



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification⁵ : A61F 11/14</p>	A1	<p>(11) International Publication Number: WO 94/17763 (43) International Publication Date: 18 August 1994 (18.08.94)</p>
<p>(21) International Application Number: PCT/SE94/00082 (22) International Filing Date: 2 February 1994 (02.02.94) (30) Priority Data: 9300437-2 10 February 1993 (10.02.93) SE (71) Applicant (for all designated States except US): BILSOM AB [SE/SE]; P.O. Box 550, S-260 50 Billesholm (SE). (72) Inventor; and (75) Inventor/Applicant (for US only): HISELIUS, Per [SE/SE]; Kastanjegatan 11 B, S-223 59 Lund (SE). (74) Agents: ONN, Thorsten et al.; AB Stockholms Patentbyrå, Zacco & Bruhn, P.O. Box 23101, S-104 35 Stockholm (SE).</p>		<p>(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, ES, FI, GB, GE, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>With international search report. In English translation (filed in Swedish).</i></p>
<p>(54) Title: EAR PROTECTION CAP WITH IMPROVED SOUND ABSORPTION</p>		
<p>(57) Abstract</p>		
<p>An earmuff incorporating elevated sound attenuation. The earmuff comprises an outer cup (10') which connects with a sealing part. Arranged within the earmuff are a plurality of separating partitioning walls (14) which extend from the bottom wall (16) of the cup towards the sealing part. The partitioning walls (14) may be integral with the cup (10') or formed separately therefrom and loosely fitted thereinto.</p>	<p>The diagram shows a cross-sectional view of an earmuff cup. The cup is labeled 10'. Inside the cup, there is a bottom wall labeled 16. A grid of vertical partitioning walls, labeled 14, is arranged within the cup, extending from the bottom wall towards the top edge of the cup. The walls are arranged in a staggered pattern, creating a maze-like structure for sound absorption.</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	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgystan	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	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

EAR PROTECTION CAP WITH IMPROVED SOUND ABSORPTION

The present invention relates to an earmuff which incorporates elevated acoustic attenuation and which comprises an outer shell or cup made of a rigid plastic material, preferably polypropylene, and a softer sealing part which connects with the outer cup and is intended to lie around one ear of the wearer, wherein the muff interior may also include sound attenuating inserts, for instance inserts made of plastic foam or like material.

As is known, an earmuff, or ear protector, is intended to form an acoustic barrier between an ear of the wearer and a source of sound. Attenuation is effected by virtue of the earmuff preventing sound waves from reaching the ear. If the cup is not sufficiently rigid, it is unable to retain its shape when subjected to high noise levels and will begin to oscillate under the influence of the driving acoustic force, this oscillation being referred to here as "co-oscillation". This co-oscillation propagates the sound and impairs the acoustic attenuating effect of the earmuff. In order to prevent such impairment, it is important that both of the cups included in a hearing protector or earmuff are sufficiently rigid, this requirement being satisfied by appropriate selection of material, material thickness and shape. A sound attenuating cup which has a rounded or bulging surface is more rigid than a cup that has a flat surface. For this reason, the majority of present-day earmuffs are dished. It is normally necessary to provide reinforcements in those instances in which flat surfaces are used.

U.S. 3,432,861 teaches an earmuff which has a rounded surface and the cup of which is provided internally with ridges which extend in mutually different directions. The ridges, or like elevations, have a relatively small height in relation to the height of the earmuff and are intended

to provide the cup with the mechanical strength required to improve the sound attenuating effect of the earmuff.

5 U.S. 3,875,592 also teaches an earmuff which has a rounded surface and with which the cup, as seen from its outside, is provided with recesses or grooves which extend into the interior of the cup and therewith form corresponding outwardly projecting ridges or fins. The cup is reinforced by the fins produced by this arrangement and the fins have
10 a relatively small height in relation to the total height of the cup.

The object of the invention is primarily to further improve the acoustic attenuation of an earmuff or hearing protector
15 of the aforesaid kind. In this regard, it is not the intention of the invention to reinforce the actual cup itself, but to provide improved attenuation of sound waves within the earmuff, so as to enable resonances within the earmuff to be eliminated, among other things. This object
20 is achieved by constructing an earmuff of the kind defined in the introduction in accordance with the features set forth in the characterizing clause of the following Claim 1.

25 According to the present invention, it is important that the partitioning walls provided in the earmuff spaces which have a substantial height in relation to the major part of the height of the earmuff, so that sound waves will not "slip" beyond the extension of the partitioning walls. The
30 partitioning walls will thus preferably extend as close as possible to the place where the ear of a wearer is intended to lie. The partitioning walls will preferably extend over the greater part of the height of the earmuff. An advantage is afforded when the partitioning walls are orientated so
35 that sound waves are greatly dampened during their passage in the earmuff, as a result of a large number of reflections between said walls.

The cup partitioning walls may either be formed integrally with the actual cup itself or may be formed separately. In this latter case, the partitioning walls will preferably form a continuous grid unit which can be placed loosely in the cup so as to rest against the inner surfaces thereof. This latter method simplifies manufacture of the cup.

Advantageous embodiments of the invention will be apparent from the dependent Claims and are described in more detail below with reference to the accompanying drawings.

Figure 1 illustrates in perspective an embodiment of a conventional earmuff and shows the earmuff from its outside.

Figure 2 is a perspective view of the parts provided within the cup of an earmuff and essential to the present invention.

Figure 3 illustrates the arrangement shown in Figure 2 from above.

Figures 4, 5 and 6 are examples of different embodiments of a partition wall arrangement configured in accordance with the invention and capable of being included in the cup of an earmuff.

An earmuff which includes any one of the arrangements illustrated in Figures 1-6 is intended to be included in a complete hearing protector (not shown in the drawings) which comprises two earmuffs which are intended to be fitted tightly around respective ears of the wearer. The two earmuffs can be mutually joined by means of a strap or headband in a known manner. The earmuffs may also be provided with means which enable them to be connected to a protective helmet or some like device.

The earmuff illustrated in Figure 1 includes an outer attenuation cup or shell 10, which is normally comprised of a rigid plastic material, preferably polypropylene. Adjacent that part of the cup 10 which is intended to lie
5 around the ear of the wearer is a separate sealing part 12. This sealing part has the form of a soft foamed plastic ring which is normally covered externally with plastic foil. It is important that the sealing part 12 lies as tightly as possible around the ear of the wearer while, at
10 the same time, feeling comfortable, i.e. the ring shall have overall soft abutment with the ear.

In the case of the Figure 1 embodiment, the cup 10 has a slightly rounded configuration. This configuration guaran-
15 tees a stable construction, since it will not begin to vibrate, i.e. co-oscillate, at those acoustic frequencies to which it is normally subjected.

According to Figure 2, the cup 10' of one earmuff is
20 provided with a plurality of cup-space partitioning walls 14, which have mutually different lengths and mutually different positions. The sealing part 12 shown in Figure 1 has been omitted in the Figure 2 illustration. Although not shown, the earmuff will also include a sound attenuating
25 insert, preferably a foamed plastic insert, which is located adjacent the opening of the earmuff that faces towards the ear of the wearer. This insert has also been omitted from the Figure 2 illustration, in order to better illustrate the inventive partition wall arrangement.

30 The partitioning walls extend from the bottom 16 of the cup 10', this bottom being generally flat in the illustrated case, and upwards towards the place intended for the ear. It will be seen from the Figure that the walls 14 have a
35 substantial height, which will preferably be more than half of the total height of the earmuff. The partitioning walls 14 are orientated in a manner to eliminate or dampen

resonances that occur within the earmuff. The partitioning walls are preferably made of polypropylene and are angled to one another so as to provide good attenuation with repeated reflection of the sound waves. In the illustrated case, the intermediate walls 14 are formed integrally with the cup 10' and are thus manufactured simultaneously therewith in one single moulding operation. It may sometimes be convenient, however, for manufacturing reasons of a technical nature to produce the actual cup 10' and the partitioning walls 14 separately from one another. In this latter case, the partitioning walls 14 will preferably hang together, which can be achieved by virtue of a mutual joining bottom surface in the form of a thin plastic layer. The partitioning walls can then be placed loosely in the cup in the form of a unit, and the unit can be secured in the cup by pressing or gluing the unit onto the bottom of the cup.

Figure 3 illustrates the arrangement shown in Figure 2 directly from above, and illustrates the configuration and mutual positioning of the partitioning walls 14 more clearly than Figure 2. The partitioning walls 14 form a symmetrical pattern in this case, although such pattern symmetry is not absolutely necessary.

Figures 4, 5 and 6 show further examples of other advantageous positions of the partitioning walls 14, 14" and 14''' respectively. All embodiments are intended to provide the best possible sound attenuation. It is also conceivable to arrange the partitioning walls in a manner to form small sound-proof cells. With suitable dimensioning, standing waves are then able to occur in the cells, although only at frequencies which lie outside the audible frequency range. The walls may conveniently be inclined to the bottom of the cup, so as to reduce the number of reflections that are directed towards the ear.

Naturally, the mutual positioning of the partitioning walls and their positioning in relation to the cup will preferably always be in relation to those frequencies of the sound waves that are to be attenuated.

5

The frequency of a standing wave is inversely proportional to the distance between the walls between which the wave occurs. The partitioning walls are primarily intended to improve attenuation at frequencies above 1,500 Hz and the distance between the walls in the earmuff will preferably not exceed 2 cm.

10

CLAIMS

1. An earmuff which includes elevated acoustic attenuation comprises an outer cup (10; 10') made of a rigid plastic material, preferably polypropylene, and a softer sealing part (12) which connects with the cup for abutment around an ear of the wearer, wherein a sound attenuating insert, for instance a foamed plastic insert or like insert may be provided in the interior space of the cup, characterized in that a plurality of separating partitioning walls (14; 14'; 14"; 14''') are mounted in said interior space such as to project from the bottom wall of the earmuff in a direction towards the sealing part (12) and therewith prevent the occurrence of standing waves within the audible frequency range.
2. An earmuff according to Claim 1, characterized in that the partitioning walls (14; 14'; 14"; 14''') are arranged to extend over the greater part of the height of the cup; and in that said walls are orientated in a manner such as to attenuate sound waves either totally or partially during their passage in the earmuff by reflection between said walls.
3. An earmuff according to Claim 1, characterized in that the partitioning walls (14; 14'; 14"; 14''') are so orientated that sound waves are attenuated by reflection between a large number of different reflection points of two or more walls.
4. An earmuff according to Claim 1 or 2, characterized in that the partitioning walls in the cup interior space delimit a plurality of cells.
5. An earmuff according to any one of Claims 1-4, characterized in that the partitioning walls are integral with the cup.

6. An earmuff according to Claim 1, characterized in that the distance between two mutually opposing partitioning walls is overall less than 2.0 cm.
- 5 7. An earmuff according to any one of Claims 1-6, characterized in that the partitioning walls are inclined in relation to the bottom of the cup.
- 10 8. An earmuff according to any one of Claims 1-7, characterized in that the partitioning walls at the central part of the cup terminate at a greater distance from one plane through the cup opening than at the cup periphery.
- 15 9. An earmuff according to any one of Claims 1-8, characterized in that the increase in attenuation obtained by the partitioning walls occurs from and with about 1,500 p/s.

FIG.1

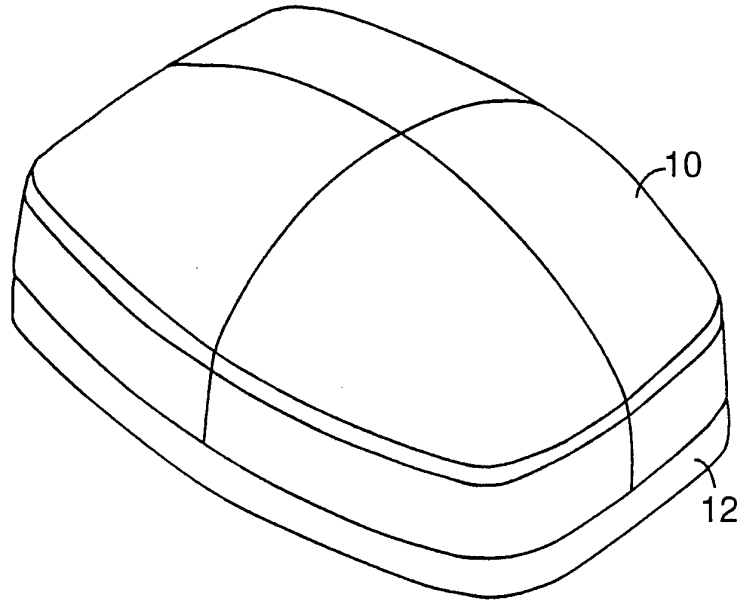


FIG.4

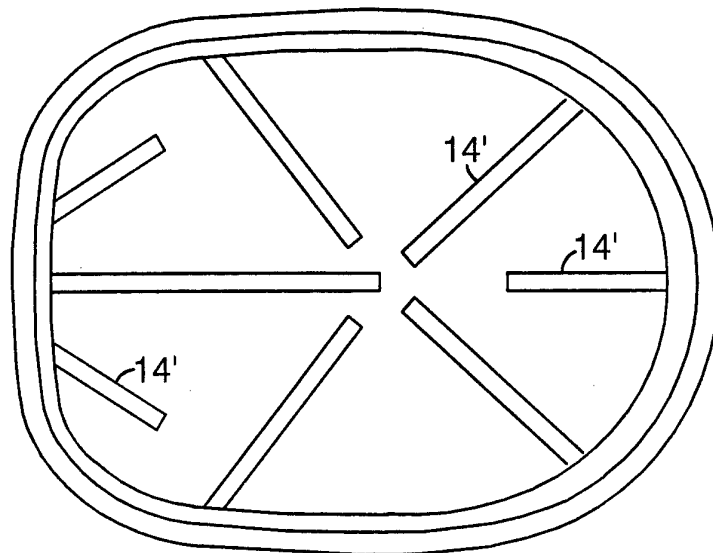


FIG.2

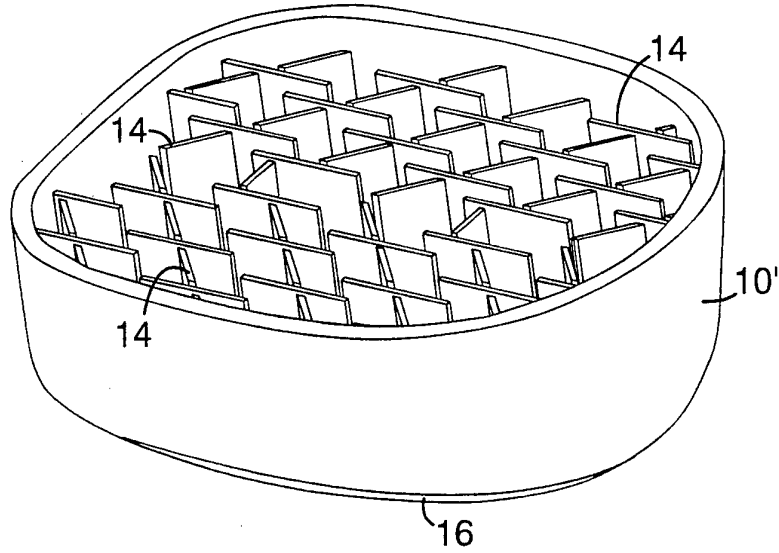


FIG.3

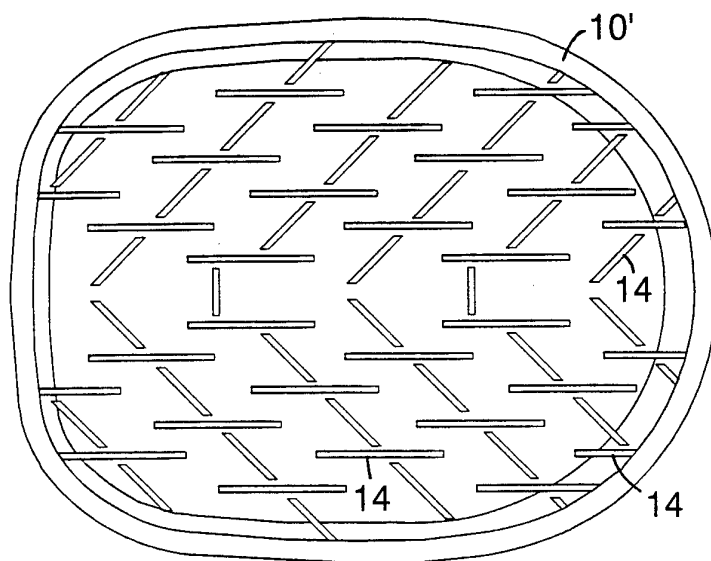


FIG.5

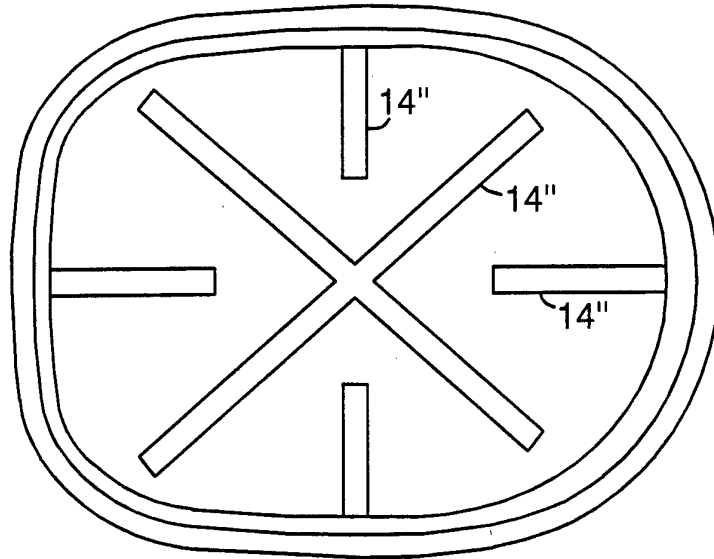
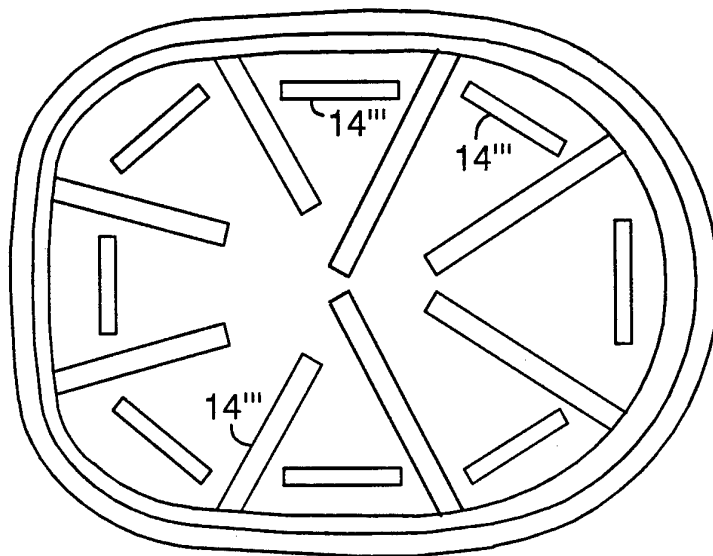


FIG.6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 94/00082

A. CLASSIFICATION OF SUBJECT MATTER

IPC⁵ : A61F 11/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC⁵ : A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, A1, 3623315 (WOLFGANG BREDE KG), 21 January 1988 (21.01.88), column 5, line 52 - column 6, line 3 --	1
A	DE, A, 2517703 (OPTAC WILFRID WELTIN), 4 November 1976 (04.11.76), page 9, line 9 - line 12 --	1
A	WO, A1, 9015584 (FOCUS VEILIG B.V.), 27 December 1990 (27.12.90) -- -----	1

 Further documents are listed in the continuation of Box C. See patent family annex.

* 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

"L" 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

"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 when the document is taken alone

"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

"&" document member of the same patent family

Date of the actual completion of the international search

19 May 1994

Date of mailing of the international search report

26 -05- 1994

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Herman Phalén
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

16/04/94

International application No.

PCT/SE 94/00082

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A1- 3623315	21/01/88	NONE	
DE-A- 2517703	04/11/76	NONE	
WO-A1- 9015584	27/12/90	CA-A- 2059285 EP-A- 0477260	13/12/90 01/04/92