 - 5, wax guard 30 comprises a thin, compressible, resilient, sound-transmitting, soft membrane layer 31 of reticulated open cell microporous foam. Wax guard 30 in turn comprises anterior and posterior attaching lobes 30a, 30p, and central lobe 30c.  
10 Laminated to the lower surface of foam membrane layer 31 is double-coated tape 32, comprising thin (about 0.0015-inch, or 6-micrometer) polyethylene film 33 and pressure-sensitive adhesive layers 34, 35. Central portion 36 of lobe 30c is free from tape 32. Thus, whereas tape 32 seals foam  
15 membrane 31 and destroys its sound-transmitting ability, central portion 36 remains open and continues to retain that ability. This embodiment of the invention is thus both simple and economical to make.

Attention is now directed to FIG. 6, showing wax  
20 guard 30 of FIG. 3 mounted on hearing aid 50. As is shown in FIG. 6, human outer ear 40 comprises pinna 41, concha 42, ear canal 43, and ear drum 44. Positioned within the outer portion of canal 22 is hearing aid 50, which includes the conventional battery, microphone, amplifier, and speaker  
25 (none of which are shown), with open-ended sound-transmitting tube 51 extending from the speaker to the inner end of hearing aid 50 and terminating in an outlet port. Wax guard 30 is positioned so that area 36 (which, it will be recalled, is free from pressure-sensitive adhesive tape) is  
30 mounted over the outlet port of sound transmitting tube 51, with adhesive-coated circumferential area 30c and lobes 30a and 30p adhered, respectively, to the inner end and anterior and posterior sides of hearing aid 50 to hold wax guard 30 in place. As previously pointed out, the outer portion  
35 of canal 43 is oval rather than circular in cross section, with the longer axis extending in a generally vertical plane. This ovality is reflected in the shape of central portion 31c of wax guard 30, and lobes 30a and 30p are accordingly intended to be mounted along the anterior and  
40 posterior sides of hearing aid 50. This positioning also

provides a somewhat snugger fit between hearing aid 50 and the wall of canal 43 and helps hold hearing aid 50 in place. This is especially important when chewing or talking causes the anterior wall of canal 43 to move in and out, which in turn causes the anterior-posterior dimension of the oval canal wall to contract and expand.

It will be noted that posterior attaching lobe 30p is smaller than anterior attaching lobe 30a, enabling it to conform easily to the concave posterior surface of any hearing aid. This is especially important for those hearing aids that are seated in concha 42, which do not extend to a great depth in canal 43 and have other plastic surfaces that can interfere with easy access to the concave posterior side of the canal-occupying part of the hearing aid.

Because foam membrane 31 is not only compressible but also resilient, sealing of hearing aid 50 against the wall of canal 43 can be maintained, even as the dimensions of canal 43 change during mastication or conversation. This improved sealing helps correct the extremely annoying feedback problem frequently encountered by hearing aid wearers while dining with friends or talking on the telephone. Indeed, it is contemplated by the inventor that different thicknesses or surface areas of foam layer 31 can be employed to achieve the desired result. Inasmuch as improper fit is one of the most frequent complaints made by persons who have just purchased hearing aids, it is believed that use of the wax guard of this embodiment of the invention may reduce such complaints. With respect to the improved sealing provided by the foam, attention is directed to the prior art product ER-13R "E-A-R RING", a ring formed from foam and intended to be slipped over the distal portion of a hearing aid to "seal leaky shells" and reduce feedback. Prior art devices of this type, which are available from Etymotic Research, Elk Grove Village, Illinois, USA, are not provided with pressure-sensitive adhesive (presumably because they would then be hard to install on a hearing aid), although the use of a drop of a permanent adhesive (e.g., tetrahydrofuran, which is presumably a solvent for the hearing aid 50) is suggested. In the absence



of adhesive, these rings have been known to remain in the ear canal after removal of the hearing aid, and if a strong adhesive is used, it will be hard to remove the ring from the hearing aid.

5           A currently preferred material for use as foam layer 31 is a polyester urethane foam about 0.05 inch (1.3 mm) thick, having about 100 pores per lineal inch (40 pores per lineal centimeter) and a void volume of about 97%. As mentioned previously, however, somewhat greater thicknesses  
10 may be appropriate for some individuals. This foam is also oleophilic, which is considered advantageous for use as a wax guard. Foams meeting these criteria are obtainable from Foamex under the trade designation "SIF Filter Foam."

          It is believed that a degree of stretchability  
15 of the foam product just described is desirable in attaining wrinkle-free conformance to hearing aids; thus, it may be feasible to provide one surface of reticulated foam directly with an adhesive. Greater strength can be imparted, however, by laminating the foam to a fine open mesh woven  
20 or nonwoven fabric (either of which might cover hole 36, 86, 96 without interfering with sound transmission) or, as in the product just described, to a double-coated tape.

          Attention is now directed to FIG. 7, which depicts the manner in which wax guards of the invention can  
25 be mounted for distribution to hearing aid dispensers or wearers of "in the ear" hearing aids. Three wax guards 30, 80, 90 are shown removably mounted on a conventional sheet of release liner 60, the adhesive-coated surface of posterior attaching lobes 30p, 80p, 90p, and central lobe  
30 30c, 80c, 90c being in contact with the release surface of liner 60. Anterior attaching lobes 30a, 80a, 90a are lifted above the surface of release liner 60, with folded release liner 70 contacting the adhesive-coated surface of lobes 30a, 80a, 90a. Liner 70 has two wings, 70a and 70b,  
35 the adhesive-coated surface of lobes 30a, 80a, 90a being in contact with wing 70a. When wax guard 30, 80, or 90 is to be mounted on hearing aid 50, the distal portion of wing 70b is grasped (preferably along with lobe 30a, 80a, or 90a, as appropriate), and the remainder of wax guard 30,  
40 80, or 90, peeled from release liner 60. Center lobe 30c,

80c, or 90c is then positioned over and circumferentially adhered to the sound outlet end of hearing aid 50 and exposed lobe 30p, 80p, or 90p then adhered to the posterior side of hearing aid 50. Wing 70a of folded release liner 5 70 is then removed from lobe 30a, 80a, or 90a while the latter is being adhered to the anterior side of hearing aid 50.

For convenience, the lined wax guard assembly shown in FIG. 7 can be distributed in a transparent plastic 10 envelope 92, which will ensure that wax guards 30, 80, and 90 do not become prematurely detached from either liner 60 or folded liner 70. It is contemplated that a kit containing a plurality of wax guards having a variety of thicknesses of reticulated open cell foam membrane 31, 81, 91 15 (e.g., 1/32, 1/16, and 1/8 inch, corresponding respectively to about 0.8, 1.6, and 3.2 mm) will prove useful to hearing aid dispensers, who can then provide the appropriate wax guard for an individual hearing aid wearer. Alternatively, as shown in FIG. 7, this kit could consist of wax guards in 20 which anterior attaching lobes 30a, 80a, 90a are of different dimensions

As still another alternative, single adhesive-coated lobes of different dimensions could be incorporated in a kit; although these lobes would not function as wax 25 guards, they could still be used to determine the appropriate degree of sealing to reduce or eliminate feedback caused by canal shape change resulting from jaw motion. Once the appropriate size has been determined, the adhesive-coated lobe could be used until it is soiled, after 30 which it would be replaced with a fresh lobe. It is further contemplated that, when using the feedback suppressing aspect of the invention, shape-retaining retarded recovery materials such as plasticized polyvinyl chloride (cf. U.S. Pat. Re. 29,487) or polyurethane (cf. U.S. Pat. No. 35 4,880,076) would be more efficient than the open cell reticulated foam used for wax entrapment and hence could be used in thinner sections.

Those skilled in the art will readily appreciate that the foregoing description is not intended to be exhaustive, and numerous variations of the invention can be 40

made without departing from the spirit of what has been taught. Thus, for example, although wax guards having two attaching lobes are currently preferred, it would be feasible to have four, the additional lobes attaching to the superior and inferior surfaces of the hearing aid. The greater the number of lobes, however, the greater the difficulty in attaching the wax guard. It should be possible to prepare a wax guard having a single attaching lobe (preferably the anterior lobe), the adhesive border on the center lobe holding it in place over the sound outlet port. It may also be possible to prepare a product that has a single continuous lobe, resulting in a construction resembling that of a condom.

Similarly, the utility of the invention is not limited to hearing aids, but is readily adaptable to any type of sound transmitting device that intrudes into the ear canal.

At the present time, the preferred dimensions of wax guard 30 are about 18.5 mm from the distal end of lobe 30a to the distal end of lobe 30p, lobe 30a being about 7.4 mm long and 6.6 mm wide. Lobe 30p is about 4.8 mm long and 5.6 mm wide. Central lobe 30c is about 8.9 mm wide. Although these exact dimensions and shapes are not critical, such products are suitable for mounting on all known "in the ear" hearing aids. Wax guards having the shape of wax guard 10 are useful on most hearing aids, although they may be somewhat difficult to install smoothly on hearing aids that fit into concha 42 and do not penetrate as far into canal 43 as hearing aids that fit almost entirely into canal 43.

Although numerous pressure-sensitive adhesives may be used to mount wax guard 10 or 30 on hearing aid 50, acrylate types are presently preferred; acrylate adhesives (e.g., a 95:5 isooctyl acrylate:acrylic acid copolymer) adhere well to the acrylate polymers used to make most hearing aids. Acrylate adhesives also tend not to irritate skin with which they may come in contact.

What is claimed is as follows:

1           1. For use in connection with a sound transmit-  
2 ting device of the type in which a housing containing a  
3 sound transmitting tube having a sound outlet port con-  
4 fronting the ear drum, said device fitting within a user's  
5 ear canal,

6           a readily installed and replaced disposable wax guard  
7 for mounting over the sound outlet port to prevent cerumen  
8 from fouling said outlet port, comprising a thin, flexible  
9 carrier membrane adapted to be temporarily adhered in posi-  
10 tion over the portion of the sound transmitting device  
11 nearest to the ear drum, the portion of said guard overly-  
12 ing said outlet port being porous to sound and receptive  
13 to cerumen.

1           2. For use in connection with an "in the ear"  
2 hearing aid of the type in which a housing containing a mi-  
3 crophone, an amplifier, and a speaker fit within the user's  
4 ear canal, with a sound-transmitting tube extending from  
5 adjacent the speaker to a sound outlet port at the portion  
6 of the housing nearest to the ear drum,

7           a disposable wax guard for mounting over the sound  
8 outlet port to prevent cerumen from fouling said outlet  
9 port, comprising a thin, flexible carrier membrane  
10 adapted to be temporarily adhered in position over said  
11 outlet port, the portion of said guard overlying said out-  
12 let port being porous to sound and oleophilic, so as to be  
13 receptive to cerumen.

1           3. The wax guard of claim 2 wherein the membrane  
2 is compressible, resilient open cell foam, one side of said  
3 membrane being provided with a normally tacky and pressure-  
4 sensitive adhesive layer except in that portion adapted to  
5 overlie the sound outlet port of the hearing aid.

1           4. The wax guard of claim 3 wherein the normally  
2 tacky and pressure-sensitive adhesive layer is in the form  
3 of a double-coated tape.

1           5. The wax guard of claim 2 wherein the sound-  
2 porous portion of the membrane is a hole having a slightly  
3 larger diameter than that of the outlet port and a mat of  
4 nonwoven fibers overlies said hole and is adhered to the  
circumjacent portions of said membrane.

1           6. The wax guard of claim 5 wherein the nonwoven  
2 mat is oleophilic.

1           7. The wax guard of claim 5 wherein the nonwoven  
2 mat consists essentially of blown microfibers.

1           8. The wax guard of claim 7 wherein the blown  
2 microfibers are polypropylene.

1           9. The wax guard of claim 6 wherein the membrane  
2 is provided with a normally tacky and pressure-sensitive  
3 adhesive so that it can be removably attached to the hear-  
4 ing aid housing.

1           10. The wax guard of claim 2 wherein the mem-  
2 brane is configured to have a plurality of lobes that can  
3 be removably adhered to the hearing aid housing.

1           11. The wax guard of claim 10 wherein there are  
2 only two lobes and they are adapted to adhere respectively  
3 to the anterior and posterior sides of the hearing aid.

1                   12. The wax guard of claim 8 wherein the blown  
2 microfibers are polypropylene.

1                   13. An "in the ear" hearing aid having a sound  
2 outlet port, the wax guard of claim 3 being mounted over  
3 said outlet port.

1                   14. The wax guard of claim 3 wherein the mem-  
2 brane is configured to have a plurality of lobes that can  
3 be removably adhered to the hearing aid housing.

1                   15. The wax guard of claim 14 wherein there are  
2 only two lobes, and they are adapted to adhere respectively  
3 to the anterior and posterior sides of the hearing aid.

1                   16. The wax guard of claim 15 wherein the two  
2 lobes are of unequal size.

1                   17. A release liner having removably adhered to  
2 the face thereof the wax guard of claim 16.

1                   18. The product of claim 17 wherein one lobe of  
2 the wax guard is removably adhered to a folded release  
3 liner and the remainder of the wax guard is adhered to a  
4 conventional release liner.

1                   19. The product of claim 18 wherein the larger  
2 lobe is adhered to the folded liner.

1                   20. A kit comprising a plurality of the products  
2 of claim 18, the dimensions of the open cell foam membrane  
3 being different on the individual guards.

1                   21. A method of providing better sealing between

2 an "in the ear" hearing aid and the ear canal in which said  
3 hearing aid is mounted comprising temporarily adhering a  
4 resilient foam material to the surface of the hearing aid  
5 that confronts the anterior wall of the ear canal.

1                   22. The method of claim 21 wherein the resilient  
2 foam material is characterized by retarded recovery.

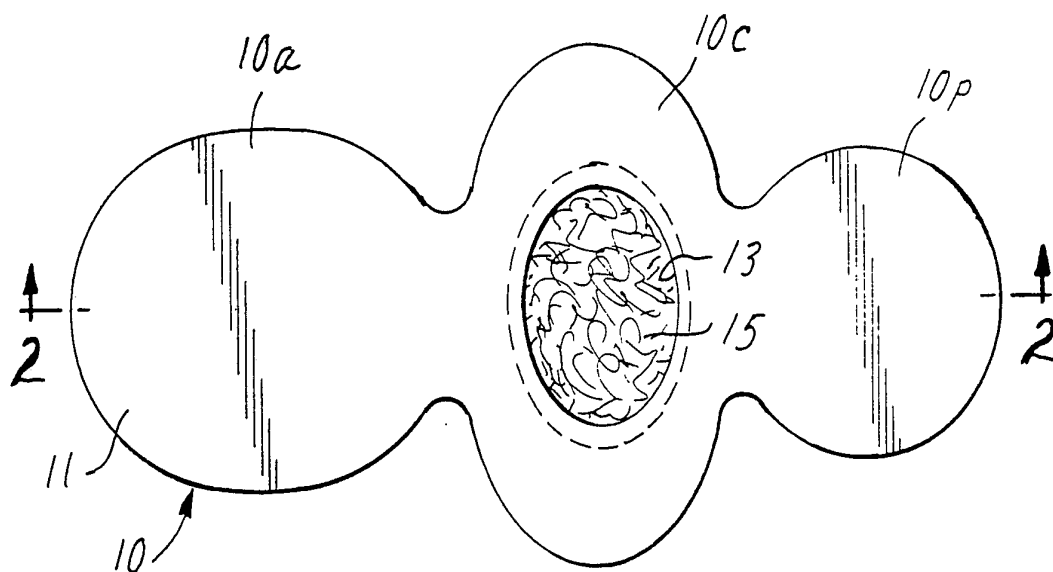


FIG. 1

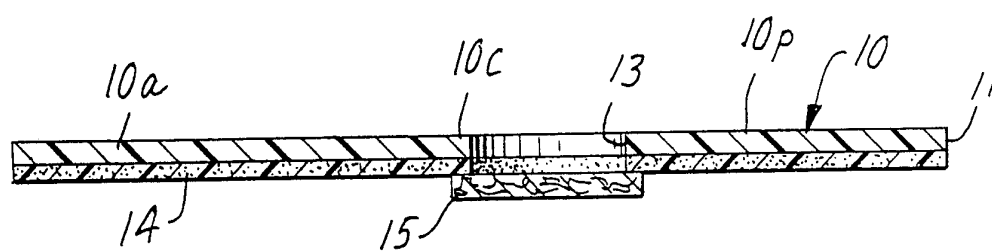


FIG. 2

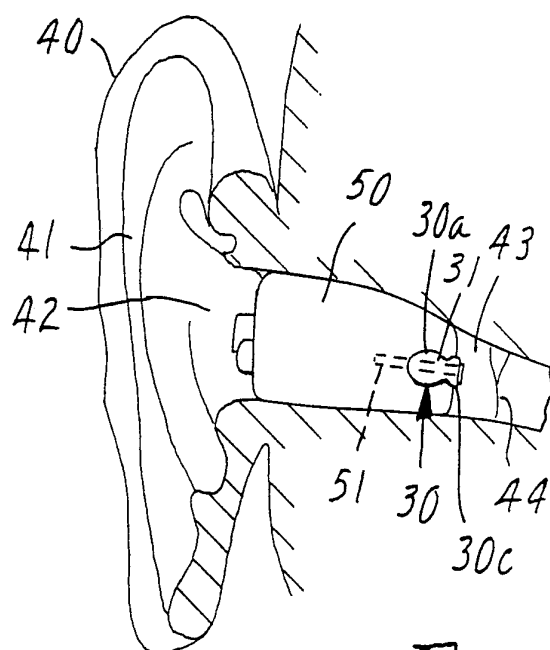


FIG. 6



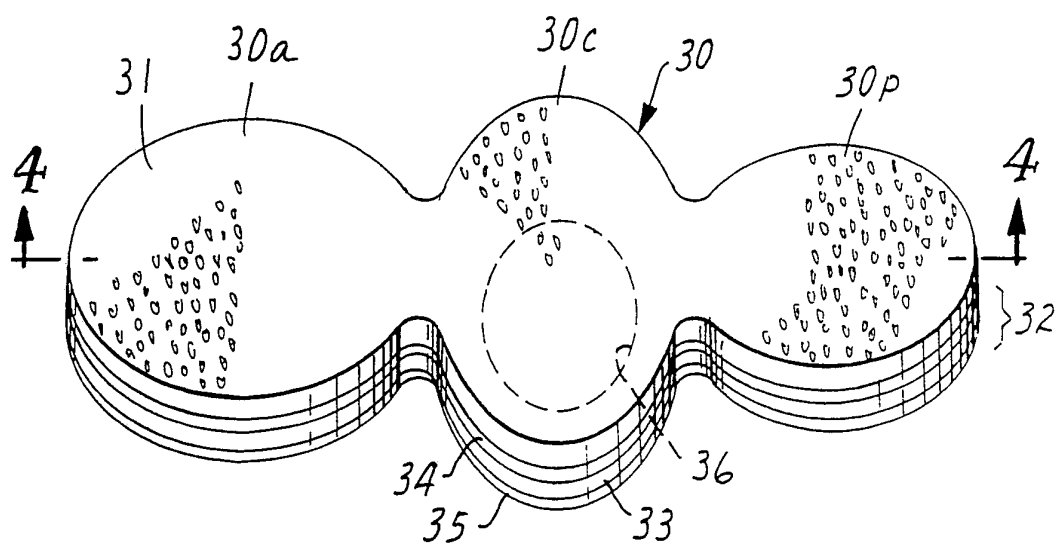


FIG. 3

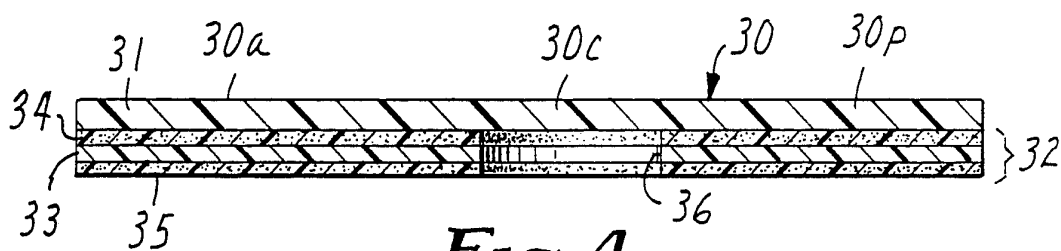


FIG. 4

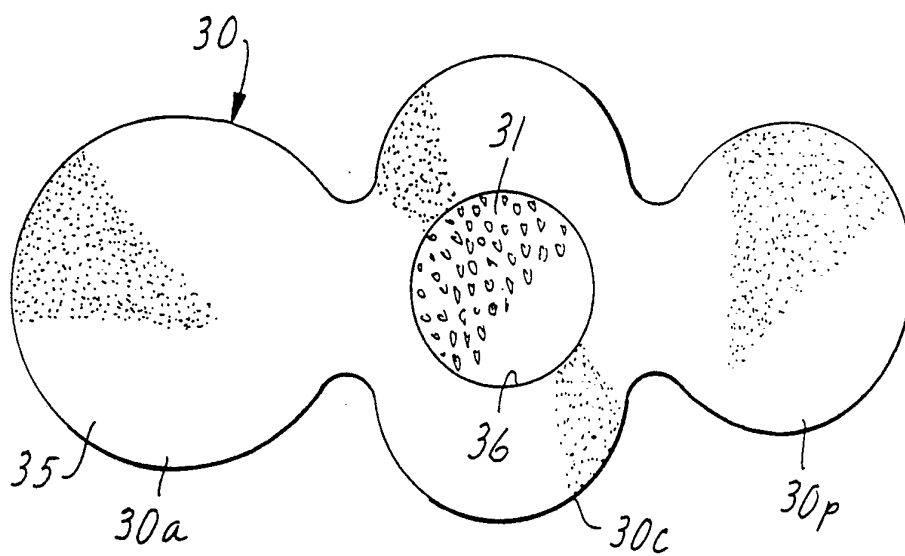


FIG. 5

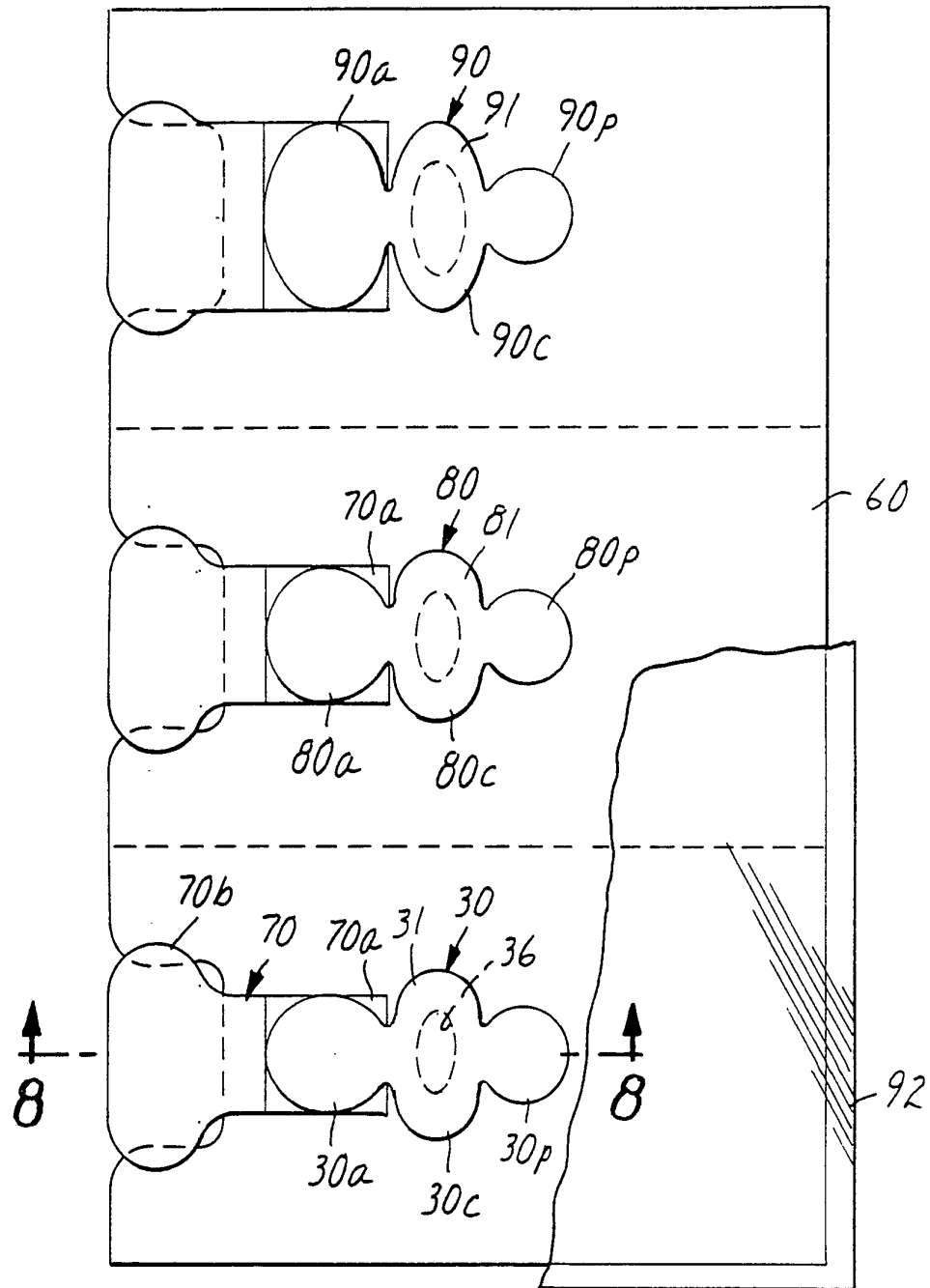
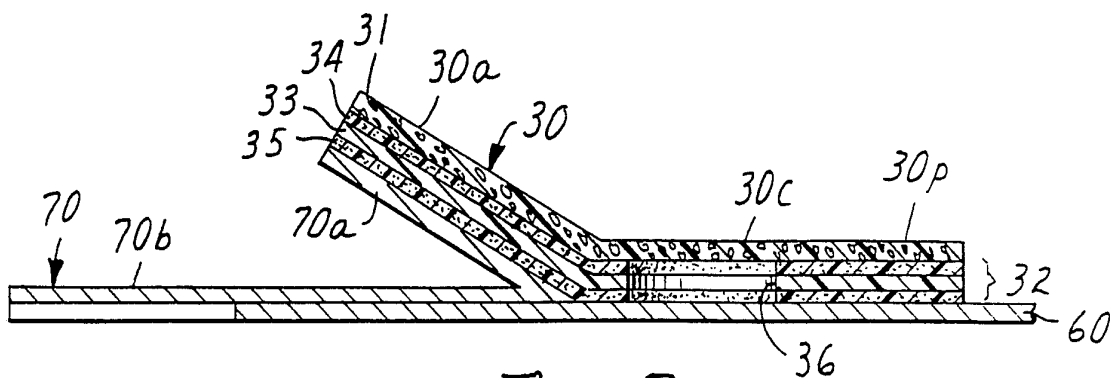


FIG. 7



*FIG. 8*

# INTERNATIONAL SEARCH REPORT

PCT/US 92/10231

International Application No

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup> According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. 5 H04R25/02		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	H04R	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	DE,A,2 818 273 (SOMMER) 8 November 1979 see the whole document ---	1,2,13
A	EP,A,0 310 866 (SIEMENS AG) 12 April 1989 see page 2, column 3, line 45 - page 3, column 3, line 29; figures ---	1,2,7
A	EP,A,0 159 571 (WESTRA ELECTRONIC GMBH) 30 October 1985 see page 2, line 10 - page 6, line 10; figures ---	12,7,8, 12
A	GB,A,2 155 276 (BELTONE ELECTRONICS CORPORATION) 18 September 1985 see claims ---	1,2,3
-/--		
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <sup>10</sup> Special categories of cited documents :            "A" document defining the general state of the art which is not considered to be of particular relevance            "E" earlier document but published on or after the international filing date            "I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)            "O" document referring to an oral disclosure, use, exhibition or other means            "P" document published prior to the international filing date but later than the priority date claimed         </div> <div style="width: 45%;">           "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention            "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step            "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.            "&amp;" document member of the same patent family         </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
17 MARCH 1993	01.04.93	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	GASTALDI G.L.	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category <sup>a</sup>	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,4 751 731 (O'CONNOR) 14 June 1988 see column 2, line 30 - column 3, line 22; figures	3,4,9, 10,11
X	---	17-20
X	EP,A,0 270 268 (MINNESOTA MINING AND MANUFACTURING COMPANY) 8 June 1988 see page 4, line 17 - page 5, line 41; figures	21,22
X	& US,A,4 880 076 (AHLBERG ET AL.) 14 November 1989 cited in the application -----	21,22

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

US 9210231  
SA 67996

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 17/03/93

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A-2818273	08-11-79	None	
EP-A-0310866	12-04-89	DE-U- 8713369 AU-A- 2336788 CA-A- 1296797 US-A- 4987597	09-02-89 06-04-89 03-03-92 22-01-91
EP-A-0159571	30-10-85	DE-C- 3413067 WO-A- 8504779 JP-B- 4014920 JP-T- 61501674 US-A- 4679650	05-09-85 24-10-85 16-03-92 07-08-86 14-07-87
GB-A-2155276	18-09-85	CA-A- 1214999 DE-A,C 3504891 FR-A,B 2560520 JP-A- 60232799	09-12-86 05-09-85 06-09-85 19-11-85
US-A-4751731	14-06-88	None	
EP-A-0270268	08-06-88	US-A- 4880076 CA-A- 1294221 JP-A- 63152300 US-A- 5002151	14-11-89 14-01-92 24-06-88 26-03-91