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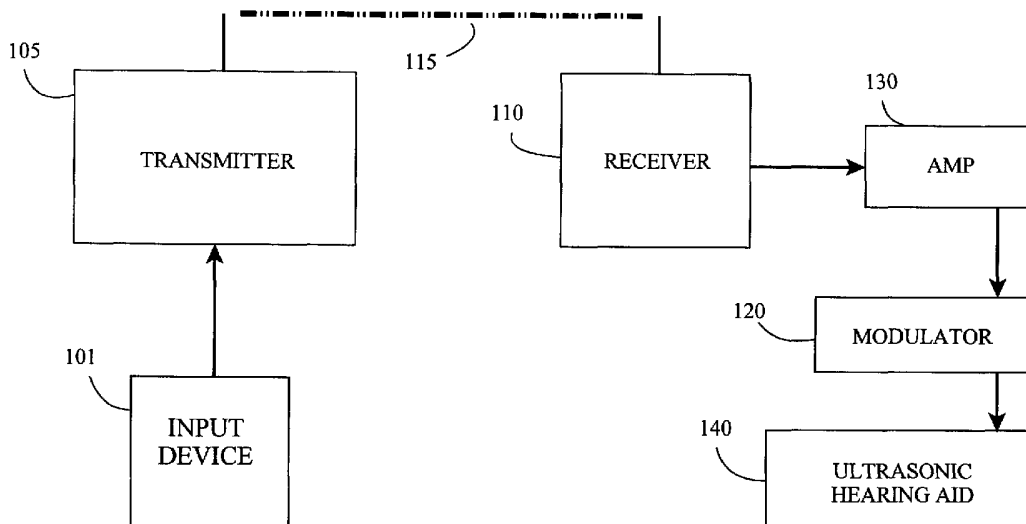
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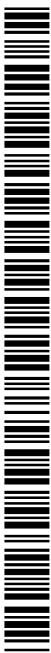
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: HEARING DEVICE IMPROVEMENTS USING MODULATION TECHNIQUES



(57) Abstract: There is provided hearing device (140) improvements using modulation techniques adapted to the characteristics of auditory and vestibular hearing. One embodiment provides for extending hearing to the infrasonic range and applying them to a carrier in the ultrasonic "quiet zone". Further extension of hearing into the ultrasonic range is provided by a modulation scheme which uses a fluid conduction coupler (720) to match impedance for a vibration transducer applied to the skin. A variation on this embodiment integrates this ultrasonic hearing extension with normal acoustic headphones. Another embodiment compensates for high frequency hearing loss by a modulation scheme which uses middle ear resonance as an amplifier. A further embodiment combines ultrasonic transposition (115) with wireless modulation to obtain secure communication.



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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US02/13081

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04R 25/00

US CL :381/312, 316; 455/90; 600/25

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)

U.S. : 381/312, 316, 320, 321; 455/90, 579, 569; 600/25; 607/56, 57.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
None

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

None

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,721,783 A (ANDERSON et al.) 24 February, 1998, see figure 1	1-6
X	US 6,169,813 B1 (RICHARDSON et al.) 02 January, 2001, see figures 1, 2 and 4-5, and col. 5, lines 66-67 through col. 6, lines 1-9.	7-12 and 19-22
X	US 6,068,589 A (NEUKERMANS) 30 May 2000, see figures 2, 4-5 and columns 14-15.	13-18
A	US 4,982,434 A (LENHARDT et al.) 01 January 1991, figure 2	7-12

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

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier document published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

03 JULY 2002

Date of mailing of the international search report

07 AUGUST 2002

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/13081

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest.  
 No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US02/18081

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s) 1-6, drawn to an apparatus of an ultrasonic hearing aid system.

Group II, claim(s) 7-12, drawn to a method for compensating for high frequency hearing loss.

Group III, claim(s) 13-18, drawn to an apparatus of an acoustically coupled skin contact hearing enhancement device.

Group IV, claims 19-22, drawn to a method for listening to low frequency sounds in high background noise.

The inventions listed as Groups I-IV do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The groups do not share the same or corresponding special technical features.