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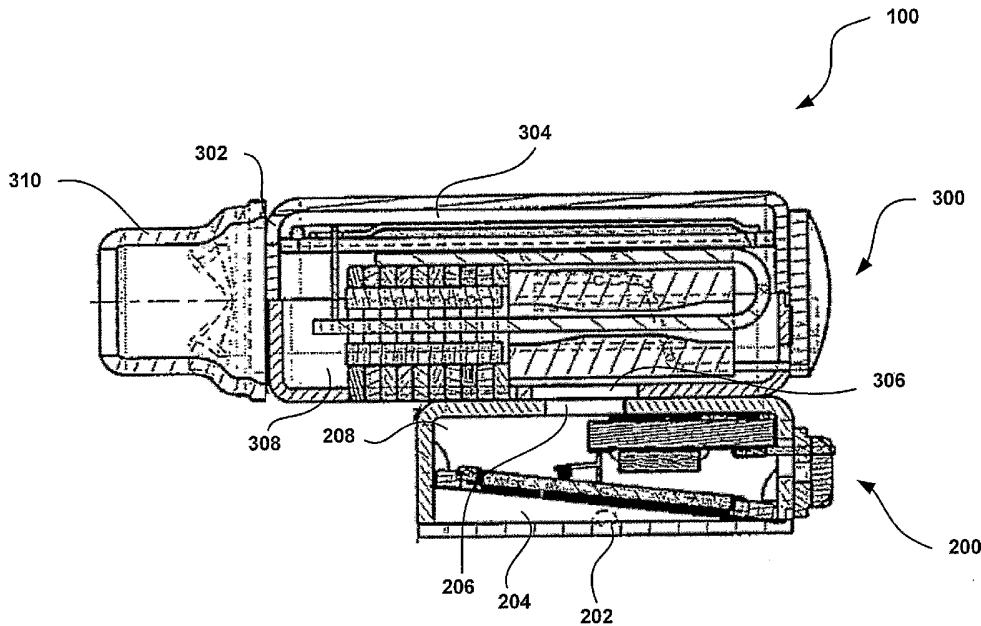
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(54) Title: CONJOINED RECEIVER AND MICROPHONE ASSEMBLY



(57) Abstract: A transducer assembly may include a first transducer having a first front volume, a first back volume and a first port acoustically coupled to the first front volume; and a second transducer having a second front volume, a second back volume and second port acoustically coupled to the second front volume. The first front volume and the second front volume are acoustically coupled to increase the effective back volume of both the first transducer and the second transducer. An optional signal processing circuit may be used to control the output of the first transducer based upon a signal received from the second transducer.

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## CONJOINED RECEIVER AND MICROPHONE ASSEMBLY

### CROSS-REFERENCE TO RELATED APPLICATION

[0001] This patent claims benefit under 35 U.S.C. § 119(e) to United States Provisional Application Serial No. 60/679,170, filed May 9, 2005 and entitled Conjoined Receiver and Microphone Assembly, the disclosure of which is hereby expressly incorporated herein for all purposes.

### TECHNICAL FIELD

[0002] This patent generally relates to miniature transducers used in listening devices and portable communication devices, and more particularly, to a conjoined receiver and microphone.

### BACKGROUND

[0003] A common problem with listening devices and portable communication devices is to avoid exceeding the discomfort threshold in the sound signal and to maintain a constant sound pressure level (SPL) to the listener. In order to simplify the operation of the devices, SPL can be maintained by signal amplitude regulation with a feedback structure. In such an arrangement, the amplifier input signal is fed to a level detector. The level detector output value is delivered to a control loop providing attenuation of the amplifier output signal at increasing input signal strength. However, such compensation is not capable of satisfactorily eliminating the excessive SPL to prevent potential long term damage to hearing characteristics of a person. Further, to improve the receiver efficiency, more power will be drawn from the power source, i.e. battery, to increase output. However, draining the energy from the battery may cause power supply voltage fluctuating and reduced battery life.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0004] For a more complete understanding of the disclosure, reference should be made to the following detailed description and accompanying drawings wherein:

[0005] FIGURE 1 is cross-sectional view of a conjoined receiver and microphone assembly;

[0006] FIGURE 2 is a perspective view of the conjoined received and microphone assembly of Figure 1;

[0007] FIGURE 3 is a schematic representation of a conjoined receiver and microphone assembly and a signal processing circuit;

[0008] FIGURE 4 is a schematic representation of a conjoined receiver and microphone assembly without a signal processing circuit; and

[0009] FIGURE 5 is a graph indicating output sound pressure level with frequency response.

### DETAILED DESCRIPTION

[0010] While the present disclosure is susceptible to various modifications and alternative forms, certain embodiments are shown by way of example in the drawings and these embodiments will be described in detail herein. It will be understood, however, that this disclosure is not intended to limit the invention to the particular forms described, but to the contrary, the invention is intended to cover all modifications, alternatives, and equivalents falling within the spirit and scope of the invention defined by the appended claims.

[0011] It should also be understood that, unless a term is expressly defined in this patent using the sentence "As used herein, the term '\_\_\_\_' is hereby defined to mean..." or a similar sentence, there is no intent to limit the meaning of that term, either expressly or by implication, beyond its plain or ordinary meaning, and such term should not be interpreted to be limited in scope based on any statement made in any section of this patent (other than the language of the claims). To the extent that any term recited in the claims at the end of this patent is referred to in this patent in a manner consistent with a single meaning, that is done for sake of clarity only so as to not confuse the reader, and it is not intended that such claim term be limited, by implication or otherwise, to that single meaning. Unless a claim element is defined by reciting the word "means" and a function without the recital of any structure, it is not intended that the scope of any claim element be interpreted based on the application of 35 U.S.C. §112, sixth paragraph.

[0012] FIGs. 1-2 illustrate an exemplary embodiment of a conjoined receiver and microphone assembly 100 for use in virtually any type of device, such as cellular phones, web-enabled cellular telephones, Personal Digital Assistants (PDAs), hand-held computers, Bluetooth wireless headset, digital cameras, other types of portable computing and Internet access appliances and devices, hearing aids, in-ear monitors, electronic hearing protection devices, and the like. The assembly 100 includes a a

first transducer, e.g., microphone 200 and a second transducer, e.g., receiver 300 mounted in back-to-back abutting relation to provide a shared volume. The shared volume is larger than is available in discrete devices and acts to increase the efficiency of the receiver 300 at low frequency response. In alternate embodiments, the microphone 200 and the receiver 300 can be mounted in front-to-front alignment to again provide a shared volume. Alternatively, the first and second transducer can both be receivers sharing a volume to enhance low frequency response and efficiency or can both be microphones enjoying the same benefits provided by the shared volume.

**[0013]** The microphone 200 includes a front inlet port 202 communicating with a front volume 204 and a back inlet port 206 communicating with a back volume 208. The receiver 300 has a sound outlet tube 310 for transmission of an acoustic signal to a user and includes a front inlet port 302 communicating with a front volume 304 and a back inlet port 306 communicating with a back volume 308. The back inlet ports 206 of the microphone 200 and the back inlet port 306 of the receiver 300 are aligned and joined such that the back volume 208 of the microphone 200 and the back volume 308 of the receiver 300 form a single back volume, i.e., a shared volume. The increased back volume of the combined volumes 208 and 308 results in an increased efficiency of the acoustic output of the receiver 300, especially at low frequency. This configuration further eliminates a need for an additional sound tube that would otherwise be necessary to couple to the back volume 208 of the microphone 200.

**[0014]** FIG. 3 illustrates a conjoined assembly 100 adapted with a signal processing circuit 400. The conjoined assembly 100 and the signal processing circuit 400 provide for monitoring and controlling the acoustic output sound pressure level (SPL) in an ear canal. However, the conjoined assembly 100 may be used to achieve the same effects in devices not disposed directly into the ear canal. A sound signal within the ear canal entering the microphone 200 is converted to an electrical signal before transmission to the receiver 300. The control signal processing circuit 400 connected between the microphone 200 and the receiver 300 operates to generate a control signal responsive to the microphone 200 output signal. The receiver 300 is responsive to the microphone 200 output signal and the control signal such that oversensitivity of the assembly 100 in the form of excessive SPL is prevented. The receiver 300 thus receives and converts the controlled electrical signal to a sound signal for transmission to the user. The control signal processing circuit 400 may

includes a control signal circuit, a converter, a SPL adjusting circuit, and/or a digital signal Processor (DSP).

[0015] Separate power sources may be provide for each of the conjoined assembly 100 and the signal processing circuit 400, which may enhance noise isolation. Furthermore, the signal processing circuit 400 may not be disposed within the housing of the conjoined assembly 100, but instead may have a separate housing and may be communicatively linked, for example by wired or wireless connection, to the conjoined assembly 100.

[0016] FIG. 4 illustrates a conjoined assembly 100 without a signal processing circuit. The conjoined assembly 100 is still operable for monitoring and controlling the acoustic output sound pressure level (SPL) in an ear canal. In this embodiment, the microphone 200 is arranged to receive the sound signal generated by the receiver 300, which is used to monitor and limit the SPL of the sound signal delivered from the receiver 300 to the ear canal.

[0017] FIG. 5 illustrates a graphical representation indicating output sound pressure level with frequency response. Back volume coupling the microphone 200 to the receiver 300 preserves more bandwidth of the receiver. When back volume coupling the microphone 200 to the receiver 300, the second peak becomes more damped. In an alternate embodiment, when the microphone 200 and the receiver 300 front-to-front alignment, a higher peak level, i.e. about 3dB is provided from the receiver 300.

[0018] All references, including publications, patent applications, and patents, cited herein are hereby incorporated by reference to the same extend as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein.

[0019] The use of the terms “a” and “an” and “the” and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Recitation of ranges of values herein are merely intended to serve as a shorthand method of referring individually to each separate value falling within the range, unless otherwise indicated herein, and each separate value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The

use of any and all examples, or exemplary language (e.g., "such as") provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

**[0020]** Preferred embodiments of this invention are described herein, including the best mode known to the inventors for carrying out the invention. It should be understood that the illustrated embodiments are exemplary only, and should not be taken as limiting the scope of the invention.

## CLAIMS

1. A transducer assembly comprising:  
a first transducer, the first transducer having a first front volume, a first back  
5 volume and a first port acoustically coupled to the first front volume; and  
a second transducer, the second transducer having a second front volume, a  
second back volume and second port acoustically coupled to the second front volume;  
wherein,  
the first back volume and the second back volume are acoustically coupled to  
10 provide an enlarged back volume in comparison to either the first back volume or the  
second back volume, separately.
2. The transducer assembly of claim 1, a housing enclosing the transducer  
assembly, the housing having a first housing portion defining the first front volume  
15 and the first back volume and a second housing portion defining the second front  
volume and the second back volume.
3. The transducer assembly of claim 1, the first transducer having a first  
transducer housing including a first aperture coupled to the first back volume, the  
20 second transducer having a second transducer housing including a second aperture  
couple to the second back volume, the first transducer housing being joined with the  
second transducer housing such that the first aperture substantially aligns with the  
second aperture to couple the first back volume and the second back volume.
- 25 4. The transducer assembly of claim 1 wherein the first transducer and the  
second transducer each are either a microphone or a receiver.
5. The transducer assembly of claim 1, wherein the first transducer is a receiver  
and the second transducer is a microphone.
- 30 6. The transducer assembly of claim 1, wherein the first port and the second port  
are aligned in a common direction.

7. The transducer assembly of claim 1, wherein the first port is aligned along a first direction and the second port is aligned along a second direction, different than the first direction.
- 5 8. The transducer assembly of claim 1, comprising a signal processing circuit operably coupled to each of the first transducer and the second transducer.
9. The transducer assembly of claim 8, wherein the signal processing circuit is operable on a signal from the first transducer for controlling the output of the second  
10 transducer.
10. The transducer assembly of claim 8, wherein the signal processing circuit is operable for controlling a sound pressure level output of the second transducer.
- 15 11. The transducer assembly of claim 1, an input of the first transducer being coupled to an output of the second transducer, the input of the second transducer being coupled to an output of the first transducer, wherein the output of the first transducer is controlled.
- 20 12. A device comprising:  
a receiver, the receiver having a receiver housing defining a receiver front volume and a receiver back volume and an acoustic outlet port formed in the receiver housing and being coupled to the receiver front volume and a receiver electric terminal, the receiver being operable to generate an acoustic output signal from the  
25 outlet port responsive to an electrical input signal at the receiver electric terminal;  
a microphone, the microphone having a microphone housing defining a microphone front volume and a microphone back volume and an acoustic inlet port formed in the microphone housing and being coupled to the receiver front volume and a microphone electric terminal, the microphone being operable to generate an  
30 electrical signal responsive at the electric terminal responsive to an acoustic input signal received at the inlet port; and  
the receiver housing being formed with a receiver housing aperture acoustically coupled to the receiver back volume and the microphone housing being formed with a microphone housing aperture acoustically coupled to the microphone



back volume and the receiver housing being coupled to the microphone housing such that the receiver back volume is acoustically coupled to the microphone back volume via the receiver aperture and the microphone aperture to provide an enlarged  
5      conjoined back volume in comparison to either the receiver back volume or the  
microphone back volume, separately.

13.     The device of claim 12, wherein the inlet port and the outlet port are aligned in a common direction.

10    14.     The device of claim 12, wherein the inlet port is aligned along a first direction and the outlet port is aligned along a second direction, different than the first direction.

15    15.     The device of claim 12, comprising a signal processing circuit operably  
coupled to each of the receiver electric terminal and the microphone electric terminal.

16.     The device of claim 15, wherein the signal processing circuit is operable on a signal from the microphone for controlling the output of the receiver.

20    17.     The device of claim 15, wherein the signal processing circuit is operable for controlling a sound pressure level output of the receiver.

18.     The device of claim 12, an electric terminal of the receiver being coupled to the electric terminal of the microphone, the input port of the microphone being  
25      coupled to the output port of the receiver, wherein the output of the receiver is controlled based upon the output of the microphone.

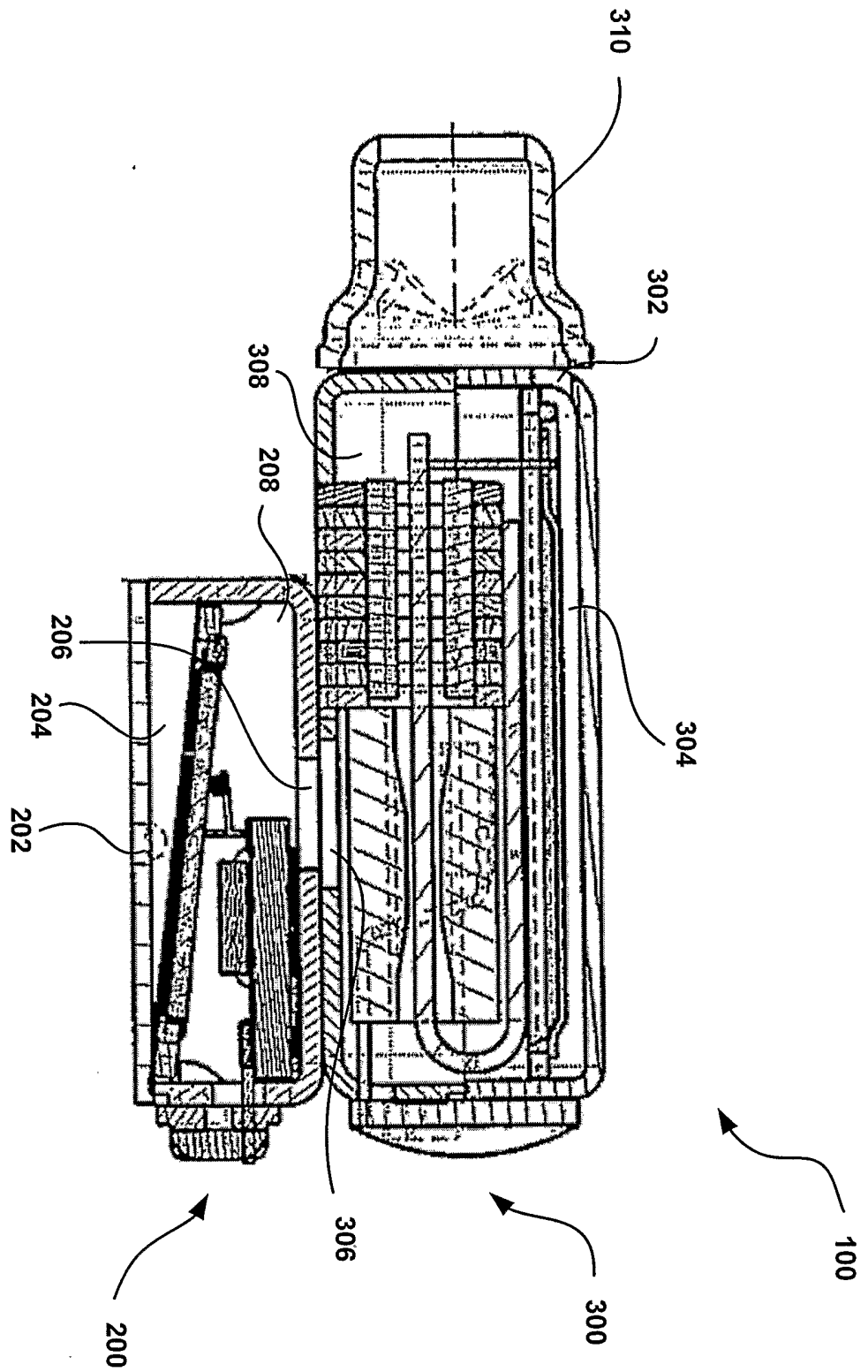
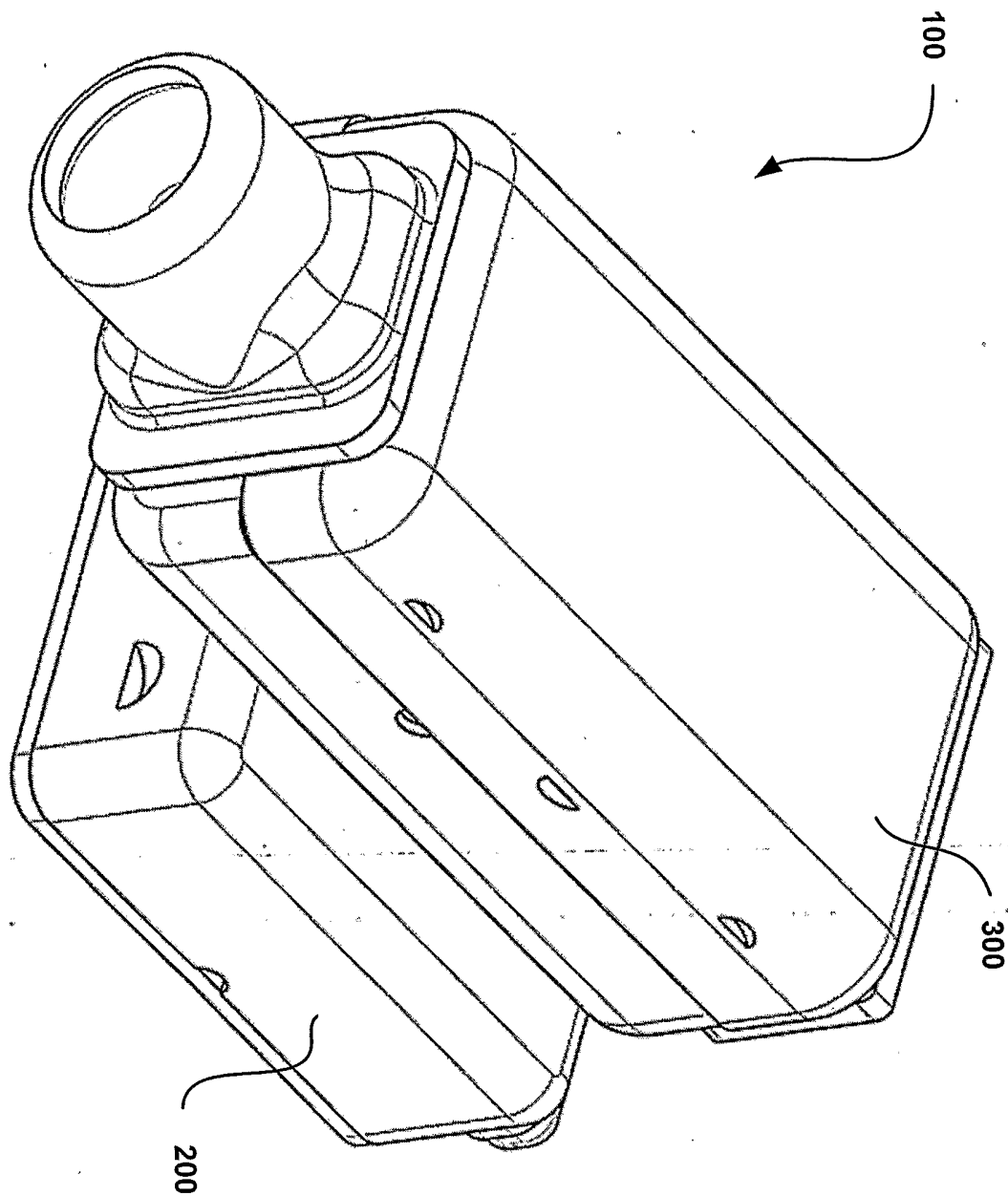


FIGURE 1



**FIGURE 2**

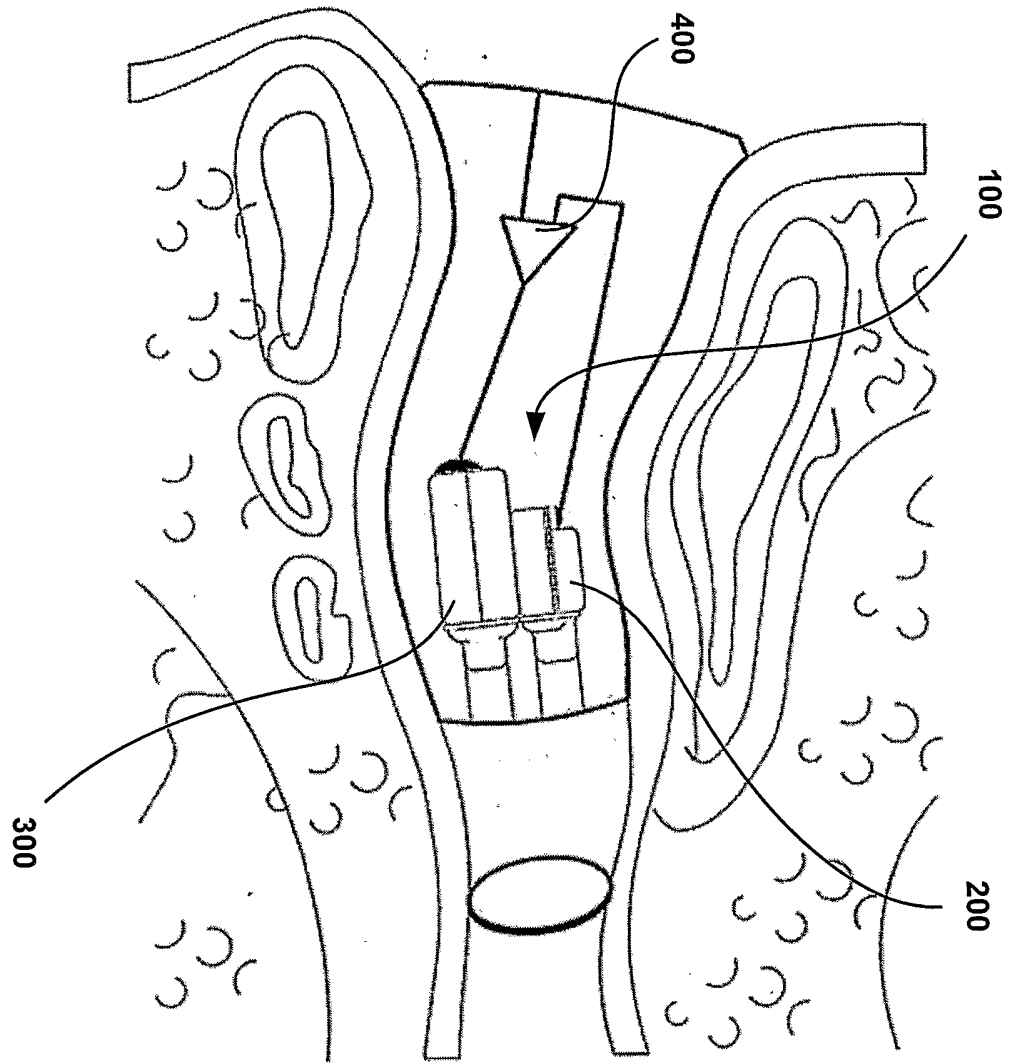


FIGURE 3

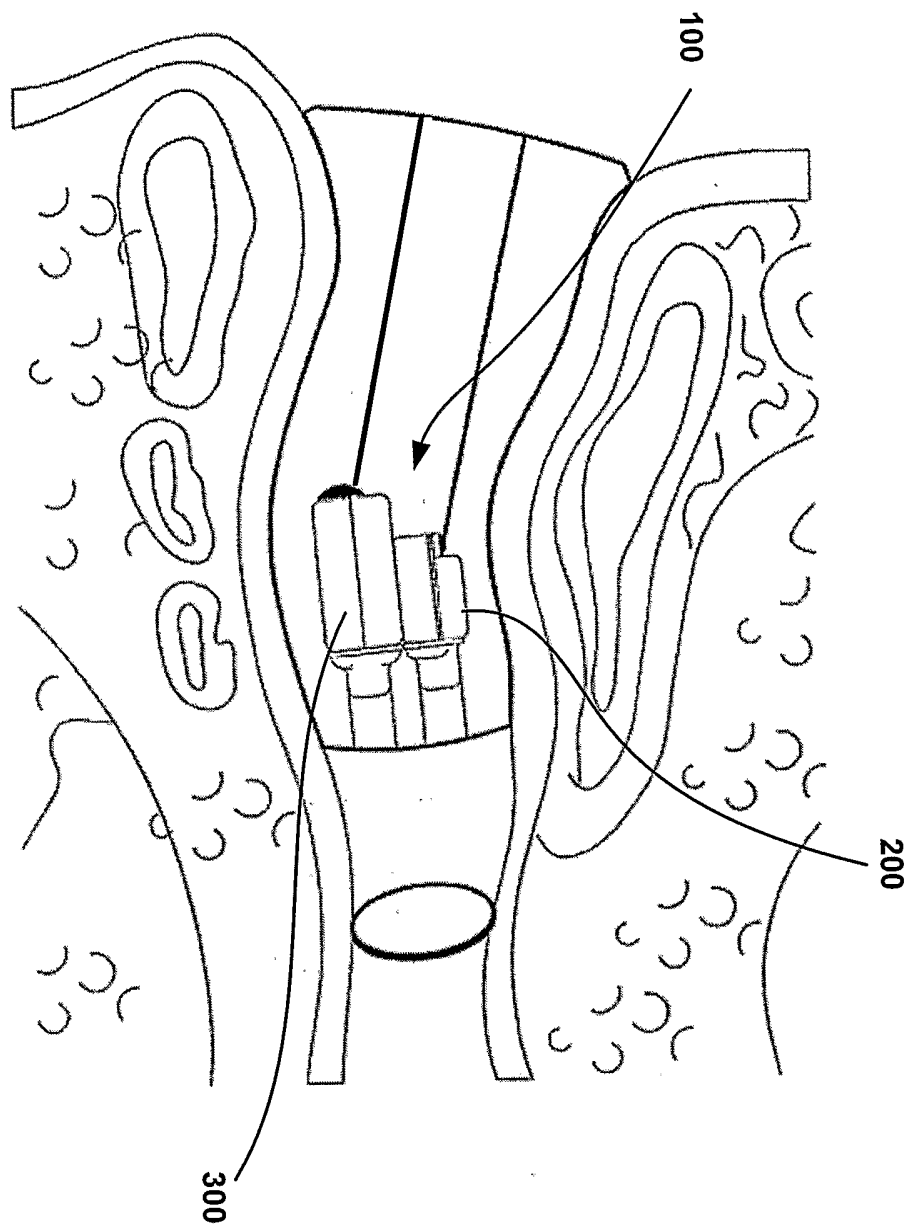


FIGURE 4

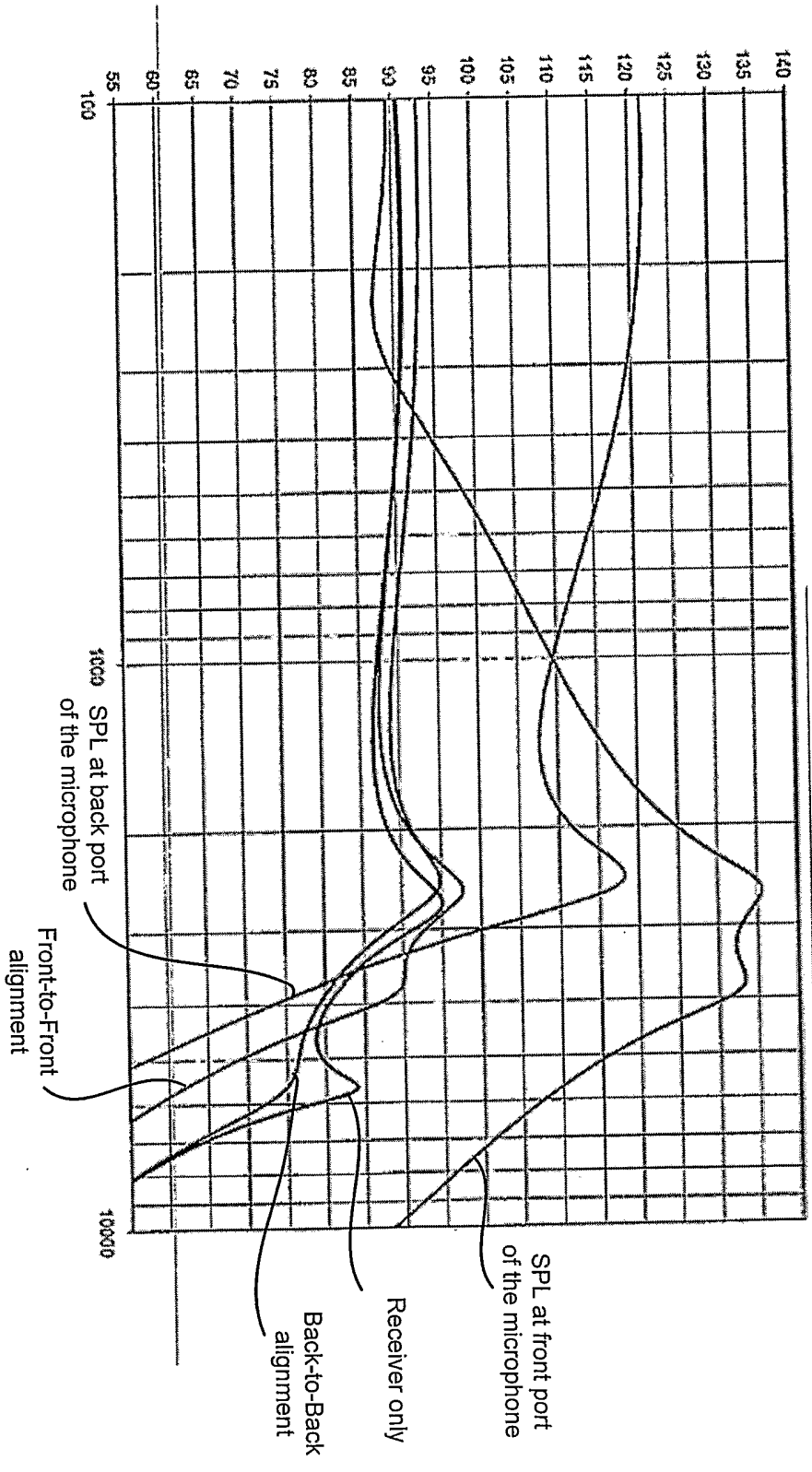


FIGURE 5

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2006/017691A. CLASSIFICATION OF SUBJECT MATTER  
INV. H04R25/00

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)  
H04R

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

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

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 018 089 A (AUSTRALIA DEPT OF HEALTH) 10 October 1979 (1979-10-10) page 2, line 25 - line 72; figures 2,3 -----	1-8, 12-15
A	DE 24 06 219 A1 (MICRO-TECHNIC HUEBER & CO) 21 August 1975 (1975-08-21) the whole document -----	5, 8, 12, 15
A	DE 25 12 343 A1 (MICRO-TECHNIC HUEBER & CO) 7 October 1976 (1976-10-07) figure 2 -----	1, 12

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

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
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DE 2512343	A1	07-10-1976	NONE	