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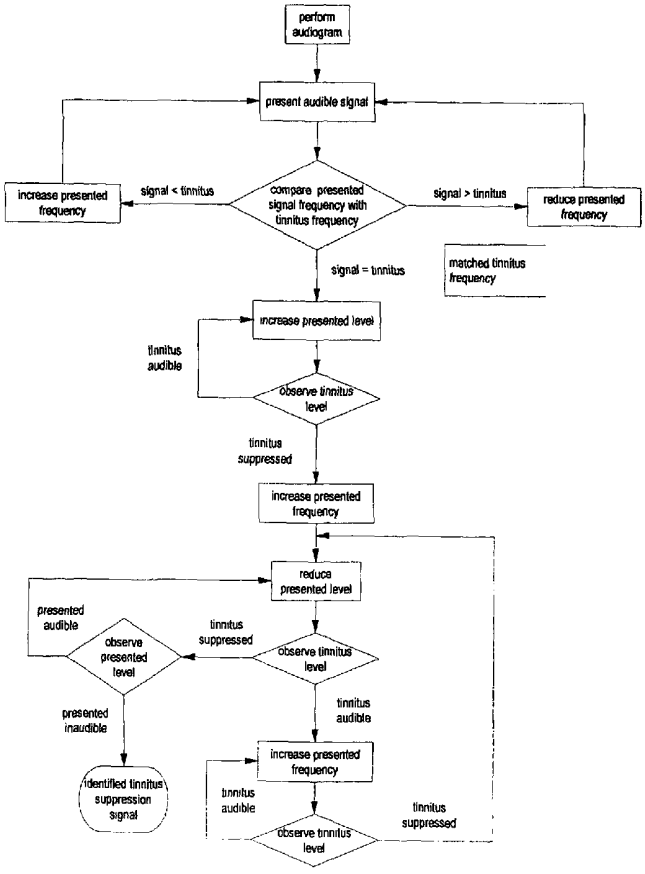
(54) Title: METHOD AND APPARATUS FOR TREATING TINNITUS



(57) Abstract: The present invention is directed to a method for treating tinnitus or ameliorating the symptom of tinnitus in a patient including the step of presenting to the patient a sound having a predetermined frequency of frequencies within the spectrum of about 20 hertz to 20,000 hertz and having a predetermined intensity, said sound being inaudible to the patient. In other aspects, the invention is directed to apparatus for use in this method.

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METHOD AND APPARATUS FOR TREATING TINNITUS

The present invention is directed to a method for treating tinnitus or alleviating the symptoms of tinnitus as well as an apparatus for use in such treatment and therapy.

Tinnitus is the perception of sound when no external sound is present and is colloquially referred to as "ringing in the ears". However, the sound heard by tinnitus sufferers is not limited to ringing but may also take other forms including hissing, roaring, whistling, chirping or clicking. It is an extremely common disease with an estimated 1 in 5 people experiencing some degree of tinnitus. In extreme cases sufferers are seriously debilitated.

There are a number of known causes of tinnitus of physiological and biochemical origin. Physiological causes include exposure to loud noise over an extended period of time, injury to the head or whiplash and medical conditions such as otosclerosis and Meniere's disease. Biochemical causes include reactions to certain medications such as ototoxic drugs and allergies. In many patients the cause of tinnitus is not known.

To date, various treatments are utilised to alleviate the symptoms of tinnitus with varying degrees of success. Anti-depressant medication has been utilised to ease discomfort and improve well being for serious tinnitus sufferers. Masking procedures have been used widely. Masking involves overriding the internal or tinnitus noise experienced by the patient with an audible external noise. Alternative approaches such as chiropractic, naturopathy, acupuncture and vitamin and mineral substances have also been tested with varying degrees of success. However to date, and to the best of the present inventor's knowledge, no reliable cure nor therapy for tinnitus has been discovered.

The present inventor has surprisingly found that if a sufferer of tinnitus is exposed to sound of certain frequencies within the normal human auditory spectrum and certain intensities, said sound being inaudible to the sufferer, for

a period of time, the sufferer's tinnitus can be treated or at least the symptoms of the disease can be alleviated.

Accordingly, in one aspect the present invention is directed to a method for treating tinnitus or ameliorating the symptoms of tinnitus in a patient including the step of:

- presenting to the patient a sound having a predetermined frequency or frequencies within the spectrum of about 20 hertz to 20,000 hertz and having a predetermined intensity, said sound being inaudible to the patient.

Throughout this document the sound presented to the patient in the method described above, shall be referred to as the "suppression signal".

In one aspect the method is carried out by exposing the patient to an artificially generated suppression signal.

Alternatively, the treatment can be achieved by selectively amplifying sounds already present in the environment and received by the patient. Accordingly, in another aspect the present invention is directed to a method of treating tinnitus or ameliorating the symptoms of tinnitus in a patient including the step of:

- selectively amplifying to a predetermined level external sound received by said patient within the spectrum of about 20 hertz to 20,000 hertz and having a predetermined frequency or frequencies, said selectively amplified external sound being inaudible to said patient.

A hearing aid device may be used in the method of the present invention to selectively amplify external sounds.

It is preferred that the sound that is amplified has a centre frequency in the range of 100 hertz and up to 20,000 hertz, more preferably 3000 hertz to 16,000 hertz.

In another embodiment the method includes a combination of presenting both, an artificially generated suppression signal and a suppression signal which is a selectively amplified external sound to the patient.

It is thought by the present inventor that tinnitus may be the expression of hypersensitivity of the inner hair cells. Inner hair cells are under the regulatory control of outer hair cells. Thus, if these outer hair cells are damaged, this inhibitory system is lost with the result that inner hair cells may fire randomly giving rise to a perception of noise by the sufferer. It is theorised that by presenting to the patient a suppression signal, outer hair cells responsive to neighbouring frequencies are stimulated. These neighbouring outer hair cells can then take over the function of defective outer hair cells thereby restoring the inhibitory system. Thus the present invention involves sensitivity modulation of inner hair cells for tinnitus control using sounds inaudible to the patient.

The inventor has found that the method described above is most effective if the frequency or frequencies of the suppression signal presented to the patient is basal to, (ie greater than) the frequency or frequencies of tinnitus perceived by the patient.

However, for some patients it has been found that the method is effective if the predetermined frequency or frequencies of the suppression signal are the same or approximately the same as the frequency or frequencies of tinnitus experienced by the patient, or lower than the frequency or frequencies of tinnitus experienced by the patient.

The inventor has realised that tinnitus sound is often associated with hearing loss and the frequency of tinnitus sound is often lower than the frequency at which maximum hearing loss occurs. The suppression signal should be at an intensity below the threshold of hearing of the patient for the frequency or frequencies of sound presented to the patient as this does not interfere with the patient in their day-to-day activities.

It is preferred that in the method of this invention the suppression signal presented to the patient is a pulsed pure tone, or pulsed narrow band. When using a pulsed narrow band signal its frequencies should vary by no more than 25% of the centre frequency, and preferably no more than 5% of the centre frequency.

Where a patient perceives a tinnitus noise to reside in one ear, the same or "ipsilateral" ear may be stimulated in the present method. In some instances it has been found that stimulation of the opposite or "contralateral" ear is more effective in the method of this invention.

In other instances, the present inventor has found that it is preferable to stimulate both ears in the method of this invention.

It is well known that the human ear can function as a loudspeaker and emit sound. Such sounds are commonly referred to as spontaneous emissions. The present inventor has recognised that if spontaneous emissions from one ear are absent or diminished, this may be an indication that the inhibitory system for that ear is not working properly. In the method of this invention, it may be preferable to stimulate the ear having the better functioning inhibitory system as it has been found that this can provide better suppression of tinnitus sound. Thus, the favoured ear to stimulate in the method of this invention may be the ear that is measured as having the highest level of spontaneous emissions.

Another factor which can help determine which ear should be stimulated is where any hearing loss resides. Where there is a hearing loss in one ear of the tinnitus sufferer and a hearing aid is used to amplify external sounds, it may be advantageous to fit the hearing aid to that ear and select a level of amplification that also helps to partially or fully restore the hearing of the ear as well as treat the tinnitus symptoms. Alternatively, if stimulating the ear that has hearing loss would cause further damage to the hearing of that ear, it may be preferable to

stimulate the ear that is not damaged. Thus, when determining which ear should be stimulated in the method of this invention, a number of factors need to be taken into consideration.

To the inventor's knowledge, hearing aids currently available do not function to amplify puretone sound or sound having a narrow bandwidth. Until now there has been no need for hearing aids having this capability. Thus, hearing aids having this ability are new. Accordingly, in another aspect the present invention is directed to a hearing aid for use in a method of treating tinnitus or ameliorating the symptoms of tinnitus in a patient, wherein the hearing aid is capable of amplifying a single frequency or a narrow band sound having frequencies no greater than 25% of a centre frequency, preferably no greater than 5%.

The inventor has also observed that tinnitus noises are often perceived by sufferers to have a frequency above 6000 hertz. However, 6000 hertz is the upper limit of sound that currently available hearing aids are designed to amplify. This is because one of the main functions of hearing aids used in the treatment of partial deafness is to assist the speech of the sufferer, the frequency of speech sounds being usually up to 6000 hertz. Accordingly, currently available hearing aids may not be suitable to treat all forms of tinnitus according to the present invention and the inventor has perceived the need to develop a hearing aid that can amplify sound having a frequency above 6000 hertz. To the knowledge of the present inventor, such a hearing aid having this capability is new.

Accordingly, in another aspect the present invention is directed to a hearing aid for treating tinnitus or ameliorating the symptoms of tinnitus, said hearing aid having the ability to amplify sound having a frequency in the range of 6000 hertz to 20,000 hertz.

Preferably, the hearing aid can function to amplify sound having a frequency in a range of up to 12,000 hertz, more preferably up to 20,000 hertz.

In other respects the hearing aids of this invention have the same features of known hearing aids which will be known to the skilled addressee.

Preferably the novel hearing aids of this invention are programmable, digital and frequency specific hearing aids.

As stated above, in one method of this invention an external sound is presented to the patient. This can be done using a portable sound reproduction device. To operate in this method, it is preferable that the device be capable of producing a sound of a single frequency or narrow bandwidth and having a range from 100 to 20,000 hertz. The sound may be a pulsed pure tone or pulsed narrow band. When using a pulsed narrow band signal its frequencies should vary by no more than 25% of the centre frequency, and preferably no more than 5% of the centre frequency.

More preferably the device is capable of reproducing sound having an intensity not exceeding the threshold of normal speech of the patient being treated. Typically the intensity of speech measured at a distance of 1 metre is around 65dBSPL.

It is believed that a portable sound reproduction device having the ability to produce sound of this very low level is new. Accordingly, in another aspect the present invention is directed to a portable sound reproduction device for use in a method of treating tinnitus or ameliorating the symptoms of tinnitus, said device capable of producing sound having:

(i) a single frequency or a bandwidth of frequencies no greater than 25% percent of a centre frequency of the bandwidth;
(ii) a frequency or frequencies in the range 100 hertz to 20,000 hertz; and
(iii) an intensity below 65 dBSPL

Preferably, the device has the further feature of;

(iv) a fine sound level control at low intensities of approximately 1dB resolution.

In one embodiment the device has a storage medium, the storage medium having stored thereon the suppression signal. Such devices include, for example a personal CD, Mini Disk, MP3 Player, Personal Digital Assistant (PDA), Portable Personal Computer or tape player. In another embodiment the portable device is digitally programmable to produce the suppression signal. Such devices may include a personal digital assistant (PDA), portable personal computer or programmable mobile telephone.

Preferably the device is capable of producing a pure output of sound. That is, it can produce the desired sound without also producing additional background frequencies.

It is preferred that the device for use in the method of this invention combines the function of the novel hearing aid and portable apparatus for reproducing the suppression signal as described above. Thus, where an external source of sound is already present, the device functions to amplify that sound. Where the external source is absent, the device operates to produce a sound having the predetermined characteristics itself.

The inventor has realised that the effectiveness of the method of this application can be improved if the external sound presented to the patient is a pulse signal or the sound that is amplified is done so in a manner so as to present it as a pulse signal to the patient. In a preferred embodiment the sound reproduction device and hearing aid of this invention can function in this manner.

Another aspect of the present invention is directed to a method of operating a sound reproduction device or hearing aid device to treat tinnitus or ameliorate the symptoms of tinnitus as described earlier.

Accordingly, a further aspect of the present invention is directed to a method of operating a sound reproduction device to present to a patient a sound having a predetermined frequency or frequencies within the spectrum of about 20 hertz to 20,000 hertz and a predetermined intensity, said sound being inaudible to said patient, for treating tinnitus suffered by said patient or ameliorating the symptoms of tinnitus experienced by said patient.

In a further aspect the present invention is directed to a method of operating a hearing aid device to amplify to a predetermined level external sound received by a patient within the spectrum of about 20 hertz to 20,000 hertz and having a predetermined frequency or frequencies, said amplified external sound being inaudible to said patient, for treating tinnitus suffered by said patient or ameliorating the symptoms of tinnitus experienced by said patient.

The sound reproduction device and hearing aid can be operated in the various preferred manners described earlier.

In another embodiment, the present invention is directed to a method of identifying the frequency or frequencies and intensity of sound to be presented to the patient in the method of treatment discussed above, including the following steps:

(i) presenting to the patient sound of varying frequencies and the identification by the patient of the frequency or frequencies that match the tinnitus sound;

(ii) increasing or decreasing the frequency and/or intensity of the sound presented to the patient, until sound that suppresses the tinnitus symptoms is obtained; and

(iii) identifying the frequency or frequencies and intensity of sound identified in the previous step.

In the process, it is desired to either increase or decrease the frequency and/or alter the intensity of the sound to identify an inaudible sound that suppresses the tinnitus.

A further optional step in the method that may be carried out before step (ii) is varying the intensity of the identified frequency or frequencies and the identification by the patient of the intensity that matches the tinnitus sound.

After the patient has identified the frequency of sound best matching the tinnitus frequency, the process may be carried out by increasing the intensity of sound of that specific frequency until there is suppression of tinnitus. Alternatively or in addition, after the tinnitus frequency has been identified, the process may be carried out by increasing the frequency and simultaneously reducing the intensity of the sound until the lowest intensity at which suppression or amelioration occurs is identified. The frequency or frequencies and intensity of this sound are the optimum frequency or frequencies and intensity for use in the method of this invention. Alternatively, or in addition to this step, the bandwidth of the sound is increased and the intensity is simultaneously decreased until sound having the lowest intensity at which suppression or amelioration occurs is identified. The frequency or frequencies and intensity of this sound are the optimum for use in the method of this invention.

A preliminary step in this identification process may be obtaining a description of the type (pitch) and loudness of the tinnitus sound from the patient before presenting sounds to the patient for identification.

As part of this evaluation process it is also preferable to ascertain from the patient the localisation of the tinnitus sound and type of tinnitus sound (i.e. whether it is of puretone, narrow band noise, broad band noise etc).

A programmable digital and frequency specific hearing aid may be used in the method of identifying the optimum intensity of amplification for use in the method of treatment. For example, once the hearing aid is fitted, the hearing aid channel which corresponds to the frequency or frequencies of the tinnitus

sound is selected and to determine what intensity of amplification is most appropriate the gain of this channel can be increased incrementally until the patient notes that the tinnitus sound is suppressed.

In another aspect the present invention is directed to a device for identifying a suppression signal for use in the method described above, the device including:

- a computing device:
- sound generating means: and
- a computer storage media containing a computer program having a software component which allows a user operating the computing device to select a frequency and intensity of sound, a software component which allows said user to alter the selected frequency and selected intensity, and a software component which causes the sound generating means to emit sound of any selected frequency and intensity.

Preferably, the device has a visual display means for displaying the selected frequency or frequencies and selected intensity or intensities. More preferably, this information is displayed on an audiograph. Accordingly, in this preferred embodiment the computer program also has software components which cause an audiograph to be displayed and selected frequencies and intensities to be displayed on the audiograph.

The frequencies and intensity selected during the process of identifying the suppression signal can be plotted on the audiograph. This forms a tinnitus suppression plot.

As this device may also be used to present sounds of differing frequencies and intensities to the patient for the purpose of assessing their hearing, it can be used to obtain an audiogram for the patient. Thus, in a preferred embodiment the computer program has a software component which causes an audiogram to be displayed on the audiograph. It is preferred that the computer program also has a software component which causes selected frequencies and

intensities to be recorded so that this information can be accessed at a future date.

It is preferred that the tinnitus suppression plot be superimposed on the audiogram. The tinnitus suppression plot should cross over the audiogram so that part of the suppression plot extends above the audiogram and into an area on the audiogram that represents the area of hearing loss for the patient. The suppression signal is preferably located in this section of the tinnitus suppression plot.

It is also preferred that a computer program has a software component which allows the user to select a bandwidth of frequencies and to alter the bandwidth.

In another embodiment, the present invention is directed to the computer program per se that is capable of performing these functions. Accordingly, in this embodiment the invention is directed to a computer program for identifying a suppression signal for use in the method described above, said program having:

- a software component which allows a user operating a computing device to select sound having a frequency and intensity;

- a software component which allows said user to alter the frequency and intensity; and

- a software component which causes a sound operating device to emit sound of any selected frequencies and intensity.

It is preferred that the program is capable of performing the additional functions described above with reference to the device for identifying a suppression signal. Thus, it is also preferred that the program has a:

- a software component which causes an audiograph to be displayed on a visual display means;

- a software component which causes selected frequencies and intensities to be displayed on said audiograph;

- a software component which causes a tinnitus suppression plot to be displayed on said audiograph;

- a software component which causes an audiogram to be displayed on said audiograph; and

- a software component which records selected frequencies and intensities.

The computing device may be a consumer grade PC or other sound-enabled programmable device.

The computer program may be delivered via the internet or other electronic media to enable the clinician or patient to load the program onto their own computing device and thereby operate the computing device in the manner described above.

It is known that a certain percentage of tinnitus sufferers experience changes in tinnitus frequency over time. Consequently, a suppression signal may also have to be varied over time to most effectively treat the patient's tinnitus. For a particular patient there may be a number of suppression signals that are utilised simultaneously or alternatively to treat the tinnitus. Thus, for this patient, a number of tinnitus suppression plots may be recorded. In a preferred embodiment the computer program allows a user to record multiple tinnitus suppression plots and suppression signals which the patient may retrieve and utilise depending on current needs.

In a further embodiment, the computer program may embody algorithms which automatically adapt to the individual patient's variation in tinnitus frequencies and intensities, providing ongoing, effective suppression for such patients.

Preferably the computer program, once operated to identify a suppression signal or signals, is capable of performing the following additional functions:

- directing a separate programmable sound generating device to generate the suppression signal or signals. In this instance, the program or a version of it may be downloaded onto the programmable sound generating device. Such a programmable device may be a personal digital assistant, portable personal computer, desktop personal computer or network device; and/or

- downloading the waveform representing the suppression signal in a standard media format to a portable or fixed storage device such as a personal CD, mini disk, MP3 player, personal digital assistant (PDA) or portable personal computer or tape player.

Suppression signals or a version of the program configured with the patient's profile may be transferred to other devices via wireless data links, local area networks, Internet, audio connection, or other electronic media.

In another aspect of the invention, the two channel (stereo) capability of consumer electronic devices enables the effective treatment of patients with bilateral tinnitus. In addition, the repeat functionality of such devices can be utilised to keep the storage requirements to a minimum while producing a continuous suppression signal. Furthermore, such devices provide multiple "tracks" which may store multiple suppression signals for the effective suppression of tinnitus in those with tinnitus modalities that vary with time. A single "track" is not limited to a single frequency.

Although it is possible in many cases to effectively apply the suppression signal with commonly available, consumer, electronic audio devices, some patients with otherwise normal hearing may find that the level control on such devices is inadequate for the very low levels required for such patients. In another aspect of the invention, an in-line attenuating device is utilised to provide much lower audio intensity levels and also to provide much finer control at such low levels.

This also minimises the risk of misuse of the audio signals output by such devices. The attenuator means that the audio device may be operated within its "normal" output levels, thereby minimising artefacts that may arise when operating at the low extreme of the said audio device's output range. In a further aspect of the invention, the attenuating device may incorporate other audio signal conditioning capabilities such as low pass filters and/or high pass filters to further improve the suppression effect of the device's output.

It has been discovered by the inventor that the tinnitus of some patients does not return immediately after the removal of the suppression signal. This is referred to as residual suppression. This effect has been observed to last for up to several hours. Thus, in a further aspect of this invention, continuous suppression of tinnitus is achieved by the intermittent application of a suppression signal .

An application service provider (ASP) distribution model is used in one form of the invention, where the computer program embodied in profile software resides on a server at a location remote from the user, and via a dedicated (e.g. dialup) or generic network connection (e.g. Internet), the user interfaces with the server for the delivery of the suppression signal. In addition, the ASP means of distribution can be utilized to permit a centralized method of collection of information, including diagnosis and monitoring, leading to the analysis and broad diagnosis and contributing factors affecting tinnitus sufferers.

The ASP distribution model is used in one form of the invention, where the profile software resides on a server means at a location remote from the clinician user, and via a communications connection the clinician can be connected to the server means. Through one aspect of the invention the clinician can access data stored in relation to a patient for the time period between visits. In a further aspect of the invention the clinician can access data stored in relation to a patient even though the patient is not at the clinician's premises for the purposes of monitoring and clinician care.

The present inventor has found that if the tinnitus sufferer also experiences hearing loss at or around the frequency of tinnitus sound perceived by the sufferer and a hearing aid is used in treating the hearing loss, the tinnitus sound can also be suppressed if the hearing aid is programmed to selectively amplify external sound at or around the same frequency as the tinnitus sound, but in this instance to a level slightly greater than the level of hearing loss for the patient at or around that frequency.

This represents an alternative method for treating tinnitus or ameliorating the symptoms of tinnitus for a patient also suffering from hearing loss. In this instance, the method includes the step of selectively amplifying external sound received by said patient in the range of about 20 hertz to 20,000 hertz, said external sound having a frequency or frequencies at or around the frequency of tinnitus sound perceived by the patient and within the range of hearing loss for said patient, said external sound amplified to a level slightly above the threshold of hearing for said patient at said frequency or frequencies.

Preferably, the level of amplification should not exceed 10 dB SPL, more preferably 5 dB SPL above the level to restore the hearing loss at the relevant frequency of frequencies. These levels of additional amplification are often not perceived by the patient, so that the patient is only aware that amplification has been carried to treat hearing loss.

It is preferred in this alternative method that the hearing aid be programmed to perform both functions, that is, amplify certain frequency or frequencies to compensate for hearing loss, and, to amplify a frequency or frequencies at or around the tinnitus frequency to suppress tinnitus.

The invention shall now be described with reference to the following figures. Figure 1 is a flowchart of the steps undertaken to identify a suppression signal for use in the method of treatment of this invention.

Figure 2 is an illustration of the display screen of the computing apparatus described earlier to determine a suppression signal for a specific tinnitus frequency in one ear using the process described in the flowchart of Figure 1.

Turning to Figure 1, the first step in the method is obtaining an audiogram for the patient. The frequency of sound that matches the tinnitus sound is obtained. The intensity of this sound is increased until the tinnitus is suppressed. Thereafter, the frequency is increased and intensity is decreased until an inaudible suppression signal is identified.

Figure 2 shows the display screen of the device used in the process illustrated in Figure 1 to obtain a suppression signal. The display screen shows an audiograph. On the audiograph there is an audiogram (line marked with 'X's) showing sound frequency versus intensity for the patient, representing the hearing threshold level of the patient. This line shows that the patient suffers a hearing loss over a band of frequencies and that the severity of the hearing loss reaches a maximum for one particular frequency. The present inventor has found that in such patients the frequency of tinnitus sound perceived by the patient is usually but not necessarily apical to the frequency of the maximum hearing loss. This perceived sound is marked with the letter A. Starting from this point, the frequency and intensity of sound presented to the patient is altered. The sounds presented to the patient are marked with a box. This forms a tinnitus suppression plot. The inventor has found that in the method of the present invention it is preferred to provide a sound to the patient having a frequency and level of intensity in area below the hearing threshold. A suppression is obtained which is marked B. As there is no hearing in this area, the auditory signal used is not perceived by the patient.

The Claims defining the invention are as follows:

1. A method for treating tinnitus or alleviating the symptoms of tinnitus in a patient including the step of :

- presenting to the patient a sound having a predetermined frequency or frequencies within the spectrum of about 20 hertz to 20,000 hertz and having a predetermined intensity, said sound being inaudible to the patient.

2. A method of treating tinnitus or alleviating the symptoms of tinnitus in a patient including the step of selectively amplifying to a predetermined level external sound received by said patient within the spectrum of about 20 hertz to 20,000 hertz and having a predetermined frequency or frequencies, said amplified external sound being inaudible to said patient.

3. The method according to Claims 1 or 2 wherein said frequency or frequencies of sound is greater than the frequency or frequencies of tinnitus sound experienced by the patient.

4. The method of any one of Claims 1 to 3 wherein said patient also suffers from hearing loss and said frequency or frequencies of sound is less than the frequency of maximum hearing loss experienced by the patient.

5. A method of identifying the frequency or frequencies and intensity of sound to be presented to a patient or amplified for a patient in a method of treating tinnitus or ameliorating the symptoms of tinnitus in a patient, said method including;

(i) presenting to the patient sound of varying frequencies and the identification by the patient of the frequency or frequencies that match that tinnitus sound;

(ii) varying the frequency and intensity of the sound until a sound which is inaudible to the patient and which treats the patient's

tinnitus or ameliorates the symptoms of the patient's tinnitus is obtained; and

(iii) identifying the frequency or frequencies and intensity of the sound obtained in step (ii).

6. A device for identifying a sound for use in the method of any one of claims 1-5, the device including:

- a computing device:
- sound generating means: and
- a computer storage media containing a computer program having a software component which allows a user operating the computing device to select a frequency and intensity of sound, a software component which allows said user to alter the selected frequency and selected intensity, and a software component which causes the sound generating means to emit sound of any selected frequency and intensity.

7. A computer program for identifying a sound for use in the method of any one of claims 1-5, said program having:

- a software component which allows a user operating a computing device to select sound having a frequency and intensity;

- a software component which allows said user to alter the frequency and intensity; and

- a software component which causes a sound operating device to emit sound of any selected frequencies and intensity.

8. A hearing aid for use in a method of treating tinnitus or ameliorating the symptoms of tinnitus for a patient, wherein the hearing aid is capable of amplifying sound having a single frequency or a bandwidth of frequency of no greater than 25% of a centre frequency of the bandwidth.

9. A hearing aid for use in a method of treating tinnitus or ameliorating the symptoms of tinnitus in a patient, said hearing aid having the ability to amplify sound having a frequency in the range of 6000 hertz to 20,000 hertz.

10. The hearing aid of claims 9 or 10 wherein the hearing aid is digital.

11. A portable sound reproduction device for use in a method of treating tinnitus or ameliorating the symptoms of tinnitus, said device capable of producing sound having;

(i) a single frequency or a bandwidth of frequencies no greater than 25% of a centre frequency of the bandwidth;

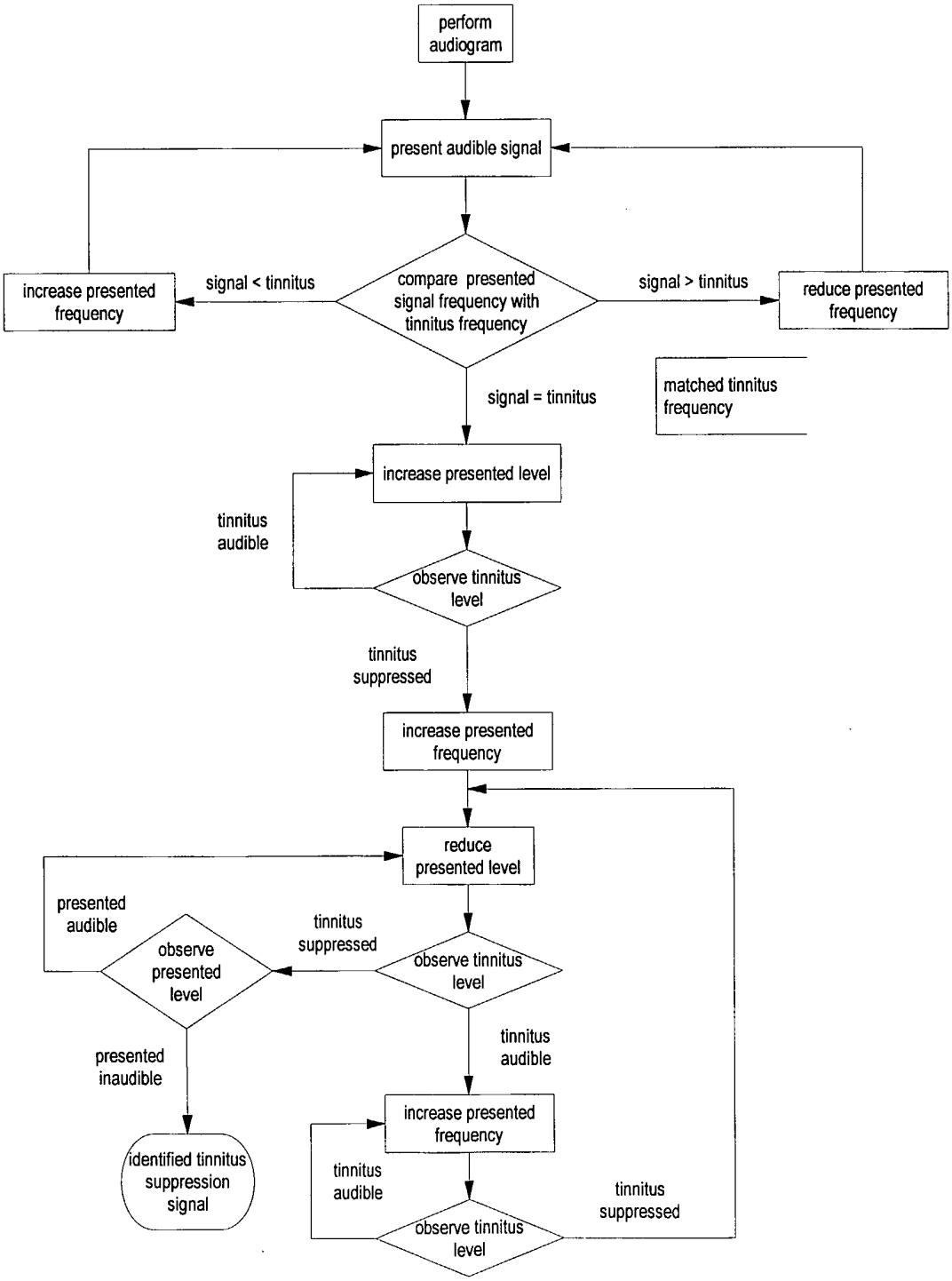
(ii) a frequency or frequency in the range of 20 hertz to 20,000 hertz; and

(iii) an intensity below 65dBSPL

12. A portable sound reproduction device according to claim 11 wherein the device has;

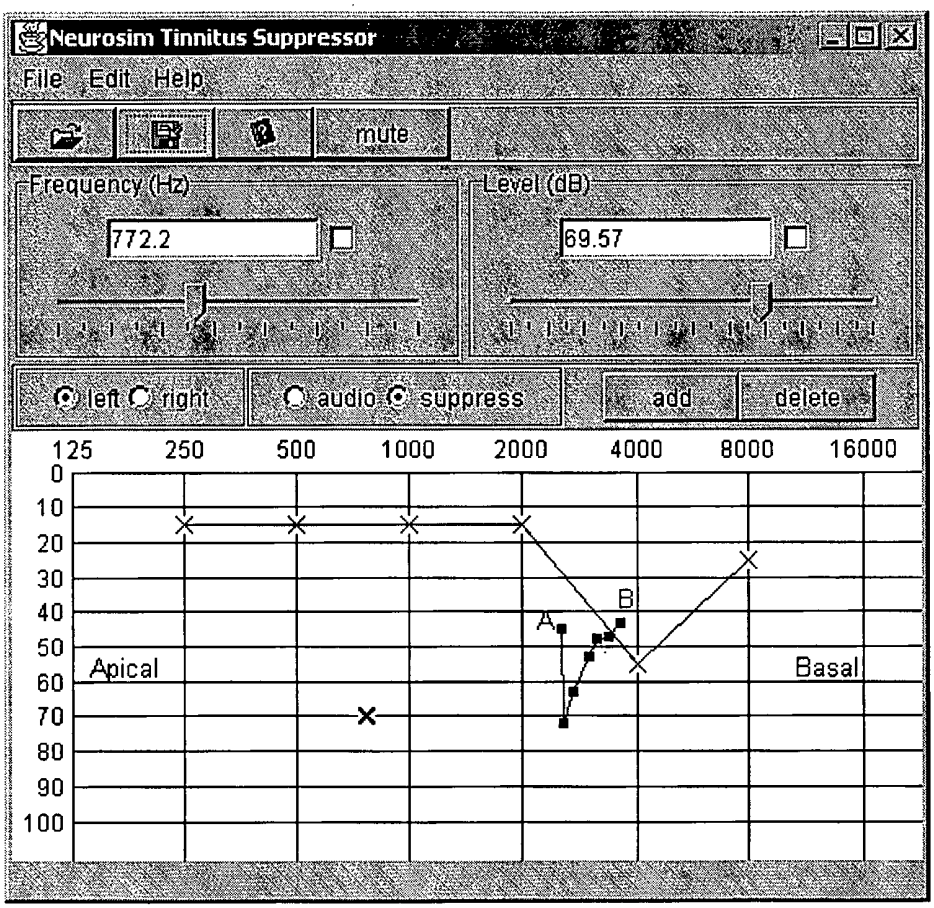
(iv) a fine sound level control at low intensities of approximately 1dB resolution.

Figure 1.



Method for identifying a suppression signal

Figure 2.


Neurosim Tinnitus Suppressor
File Edit Help
mute
Frequency (Hz)
772.2
Level (dB)
69.57
left right
audio suppress
add
delete
125
250
500
1000
2000
4000
8000
16000
0
10
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Apical
Basal

INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: A61B 5/12, H04R 25/00, A61F 11/00

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)

Refer Electronic data base consulted below

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 practicable, search terms used)

DWPI & keywords: tinnitus sound tone intensity level hear narrow deaf aid response bandwidth and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5167236 A (JUNKER) 1 December 1992 Column 2 lines 22-27, 29-31	1-4
A	DE 29616956 U1 (AURIC HORSYSTEME GMBH & CO KG) 6 February 1997	1-4
X	WO 85/00509 A1 (WESTRA ELECTRONIC GMBH) 14 February 1985 Abstract	6,7

[X] Further documents are listed in the continuation of Box C [X] 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 application or patent 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
27 June 2001

Date of mailing of the international search report
2 July 2001

Name and mailing address of the ISA/AU

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU01/00332

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6155971 A (CALHOUN et al) 5 December 2000 Column 6 line 24 - column 8 line 54	6,7
X	GB 2030753 A (VIENNATONE GESELLSCHAFT MBH) 10 April 1980 Whole document	6,7
X	DE 4408443 A1 (MULLER) 12 October 1995 Whole document	6,7
X	US 5263089 A (RIBIC) 16 November 1993 Figure 4b	8
X	WO 94/10819 A1 (AUDITORY SYSTEM TECHNOLOGIES) 11 May 1994 Whole document	8
X	US 5764778 A (ZUREK) 9 June 1998 Column 4 lines 1-8	9,10
X	US 4539440 A (SCIARRA) 3 September 1985 Column 6 lines 40-60	9,10
X	JP 01-158900 A (IGUCHI) 21 June 1989 Column 14 line 8, figure 5	9,10
X	DE 19525944 A1 (BERNDSEN) 23 January 1997 Column 2 lines 14-17	9,10
X	FR 2350829 A (NIR) 9 December 1977 Whole document	9,10
X	GB 2055020 A (DAVAVOX A/S) 18 February 1981 Page 1 lines 94-114	11,12
X	GB 2134689 A (NATIONAL RESEARCH DEVELOPMENT CORPORATION (UNITED KINGDOM)) 15 August 1984 Page 4 lines 4-59	11,12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU01/00332

C (Continuation)	**DOCUMENTS CONSIDERED TO BE RELEVANT**	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5403262 A (GOOCH) 4 April 1995 Whole document	11,12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU01/00332

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search 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 3 of first sheet)

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

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.
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Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1-5 are directed to a method of treating tinnitus or of identifying frequencies to treat tinnitus which are presented to the patient at an inaudible level. It is considered that presenting the frequencies to the patient at an inaudible level comprises a first "special technical feature".

2. Claims 6 and 7 are directed to a device and program to control a sound generating means with the frequency and intensity of the emitted sound to be varied under control of the user. It is considered that control of the frequency and intensity of the emitted sound of a sound generating means comprises a second "special technical feature".

3. Claim 8 is directed to a hearing aid capable of amplifying sound at a single frequency or a bandwidth of no greater than 25% of a centre frequency. It is considered that a hearing aid capable of amplifying sound at a single frequency or a bandwidth of no greater than 25% of a centre frequency comprises a third "special technical feature".

4. Claim 9 is directed to a hearing aid with the ability to amplify sound in the frequency range of 6000 to 20000 hertz. It is considered that a hearing aid with the ability to amplify sound in the frequency range of 6000 to 20000 hertz comprises a fourth "special technical feature".

5. Claims 11 and 12 are directed to a sound reproduction device with a specific capability to produce sounds with a given frequency(s) in the range 20 - 20K hertz and with an intensity below 65dBSPL. It is considered that a sound reproduction device with a specific capability to produce sounds with a given frequency(s) in the range 20 - 20K hertz and with an intensity below 65dBSPL comprises a fifth "special technical feature".

Since the abovementioned groups of claims do not share any of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept, a priori.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU01/00332

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5167236	AU	47518/90	EP	449860	WO	90/07251
DE	29616956	NONE					
WO	85/00509	DE	3325955	US	4847763	DE	3334524
		DE	3404883				
US	6155971	NONE					
GB	2030753	AT	6360/78	DE	2933294	DK	3575/79
		NL	7906527				
DE	4408443	NONE					
US	5263089	AT	2237/90	CA	2054136	EP	485357
WO	94/10819	AU	55393/94	US	5406633		
US	5764778	CA	2178453				
US	4539440	NONE					
JP	01-158900	NONE					
DE	19525944	NONE					
FR	2350829	NONE					
GB	2055020	CH	655629	DE	3027791	DK	3148/79
GB	2134689	NONE					
US	5403262	NONE					

END OF ANNEX