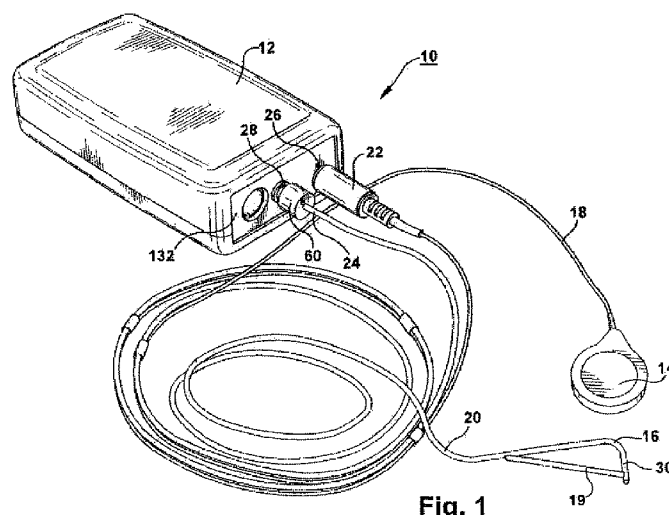




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(54) **Title:** METHOD AND SYSTEM FOR TRAINING VOICE PATTERNS**Fig. 1**

(57) **Abstract:** One example embodiment of the present disclosure includes method and system to improve communication comprising an assembly (10) fixedly positioned during use in close proximity to a user's ear. The assembly includes an accelerometer (14) to detect the initiation and duration of the user's speech and an output presentation system. The output presentation system comprises a non-occlusive ear fitting (16) that presents unintelligible noise (31, 68) that is unrelated to the sound-frequency or intonation of the user's current speech. The unintelligible noise (31, 68) is presented to the patient at a level less than 85 dB. The system further comprises a control arrangement (38) to maintain presentation of the noise (31, 68) substantially throughout the detected duration of the user's speech, but substantially not at other times.



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TITLE: METHOD AND SYSTEM FOR TRAINING VOICE PATTERNS

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] The following application claims priority to co-pending U.S. Provisional Patent Application Serial No. 61/445,780 filed February 23, 2011 entitled *METHOD AND SYSTEM FOR TRAINING VOICE PATTERNS* and U.S Non-provisional Patent Application Serial No. 13/398,399 filed February 16, 2012 entitled *METHOD AND SYSTEM FOR TRAINING VOICE PATTERNS*. Priority is claimed from all of the above-identified applications, which are incorporated herein by reference in their entirety for all purposes.

GOVERNMENT FUNDING

[0002] This invention was made with government support under National Institutes of Health (“NIH”) Grant No. R01DC009409. The United States government has certain rights in the invention.

TECHNICAL FIELD

[0003] The present disclosure relates to a method and system for training voice patterns, and more specifically, the present disclosure comprises a voice enhancement system and method used to increase individuals’ sound pressure level (“SPL”) and change their speech rate. The voice enhancement system and method increases the individuals’ SPL and changes their speech rate by eliciting the Lombard effect. The Lombard effect is an external cue for increasing voice loudness.

BACKGROUND

[0004] Individuals can suffer from various diseases that result in one or more voice impairments. Such voice impairments can include, but are not limited to, hypophonia (reduced loudness), monoloudness, monopitch, disordered rate and articulation, and a voice that is hoarse, breathy, harsh, and/or tremulous.

[0005] Parkinson's Disease is a progressive movement disorder in which there is a deficit in dopamine production in the basal ganglia. Parkinson's Disease is just one disease identified as being associated with one or more voice impairments. Further discussion relating to Parkinson's Disease and its connection with voice impairments is found in International Patent Application Serial Number PCT/US2010/045568 filed August 16, 2010 entitled *METHOD AND APPARATUS FOR INCREASING VOICE LOUDNESS*, herinafter referred to as "the '568 Application". The '568 Application is incorporated herein by reference in its entirety for all purposes.

SUMMARY

[0006] One example embodiment of the present disclosure includes a method and system to improve communication comprising an assembly fixedly positioned during use in close proximity to a user's ear. The assembly includes an accelerometer to detect the initiation and duration of the user's speech and an output presentation system. The output presentation system comprises a non-occlusive ear fitting that presents unintelligible noise that is unrelated to the sound-frequency or intonation of the user's current speech. The unintelligible noise is presented to the patient at a level less than 85 dB. The system further comprises a control arrangement to maintain presentation of the noise substantially throughout the detected duration of the user's speech, but substantially not at other times.

[0007] Another example embodiment of the present disclosure includes a system for training patients exhibiting hypophonic speech conditions as a result of age or disease state to have improved communication. The system comprises an activation device responsive to movement or vibrations in a patient during speech, and which is relatively unresponsive to unrelated air-based sound waves, and upon sensing the patient's speech movement or vibration produces an output signal. The system further comprises a presentation assembly having an ear fitting that transmits noise to the ear of a patient during a noise enabling condition, and a control arrangement coupled to the activation device for receiving the output signal. The control arrangement comprises a signal processor having a prescribed threshold that is analyzed against the output signal such that one or more output signals above the threshold generates the noise enabling condition resulting in noise transmission from the control arrangement to the presentation assembly.

[0008] Yet another example embodiment of the present disclosure includes a method for training a patient to have at least one improved communication characteristic. The method comprises positioning a non-occlusive ear fitting in a patient's ear that transmits noise to the ear of the patient during a noise enabling condition and positioning externally an accelerometer on a patient at a location that moves or vibrates during speech. The method further comprises transmitting an output signal from the accelerometer to a control arrangement upon sensing movement or vibration experienced during speech of the patient and analyzing the output signal with a signal processor within the control arrangement against a prescribed threshold. The method also includes transmitting audio noise to the ear fitting from the control arrangement when the output signal is above the threshold generating the noise enabling condition.

[0009] While another example embodiment of the present disclosure comprises a system for training patients exhibiting hypophonic speech conditions associated with at least one of Parkinson's disease, normal pressure hydrocephalus, vascular dementia, and presbylaryngis to have improved communication. The system comprises a mobility

arrangement forming the system including an activation device, a presentation assembly, and a control arrangement that is portable and positioned on a patient during training and the activation device and the assembly are worn in close proximity to a patient's ear during training. The activation device is enabled to produce an output signal substantially in response to sensing speech movement by a patient or skin vibrations resulting from a patient's facial or neck movement that occurs during speech or attempted speech. The presentation assembly comprises an ear fitting that transmits unintelligible noise to the ear of a patient during a noise enabling condition. The control arrangement is coupled to the activation device for receiving the output signal. The control arrangement comprises a signal processor having a prescribed threshold that is analyzed against the output signal such that a value of the output signal above the threshold generates the noise enabling condition resulting in a noise signal being transmitted from the control arrangement to the presentation assembly, generating the unintelligible noise to the ear of a patient.

[0010] A further example embodiment of the present disclosure comprises a training arrangement for improving communications in patients exhibiting hypophonic speech conditions associated with at least one of Parkinson's disease, normal pressure hydrocephalus, vascular dementia, and presbylaryngis. The arrangement comprises a portable assembly fixedly positioned in close proximity to a patient's ear during use or training. The portable assembly comprises an actuating device for converting mechanical movement of the patient's body to an electrical output signal generated at an initiation and throughout a duration of the patient's speech, a microcontroller capable of receiving the electrical output signal from the actuating device, and an output presentation system in communication with the microcontroller. The output presentation system comprises a non-occlusive ear fitting that presents unintelligible noise at a level less than 85dB that is unrelated to audible frequencies or intonation of the patient's current speech, the unintelligible noise is generated from the microcontroller during a noise enabling condition that occurs substantially throughout a detected duration of the patient's

speech, but substantially not at other times. The microcontroller comprises a signal processor that establishes a prescribed threshold that is analyzed against the electrical output signal such that a value of the electrical output signal above the threshold generates the noise enabling condition resulting in the unintelligible noise being transmitted from the microcontroller to the output presentation system. The system also includes memory for storing patient information during use or training based on the operation of the microcontroller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The foregoing and other features and advantages of the present disclosure will become apparent to one skilled in the art to which the present disclosure relates upon consideration of the following description of the invention with reference to the accompanying drawings, wherein like reference numerals, unless otherwise described refer to like parts throughout the drawings and in which:

[0012] FIG. 1 is a voice enhancement system constructed in accordance with one embodiment of the present disclosure;

[0013] FIG. 2A is an earpiece positioned within an ear of a patient using the voice enhancement system and methods for treatment and the positioning of an activation device in accordance with one example embodiment of the present disclosure;

[0014] FIG. 2B illustrates another example embodiment for the positioning of an activation device for a voice enhancement system of the present disclosure;

[0015] FIG. 2C illustrates an example embodiment of a voice enhancement system comprising a compact design where the entire system is positioned near the patient's ear;

[0016] FIG. 3 is a rear cover of a housing for the voice enhancement system illustrated in FIG. 1;

[0017] FIG. 4 is a block diagram illustrating a control arrangement of a voice enhancement system constructed in accordance with one embodiment of the present disclosure;

[0018] FIG. 5 are images of an accelerometer used in connection with one embodiment of the voice enhancement system;

[0019] FIG. 6 is a printed circuit board of the voice enhancement system;

[0020] FIG. 7 is a portion of the voice enhancement system illustrating the positioning of the printed circuit board of FIG. 6 within a housing;

[0021] FIGS. 8-10 are electrical schematics forming the control arrangement of the voice enhancement system constructed in accordance with one example embodiment of the present disclosure;

[0022] FIG. 11 is a flowchart summarizing a method for increasing voice loudness in a patient in accordance with one embodiment of the present disclosure;

[0023] FIGS. 12-13 illustrate testing data from Parkinson's Disease patients and the results realized by the patients as a result of wearing the voice enhancement systems over a prescribed period of time;

[0024] FIG. 14 illustrated one methodology used for training patients using the voice enhancement system in accordance with one example embodiment of the present disclosure;

[0025] FIG. 15 illustrates another methodology used for training patients using the voice enhancement system in accordance with one example embodiment of the present disclosure;

[0026] FIG. 16 illustrates various positions for locating an activation device of the voice enhancement system in accordance with one example embodiment of the present disclosure; and

[0027] FIGS. 17-18 illustrate testing data from Parkinson's Disease patients and the results realized by the patients as a result of wearing the voice enhancement systems over a prescribed period of time

DETAILED DESCRIPTION

[0028] Referring now to the figures generally wherein like numbered features shown therein refer to like elements throughout unless otherwise noted. The present disclosure relates generally a method and system for training voice patterns. More specifically, the present disclosure comprises a voice enhancement system and method used to increase individuals' SPL and change their speech rate. The voice enhancement system and method increases the individuals' SPL and changes their speech rate by eliciting the Lombard effect. The Lombard effect is an external cue for increasing voice loudness. The present method and system uses the Lombard effect to assist individuals experiencing problems with vocal intensity, articulation, and/or volume as a result of a physically degenerative condition such as Parkinson's Disease.

[0029] The Lombard effect produces an involuntary reaction in speakers to increase their voice loudness when speaking in noisy environments. In addition, the Lombard effect is known to not only influence the voice loudness in its speakers, but it can also alter the speaker's articulation quality, speech rate, and pitch.

[0030] Referring now to the figures, and in particular to FIG. 1, is a voice enhancement system 10 (hereinafter "VES" or "system") constructed in accordance with one embodiment of the present disclosure. The voice enhancement system 10 comprises a number of components and is designed to be used with patients diagnosed with physical ailments resulting in reduced vocal volume or intensity and experiencing problems with vocal loudness as a result of their disease.

[0031] Parkinson's Disease, including idiopathic Parkinson's Disease is an example of one type of ailment treatable by the system 10; however, other diseases or speech disorders having similar ailments that can cause speech deficiencies, for example hypophonia, general articulation, low sound pressure level, high speech rates, reduced respiratory support, and poor vowel articulation are intended to be treated with the voice enhancement system 10 without departing from the spirit and scope of this disclosure.

[0032] The voice enhancement system 10 as shown in FIG. 1 comprises a number of electrical components that are both internal and external to a housing 12. Located externally from the housing 12 is an activation device or accelerometer 14 and earpiece 16 that are coupled *via* feeds 18, 20 having connectors 22, 24, respectively to ports 26, 28 of the housing. In one example embodiment, the accelerometer 14 is an accelerometer manufactured by Knowles Acoustics of Itasca, IL. under part number BU-27135-000. In another example embodiment, the activation device 14 is a sensor capable of transforming energy from one form to another such as a transducer. In yet another example embodiment, the activation device 14 comprises a piezoelectric, piezoresistive, or capacitive type accelerometer.

[0033] The accelerometer 14 acts as an input device to the enhancement system 10. The accelerometer 14 is relatively unaffected by noises in the environment. The accelerometer 14 was chosen, rather than a microphone, so that the enhancement system 10 would not be activated as a result of noise in the room or communication by a third person's speech. Stated another way, the activation device or accelerometer 14 provides an input signal to the voice enhancement system 10 that detects the initiation and duration of the patient's speech and is not activated by surrounding noise and/or non-patient noise.

[0034] During treatment, the accelerometer 14 is placed on any body part suitable for the activation device 14 is worn on or attached to a portion of the patient's neck, such as on a skin surface adjacent one or both of the of thyroid lamina or in the sternal notch. In yet

another example embodiment shown in FIG. 2A, the accelerometer 14 is worn on or attached to the surface of the patient's skin covering the temporal bone to receive bone conduction vibrations from the wearer to detect the onset of speech.

[0035] FIG. 16 illustrates various positions for locating an activation device 14 of the voice enhancement system 10 in accordance with one example embodiment of the present disclosure. In FIG. 16, the activation device 14 is positioned on or in contact with one of the soft tissue regions i1-i12 about the patient's ear, the regions i1-i12 were found to be highly sensitive to detecting speech vibrations.

[0036] The regions i1-i12 include the soft tissue area just under the mandible behind the ear lobe i1-i6 and in front of the ear i7-i12. Each of the soft tissue regions i1-i12 identified for the positioning or contact of the activation device 14, advantageously allows for enhanced sensing of speech vibrations independent of the facial features of the patient.

[0037] While the activation device 14 could be positioned on any of the regions i1-i12 using an adhesive, in a preferred example embodiment, the activation device contacts the patient's skin from a fixture 33 extending from, or directly on the system 10, as illustrated in FIGS. 2A, 2C, and 16.

[0038] In an alternative example embodiment, the activation device 14 contacts one of the regions i1-i12, as it attached and extending from a headset (such as a Bluetooth headset) coupled to the patient's ear. In such embodiment, the activation device 14 is not in continuous contact with the patient's skin.

[0039] Examples of body parts suitable for detection of speech initiation using the system 10, in addition to the temporal bone and neck, include areas near the patient's mouth or lips. All of such body parts and positions are intended to be within the scope and spirit of the present disclosure.

[0040] In the example embodiment of FIG. 2A, the accelerometer 14 is attached in close proximity to the patient's ear. In both the embodiments of FIGS. 2A and 2B, the accelerometer 14 is attached to an epidermal surface using an adhesive.

[0041] The earpiece 16 acts as an output of the system 10, transmitting noise to the patient's ear during prescribed times during treatment. In one example embodiment, the prescribed time during a noise enabling condition starts when the patient initiates speech and continues while the patient talks and may continue for a prescribed duration when the patient ceases speech. The earpiece 16 is a mono-aural device that, in the illustrated example embodiment is non-occlusive to the patient's ear. The non-occlusive earpiece 16 advantageously allows the patient to hear their own speech during use of the system 10. Such advantageous results would not be experienced at the same level with an occlusive earpiece, which would have a tendency to obstruct the patient's hearing. An occlusive earpiece would have the effect of making the patient's voice sound louder to themselves, causing them to talk more quietly. Use of a non-occlusive earpiece avoids this negative effect.

[0042] The earpiece 16 having a support 19 is fed to the ear of the patient through thin tubing or feed 20 and an open ear fitting 30 as best seen in FIG. 2A. A suitable example of earpiece 16 that includes a feed 20 and an open ear fitting 30 is a product manufactured by Phonak AG of Switzerland under the name Fit'nGo Kit; however other open ear fittings made by other manufacturers could also be used with the system 10. The open ear fitting 30 is typically fit into the patient's ear by an audiologist. Use of an open ear fitting 30 avoids a reduction in vocal intensity due to the occlusion effect, which can occur with a closed ear fitting.

[0043] In one example embodiment, the amplitude of the noise generated by the system 10 and transmitted to the output or earpiece 16 can be changed by a third party (*e.g.* a physician, speech-language pathologist, medical personnel *etc.*) treating the patient, but not

by the user of the system. In the exemplary embodiment, the highest output level of the system 10 is less than 85 dBA, and ranges at levels below 80 dBA, which is adequate to elicit the Lombard Effect and would not be expected to cause damage to the hearing mechanism or hearing of the patient that is being treated.

[0044] Referring now to FIG. 3 is a rear perspective view of the housing 12 used to support a portion of the electronics of the voice enhancement system 10. The voice enhancement system 10 illustrated in the example embodiment of FIGS. 1 and 3 is a portable system, allowing unrestrained mobility of the patient since it is designed to attach to the patient's body. In particular, rear view of the housing 12 shown in FIG. 3 illustrates a rear cover 32 of the housing having a support clip 34 integrated into the cover for attaching to the patient's clothing during use. Alternatively, the support clip 34 is used to hold the system 10 by attaching it to the patient's waist through either a belt clip or a fanny pack (depending on the patient's preference). The feeds 18, 20 can be fed underneath the patient's clothing to reduce the visible impact, that is, making the system 10 more inconspicuous to the patient's environment.

[0045] In the illustrated example embodiment of FIG. 1, the system 10 weighs no more than 6 ounces. Illustrated in FIG. 2C is an example embodiment of a voice enhancement system 10 comprising a compact design where the entire system 10 is positioned near the patient's ear. In particular, the non-occlusive earpiece 16, housing 12, and activation device (*e.g.* accelerometer) 14 are in contact with the patient's ear. In the example embodiment of FIG. 2C, the activation device 14 is cased partially within the housing 12. The housing 12 in FIG. 2C contains all the electronics necessary, as further discussed below for processing signals from activation device 14 and producing noise 31 to the earpiece 16. The housing 12 also contains a power source such one or more batteries for supplying power to the system 10.

[0046] During treatment, the patient may wear the voice enhancement system 10 for several hours a day, increasing with treatment up to eight (8) hours per day. The treatment and design of the system 10 is such that it is highly mobile for the patient, allowing treatment to take place during daily living activities.

[0047] The system 10 is designed in such a way to externally cue the patient, for example, *via* the Lombard effect upon initiation of the patient's speech, resulting in several positive and trained conditions in the patient, including increased sound pressure levels, reduced speech rate, improved respiratory support (reduced breathing pauses), and improved articulation. In one embodiment, the system 10 during treatment generates noise 31 that is projected from the earpiece 16 into the patient's ear upon the initiation of the patient's speech. In yet another example embodiment, the noise 31 is communicative unintelligible noise, simulating conversation between individuals, which is sent to the earpiece 16 worn in one of the patient's ears while he/she is talking. In one embodiment, the communicative noise 31 is generated from a product called Multitalker (20 Talkers) (MT) digital audio manufactured by AUDiTEC of St. Louis, MO. In yet another example embodiment, the noise 31 is white noise and/or random noise.

[0048] The presence of communicated noise 31 received by the earpiece 16 is an external cue to the patient to talk louder, naturally eliciting louder and clearer speech through the Lombard Effect. The Lombard Effect provoked by the use of the system 10 causes the patient to naturally and automatically speak louder under conditions of background noise generated by the system. The system 10 is believed to be most effective when the noise transmitted to the patient's earpiece 16 is more communicative in nature. However, random noise could also be transmitted to the patient's earpiece 16 without departing from the scope and spirit of this disclosure. Individuals that suffer from hypophonia, which is found in some forms of Parkinson's Disease can use the system 10 for treatment by wearing the system in

natural communication contexts, achieving a louder, clearer, and more intelligible voice, without needing to self-cue.

[0049] Illustrated in FIG. 4 is a block diagram depicting a control arrangement 38 forming the voice enhancement system 10 in accordance with one example embodiment of the present disclosure. The control arrangement 38 in block diagram of FIG. 4 illustrates generally the components of the system 10, further shown in detail in FIGS. 8-10 and how the electrical components are interconnected. Centrally located within diagram is a central processing unit ("CPU") or microcontroller 40. In one embodiment, the microcontroller 40 is a 16 Bit 120K microprocessor. An example of a suitable microcontroller 40 is an MSP430F2618TPN manufactured by Texas Instruments.

[0050] The accelerometer 14 during use in one example embodiment is mounted on the patient's neck and is connected to electrical components 42 that are coupled the microprocessor 40 using feed 18 (*see* FIGS. 1 and 5). In one example embodiment, the feed 18 is a thin, flexible cable and a 3.5mm mini-phone audio connector 22 (*see* FIG. 1).

[0051] Referring again to FIG. 4, the connector 22 applies an output signal 43 upon speech by the patient generating movement detected by the accelerometer 14 to a preamplifier 44 with a gain of 2000. In one example embodiment, the accelerometer 14 activates the system 10 by sensing vibrations solely from the patient's vocal folds. An amplified signal 46 is transmitted through lead 48 that couples the preamplifier 44 to a band-pass filter 50. The band-pass filter 50 limits the frequency content of the signal 46 to form a filtered signal 52. In the illustrated example embodiment, the filtered signal 52 is limited by the band-pass filter 50 to a frequency content of approximately 100HZ to 400HZ.

[0052] The filtered signal 52 is transmitted *via* lead 54 that couples the band-pass filter 50 to a comparator 56. The filtered signal 52 is then compared by the comparator 56 to a reference level 58 that is set by an adjustment 60 located on the housing 12. Every time the

amplitude of the filtered signal 52 exceeds the reference level 58, the comparator 56 changes state, from low to high in an output signal 62. The output signal 62 is transferred to the microcontroller 40 *via* lead 64. In one example embodiment, the output signal 62 switches between 3.3 volts DC to 0 volts DC when changing from high to low state.

[0053] When the filtered signal 52 value drops back below the reference level 58, the comparator 56 changes state from high to low. This produces a stream of pulses in the output signal 62 that are applied to an interrupt 66 located within the microcontroller 40. As the state in the filtered signal 52 changes from high to low or *vice versa*, the noise transmitted from the system 10 into the earpiece 16 of the patient is enabled and disabled as the change in state occurs. The adjustment 60 that changes the reference level 58 allows medical personnel (such as physicians, nurses, speech-language pathologists *etc.*) treating the patient to manually optimize the sensitivity of the voice enhancement system 10 to the needs of each individual patient. Stated another way, the adjustment 60 allows the threshold for enabling and disabling the noise 31 received by the patient through the earpiece 16 to be adjusted based on the output signal 43 transmitted by the accelerometer 14.

[0054] The interrupt 66 of the microcontroller 40 uses a subroutine to analyze the pulses in the output signal 62 from the comparator 56 to determine when the patient begins speaking. Once it is determined that the patient is speaking, the microcontroller 40 begins reading the communicative noise 31 or audio 68, such as the product Multitalker (20 Talkers) (MT) digital audio manufactured by AUDiTEC of St. Louis, MO. from a micro memory card 70 that is coupled *via* lead 72 to the microcontroller. The microcontroller 40 then begins playing the communicative noise, random noise 31, or audio 68 through an amplifier 74 and a speaker 78 coupled to the microcontroller through lead 76 and feed 20 of the earpiece 16. In the illustrated exemplary embodiment, the amplifier 74 is a Class D amplifier and is combined with the speaker 78, using a digital to analog converter located within the

microcontroller 40. The speaker 78 is connected to the patient's ear with thin clear plastic tubing of the earpiece 16. One suitable example of the earpiece 16 and speaker 78 is a product called Fit'nGo Kit open ear fitting manufactured by Phonak AG of Switzerland.

[0055] In one example embodiment, the microcontroller 40 is programmed 140 (*see* FIG. 9) *via* software such that once the patient stops speaking for approximately 0.5 seconds, the microcontroller 40 stops playing the audio 68 or communicative noise 31. In another example embodiment, the software is programmed such that the audio or communicative noise 31 continues to occur for a range of approximately 500-750 milliseconds. This reduces breaks in audio 68 or communicative noise 31, which could be irritating to the patient during voiceless sound periods.

[0056] When the patient starts talking again, the microcontroller 40 continues playing the audio 68 or communicative noise 31 from where it stopped previously. In yet another example embodiment, the micro memory card 70 contains about 12 minutes and 30 seconds of communicative noise 31 or audio 68 data on a data file 80 located within the memory card. Once the entire audio data file 80 is played, the entire data file is started over at its beginning. This ensures that there is no obvious repetition of the audio generating the communicative noise 31 or audio 68.

[0057] The micro memory card 70 is also used to store data 82 about the usage of the voice enhancement system 10. When the audio or communicative noise 68 begins playing, a data record 84 is written to the memory card 70. Also when the audio 68 stops, another data record 86 is written to the memory card. The memory card 70 further contains a patient information record 88 that includes the patient number, as well as the date and time that the system 10 was initialized. Each patient information record 88 further contains audio 68 ON/OFF occurrences, elapsed time in days, hours, minutes, seconds and hundredths of seconds since the system 10 was initialized. Additional patient information record 88

includes the intensity of the speech vibrations detected by the accelerometer 14, as well as the relative sound output 31, 68 by the microprocessor 40.

[0058] The voice enhancement system 10 is designed to be connected to a computer 90 using a serial interface 92. However, other interfaces 92, including USB, remote, and wireless connections for communicating the computer 90 and the system 10 are also viable forms of communication covered by the spirit and scope of this disclosure. The usage data 82-88 can then be downloaded from the system's memory card 70 *via* the interface 92 to the computer 90. In the exemplary embodiment, the usage data 82-88 is downloaded to the computer 90 using a program called PKTalker that is written in LabVIEW. In an alternative example embodiment, an application specific program in the form of computer readable media is created for reading the usage data 82-88 by a computer 90.

[0059] The system 10 receives its power from a power supply 94. In the illustrated example embodiment, the source of the power supply 94 is two AA alkaline batteries that depending on usage, will provide power to the system to operate for approximately 7-10 days on one set of batteries. As best seen in FIG. 7, the batteries that act as the power supply 94 are located within the housing 12. In an alternative example embodiment (for example FIG. 2C), the power supply 94 supporting the system 10 is smaller and uses for example a rechargeable battery that is charged *via* a USB connection to the system.

[0060] Illustrated in FIG. 6 is a printed circuit board ("PCB") 96 used to support a portion of the electrical components 42 circuitry 100, microcontroller 40, and micro memory card 70 used within the system 10. The PCB 96 is located within the housing 12 as best seen in FIG. 7. The PCB 96 used by the system 10 is a four (4) layer PCB and constructed using surface mount components.

[0061] In an alternative exemplary embodiment, the system 10 further comprises hardware to allow for external communication to a remote computer source. In one example

embodiment, the system 10 includes a universal serial bus (“USB”) or wireless connection, allowing communications with a remote computer for retrieving data and programming the data card 70.

[0062] In another alternative example embodiment, the system 10 is small enough for mounting to allow the accelerometer or transducer 14 to attach with a short connection to the patient’s ear. One example embodiment is constructed such that the entire system 10 is small enough to be configured for positioning behind the patient’s ear with the accelerometer 14.

[0063] In yet another alternative example embodiment, the system 10 uses an open wireless protocol, such as Bluetooth to deliver the audio to the patient’s ear with a wireless connection to the accelerometer 14. In the alternative example embodiment, the system 10 is constructed to work with a Bluetooth headset, using processing capabilities of the microphone signal to determine when the patient is talking instead of the accelerometer 14.

[0064] The accelerometer 14 is coupled to the system 10 *via* the connector 22, which is shielded cable. In the illustrated example embodiment showing an electronic circuitry 100 of the system 10 in FIG. 8, the connector 22 is a 3.5mm mini-phone audio jack. Two ferrite beads, L1 and L2, are connected between an input lead 102 and reference lead 104 from the accelerometer 14 to an input 106 of the preamplifier 44 and an internal ground reference 108 of the system 10. The ferrite beads, L1 and L2 attenuate radio frequency noise picked up by the accelerometer 14 and connector 22. The ferrite beads L1 and L2 also attenuate radio frequency noise created by the system’s microcontroller 40 to reduce the system’s 10 radio frequency emissions. In the illustrated example embodiment, the size of the ferrite beads L1 and L2 have a 330 ohm impedance at 100 Mhz.

[0065] In FIG. 8, an electrostatic discharge suppressor (“ESD”) 110 also identified in the electrical schematic as CR1 protects the preamplifier 44 input 106 from static discharges. A resistor 112 also identified in the electrical schematic as R16 is an appropriate load resistor

for the accelerometer. In the illustrated embodiment, the resistor 112 is a 5.6K Ohm .1W rated resistor. The dashed box representing the preamplifier 44 contains three (3) operational amplifiers ("OP-AMPS") that combine to produce a voltage gain of 2000X. A variable potentiometer 114 also identified in the electrical schematic as R3 is used to adjust the DC balance of the preamplifier 44. A test point 116 also identified in the electrical schematic as J1 is used to analyze the preamplifier 44 output and to adjust the DC level to 1.5 volts with no signal present.

[0066] The amplified signal 46 is transmitted by an output 118 from the preamplifier 44 along lead 48 to an input 120 of the band-pass filter 50. In the illustrated example embodiment, the band-pass filter 50 is a fourth (4th) order band-pass filter that is centered at approximately 200HZ. A test point 120 also identified in the electrical schematic as J4 is used to observe an output 124 of the band-pass filter 50.

[0067] The output 124 of the band-pass filter 50 is connected to one input 126 of the comparator 56. Another input 128 of the comparator 56 is connected to the adjustable voltage reference 130 formed by R25, R27, R24 and C18. R27 is a potentiometer connected to a variable adjustment 60 that is accessible from the front panel 132 (*see* FIG. 1). The variable adjustment 60 in combination with potentiometer R27 is used to adjust the amplitude at which the system 10 detects that the patient is speaking through the vibration, movement of muscle, facial tissue, *etc.*, generated during speech. This allows the sensitivity of the system 10 to be set for a given patient. A test point 136 also identified in the electrical schematic as J3 is used to monitor the reference level during initial testing and adjustment. An additional test point, identified as reference character J6 in the electrical schematic is used to monitor the comparator output 62 to the microcontroller interrupt 66.

[0068] FIG. 9 shows that the output of the level comparator 58 (VOX) is connected to pin 37 (P4.1/TB1) of the TMS430F2618 microcontroller 40 also identified in the electrical

schematic as U12. Pin 37 is configured in software to function as an interrupt. The system 10 includes a program 140 internal to the microcontroller 40 that uses this interrupt to trigger the playback of the audio 68 to the patient. The audio data 82-88 is stored in memory card 70 also identified in the electrical schematic as U15. The memory card 70 is connected to the microcontroller 40 using an SPI serial interface connection to UCB0 (serial interface). The system program 140 also stores patient usage data 88 in flash memory 142 (*see* FIG. 9) every time the audio 68 is played.

[0069] Connector 144 also identified in the electrical schematic of FIG. 9 as J12 is an RS232 serial interface IC U16 used to connect the system 10 to a serial interface of a computer 90 so that the usage data 82-88 can be read from the flash memory 142 and the flash memory can be cleared of the usage data. The clearing of data in flash memory *via* software is understood by one skilled in the art. In the illustrated embodiment, the usage data 82-88 stored in the flash memory 142 is cleared using custom software written in LabView. The software code or operating program 148 used to operate the system 10 and is downloaded into the microcontroller 40 using conventional interfaces appreciated by one skilled in the art. A JTAG connector 146 also identified in the electrical schematic as J13 is used during testing and loading of the system's 10 operating program 148 into the microcontroller's flash memory 142.

[0070] The amplifier 74 and speaker 78 module also identified in the electrical schematic as U9 is used to deliver the audio 68 to the patient. The amplifier 74 and speaker 78 are connected to the microcontroller 40 digital-to-analog output pin 5 also identified in the electrical schematic FIG. 9 as (DAC0). In the exemplary illustrated embodiment, the audio 68 is delivered to the patient through a 0.05 inch ID 0.09 inch OD piece of TYGON® tubing 20 (*see* FIG. 1) manufactured by Saint-Gobain Performance Plastics Corporation of Aurora,

Ohio. In the illustrated example embodiment, the audio data 80 is output from the microcontroller 40 at a sample rate of 8kHz.

[0071] Resistor 150 and capacitor 152, also identified in the electrical schematic as R31 and C30, respectively form a low pass filter 154 used to attenuate converter artifact. In the illustrated example embodiment, the low pass filter 154 attenuates converter artifact that is over approximately 5kHz. The externally accessible potentiometer 134 also identified in the electrical schematic as R28 is used to adjust the amplitude of the output audio 68 signal. A test point 156 also identified in the electrical schematic as J9 is used to measure the audio output signal 68 during device testing.

[0072] FIG. 10 illustrates the schematics for the device power supplies 94. A screw terminal connector 158 also identified in the electrical schematic as J10 is coupled to the two battery power source. In the illustrated embodiment, two (2) AA batteries are used to power the system 10. In an alternative example embodiment, the power supplies 94 comprise a single or multiple rechargeable battery or batteries. L3 and L4 are ferrite beads used to attenuate RF interference. In the illustrated embodiment, the L3 and L4 ferrite beads have a 330 ohm impedance at 100 Mhz.

[0073] A schottky diode 160 also identified in the electrical schematic as CR2 is used to protect the power supply 94 from backward connected batteries. A switched capacitor power supply regulator IC 162 also identified in the electrical schematic as U 14 produces a main DC power supply 164 for the system 10. In the illustrated embodiment, the main DC power supply 164 provides 3.3 volts DC of power to the digital circuitry of the system 10. A test point 166 also identified in the electrical schematic as J5 connects a reference for measurements made during device setup and testing. A test point 168 also identified in the electrical schematic as J11 is used to check the main DC power 164.

[0074] A low dropout linear regulator 170 also identified in the electrical schematic as U11 provides regulated DC power for the analog and audio circuitry in the system 10. In the illustrated example embodiment, the linear regulator 170 provides 3.0V DC power to the analog and audio circuitry in the system 10. A test point 172 also identified in the electrical schematic as J8 is used to check the 3.0V DC supply. A low dropout linear regulator 174 also identified in the electrical schematic as U10 is used to provide 1.5 volt DC power for the system 10. The regulator 174 is used to power the amplifier 74 and speaker 78 as well as for a pseudo reference for the OP-AMPS in the preamplifier 44 and filter 50. A test point 176 also identified in the electrical schematic as J7 is used to check the 1.5V DC supply.

[0075] Illustrated in FIG. 11 is a flowchart summarizing a method 200 for increasing voice loudness in a patient in accordance with one embodiment of the present disclosure. At 210, the method 200 comprises positioning an accelerometer on a patient. At 220, the method 200 comprises transmitting an output signal from the accelerometer when the patient is speaking. At 230, the method 200 comprises analyzing the output signal against a prescribed threshold. At 240, the method 200 comprises transmitting audio noise to the patient from a microcontroller when the output signal is above the threshold.

[0076] An additional benefit of the system 10 is that the patient will be trained to use a louder voice even when not wearing the system over the course of the treatment period, leading to an extended therapeutic effect. For example, patients after using the system 10 for an extended period of time will produce louder and clearer speech, increasing a number of decibels (dBA) in SPL than experienced at the start of treatment without the device on. This therapeutic effect will beneficially grow over a treatment period using the system 10 on and off the patient, allowing the patient to maintain louder and clearer speech between longer treatment periods.

[0077] In one example embodiment, the system 10 is additionally used to measure a patient's SPL *via* the accelerometer 14, which provides feedback communications to the

microcontroller 40. Alternatively or in combination with the accelerometer 14, a microphone 315 is coupled to the microcontroller 40 and used to provide SPL data relating to the patient during use of the system 10. The collection of the patient's SPL measurements occur with the system 10 on the patient, with or without the activation of the audio 68 or communicative noise 31.

[0078] In another example embodiment, the system 10 includes two or more settings that alter the levels of the audio 68 or communicative noise 31. For example, a first setting is used for normal or at home conditions. A second setting is used when increased audio 68 or communicative noise 31 is required, for example at a basketball game or large outdoor activity. Higher background noises in setting 2 can overcome the environmental competing effects of using setting one in louder environments. The settings can be adjusted by the patient manually, or alternatively, the microphone 315 can detect environmental conditions and the controller 40 can adjust the setting levels automatically.

Testing Results and Training Using the Voice Enhancement System 10

[0079] FIGS. 12-13 and discussion below involve testing results from training thirty-six (36) Parkinson's Disease Patients ("PDPs") in a study using the voice enhancement system 10 over an eight (8) week period. The PDPs realized a number of positive changes in their communication as a result of the training and use of the system 10. The positive changes that were realized discussed further below include: increased Sound Pressure Levels and altered Speech Rate.

[0080] FIGS. 12-13 relating to the testing results illustrate data taken from one session before the system 10 was positioned on the patient or user is labeled "Pre". The data taken as the end of the eight (8) week training period is labeled "Post". At all data points shown in FIGS. 12-13, the data was measured with the system 10 off (labeled "Off") and then on (labeled "On").

The training consisted of the patients wearing the system in communicative environments for 4-6 hours per day for eight (8) weeks. The PDPs returned every two (2) weeks for evaluation. Testing then occurred with the patients having the system 10 off and on.

Sound Pressure Level

[0081] Sound Pressure Level (“SPL”) is a measure of the intensity of the voice. PDPs often have weak, quiet voices, making vocal intensity a major therapy target. Referring now to FIG. 12, the SPLs (shown along the vertical axis) were higher with the system 10 on than when the system 10 was off before training due to the Lombard Effect. The SPL data in FIG. 12 was collected from an extemporaneous speech task where PDPs talked about a topic of their choice for two (2) minutes. This task is indicative of real-world speech production.

[0082] Unlike the left side of FIG. 12 that illustrates the effects of the system 10 before training, the right side of FIG. 12 demonstrates that the patients continue to increase SPL and loudness when wearing the system after eight (8) weeks of therapy. When comparing the Pre Off and Post Off data of FIG. 12, it illustrates the effects of training (or therapy) with the system 10 over an eight (8) week period. The patients benefited by increasing SPL and loudness, according to the data shown in FIG. 12 even when the patients were not using the system after training.

Speech Rate

[0083] Speech Rate is a measure of the number of syllables produced per second. PDPs sometimes speak more quickly than typical speakers, making a reduction in rate one possible therapy target. FIG. 13 illustrates the training effect of the system 10 on speech rate (syllables produced per second). A higher number reflects a faster speech rate.

[0084] Speech rate data was collected in FIG. 13 during the study from an extemporaneous speech task where patients talked about a topic of their choice for two (2) minutes. This task is indicative of real-world speech production. As can be seen in FIG. 13, the patients in the study realized a significant change (for the patients depicted in FIG. 13, the change was a decrease) in speech rate after experiencing training for an eight (8) week period with the voice enhancement system 10.

[0085] The data of FIG. 13 demonstrate a training effect in that patients are producing a slower speech rate after training even while the system is off. Although not all patients in the study demonstrated a reduction in speech rate and some experience an increase. As well, not all patients in the study demonstrated a large (greater than one (1) syllable per second) change. But, those patients that did demonstrate a large change transitioned toward a more typical rate.

[0086] Such changes in speech rate were advantageously experienced for at least two reasons. First, data from the study on the results of the Lombard Effect in individuals with Parkinson's disease have not typically shown a change in rate. Typically, younger and older adults tend to slow their rate when speaking in a noisy or loud environment. Individuals with Parkinson's disease have not typically shown any significant change in rate. However, these data are the first to show the effects of training over eight (8) weeks with the Lombard Effect. Secondly, trained changes in rate during connected speech (as demonstrated above) are rare in speech therapy. No other therapy is known to have been proven to make large changes in rate possible during connected speech. Such large changes in speech rate have been advantageously experienced as a result of the type of training methodologies used and described herein, along with the implementation of such training in connection with the use of the voice enhancement system 10.

Lung Volume Initiation and Lung Volume Termination

[0087] FIGS. 17-18 illustrate testing data from Parkinson's Disease patients and the results realized by the patients as a result of wearing the voice enhancement systems 10 over a prescribed period of time. In particular, FIGS. 17-18 illustrate the impact the device 10 has on the patient's respiratory system, namely lung volume initiation and termination.

[0088] FIGS. 17-18 and discussion below involve testing results from training thirty-six (36) Parkinson's Disease Patients ("PDPs") in a study using the voice enhancement system 10 over an eight (8) week period. The PDPs realized a number of positive changes in their respiratory system as a result of the training and use of the system 10. The positive changes that were realized discussed further below include: increased lung volume.

[0089] FIGS. 17-18 relating to the testing results illustrate data taken from one session before the system 10 was positioned on the patient or user is labeled "Pre". The data taken as the end of the eight (8) week training period is labeled "Post". All data shown in FIGS. 17-18, the data was measured with the system 10 off (labeled "Comf") and then on (labeled "With Device"). The training consisted of the patients wearing the system in communicative environments for 4-6 hours per day for eight (8) weeks. The PDPs returned every two (2) weeks for evaluation. Testing then occurred with the patients having the system 10 off and on.

[0090] As illustrated in FIGS. 17 and 18, the measurements of lung volume initiation reflect the amount of air volume in the lungs when the patient begins to talk. Similarly, lung volume termination reflects the amount of air in the lungs when the patient stops talking. These measures can be used to determine the adequacy of respiratory support for speech. Pre-training, using the device and speaking at a higher intensity resulted in patients using much higher lung volume initiations and terminations. This means that patients used greater inspiratory muscle effort to breathe to a higher lung volume before speaking. Given the potential for chest wall rigidity in Parkinson's disease, this is not the most efficient

mechanism of support from the respiratory system. However, after training, even though patients were speaking at a higher intensity at comfortable, they only marginally increased their lung volume initiations and terminations. Further increasing vocal intensity by again using the device after training did not result in a change in lung volume initiations and did result in a decrease in lung volume terminations. The post-training response from the PDPs was consistent with patterns seen in typical older adults speaking in noise. This means that respiratory support for speech was more typical in the patients after training.

Methodologies For Use With the Voice Enhancement System 10

[0091] One methodology 300, illustrated in FIG. 14 used for training patient's with the system 10 in accordance with one exemplary embodiment of the present disclosure comprises interviewing each patient to determine a patient specific pre-training typical sound pressure level 310. A typical sound pressure level 310 is determined by measuring the loudness or sound level projected by each patient during speech while the patient is "off" the system 10. Once the typical sound pressure level 310 (measured in dBAs) is determined, this level 310 is used to set the audio 68 or communicative noise 31 projected from the system 10 to the patient through one or more earpieces 16. A patient's typical sound pressure level for the system 10 is set based on a dialog between medical personnel (such as physicians, nurses, speech-language pathologists *etc.*) and the patient.

[0092] The methodology 300 continues by increasing the audio 68 or communicative noise 31 in the voice enhancement system 10 to an offset amount 312, while the device is positioned on the patient during connected speech. In one example embodiment, the offset amount 312 is approximately five (5) (dBA) higher SPL than the patient's typical sound pressure level 310. In the illustrated example embodiment of FIGS 1 and 14, the noise is increased in the system 10 by a turn-screw adjustment accessible through the housing 12 by

medical personnel. The voice enhancement system 10 is then positioned on the patient for training. In an alternative example embodiment, the noise 31 is increased in the system 10 through an interface using computer readable media such as software.

[0093] The methodology 300 further continues by remeasuring the patient's typical sound pressure level 310 every two weeks off the system 10. The system 10 would then be recalibrated to elicit an approximately five (5) (dBA) increase in SPL above the typical SPL 310 during connected speech. The methodology 300 was used to train patients in the study reflected in the data of FIGS. 12 and 13.

[0094] Referring again to FIG. 14, the methodology 300 is shown for training patient's using the voice enhancement system 10 in accordance with one exemplary embodiment of the present disclosure. At 305, a pre-training patient's typical sound pressure level 310 is determined for the patient without the system 10. The method proceeds to 325, where the audio 68 or communicative noise 31 is increased to augment the patient's typical sound pressure level 310 by an offset amount 312. At 330, the voice enhancement system 10 is positioned on the patient for training. At 335, the patient's typical sound pressure level 310 is remeasured without the system 10 periodically during training. At 345, a determination is made on whether or not the patient's typical sound pressure level 310 increased over the training period. If the determination at 345 was an affirmative, the methodology 300 returns to step 325, resulting in an increase of the audio or communicative noise to the patient's earpiece 16 by further increasing the output of the system 10 to maintain the offset amount 312. If the determination at 345 was negative, the methodology 300 returns to step 330, resulting in a continuation of the training with the voice enhancement system 10 at the same output level of the noise projected from the system into the one or more earpieces 16 to the patient.

[0095] FIG. 15 illustrates yet another methodology 500 for training patient's using the voice enhancement system 10 in accordance with another exemplary embodiment of the present disclosure. The methodology 500 comprises interviewing each patient to determine each patient's typical sound pressure level 510. Similar to the methodology 300 described above, a patient's typical sound pressure level 510 is established based on a dialog. After the dialog and measurement of the patient's typical sound pressure level 510, the patient is fitted with the system 10.

[0096] The methodology 500 continues by increasing the audio 68 or communicative noise 31 in the voice enhancement system 10 to an offset amount 512 using a computer interface in communication with the microcontroller 40 while the device is placed on the patient during connected speech. In one example embodiment, the offset amount 512 is approximately five (5) (dBA) higher SPL than the set pre-training typical sound pressure level 510.

[0097] In an alternative example embodiment, software 140 operating the microcontroller 40 of the voice enhancement system 10 includes heuristic arrangements 516 that analyze signatures or characteristics in the patient's speech patterns and/or loudness to alter the offset amount 512 relative to the typical sound pressure level 510. For example, the heuristic arrangements 516 in the system program 140 microcontroller 40 may increase or decrease the offset amount 512 at a prescribed period 518 based on information about the patient or system 10 stored, for example, in patient usage data 88 found in flash memory 142 or micro memory card 70. The prescribed period 518 can be as short as microseconds and as long as weeks.

[0098] At set intervals, the methodology 500 further continues allowing the system 10, and more specifically microcontroller 40, to check and adjust the audio 68 or communicative noise 31 projected from the earpiece 16 by increasing the audio or noise (to a

safe limit) and testing the patient's response to the increase. Based on the patient's response the audio 68 or communicative noise 31 projected to the earpiece 16 the offset amount 512 may be periodically adjusted by increasing or decreasing for training speech. Such a periodic adjustment to the system 10 may occur manually by medical personnel, remotely from medical personnel through for example, a wireless protocol transmitted to a receiver coupled with the microcontroller 40, autonomously through the heuristic arrangements 516 of the microcontroller 40, or any combination thereof. The methodology 500 further continues by retesting the patient's typical sound pressure level 510 and adjusting the offset amount 512 based on the history of the voice enhancement system 10 and the patient's presentation.

[0099] Referring again to FIG. 15, the methodology 500 is shown for training patient's using the voice enhancement system 10 in accordance with one exemplary embodiment of the present disclosure. At 505, a pre-training typical sound pressure level 510 is determined for the patient. The method proceeds to 525, where the audio or communicative noise is increased to an offset amount 512 *via* a computer interface with the microcontroller 40 or through heuristic arrangements 516 within the microcontroller 40. At 530, the system 10 is positioned on the patient for training. At 535, a periodic check, and adjustment of the system 10 occurs along with a testing of the patient, all of which occur by manual operation, remote operation, and/or autonomous operation. At 545, a determination is made on whether or not the patient's typical sound pressure level 510 increased over the training period. If the determination at 545 was an affirmative, the methodology 500 returns to step 525, resulting in an increase of the audio or communicative noise to the patient's earpiece 16 by further increasing the output of the system 10 to maintain the offset amount 512. If the determination at 545 was negative, the methodology 500 returns to step 530, resulting in a continuation of the training with the voice enhancement system 10 at the same

output level of the noise projected from the system into the one or more earpieces 16 to the patient.

[00100] What have been described above are examples of the present invention. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the present invention, but one of ordinary skill in the art will recognize that many further combinations and permutations of the present invention are possible. Accordingly, the present invention is intended to embrace all such alterations, modifications, and variations that fall within the spirit and scope of the aforementioned disclosure.

IN THE CLAIMS

What is claimed:

1. A system to improve communication comprising:
an assembly fixedly positioned during use in close proximity to a user's ear;
said assembly comprising an accelerometer to detect the initiation and duration of the user's speech and an output presentation system;
said output presentation system comprising a non-occlusive ear fitting that presents unintelligible noise that is unrelated to the sound-frequency or intonation of the user's current speech;
said unintelligible noise is presented to the patient at a level less than 85 dB; and
a control arrangement to maintain presentation of said noise substantially throughout the detected duration of the user's speech, but substantially not at other times.
2. The system to improve communication of claim 1 wherein said unintelligible noise is one of white noise, random noise, and multi-talker babble noise.
3. The system to improve communication of claim 1 wherein said control arrangement further comprises a comparator having a prescribed threshold, which can be fixed or adjustable, such that movement to said accelerometer resulting in an output above said threshold generates said noise until said output drops below said threshold.
4. The system to improve communications of claim 3 wherein said unintelligible noise continues for a prescribed period of time after said output drops below said threshold.
5. The system to improve communication of claim 1 wherein the user of the system experiences an improved communication characteristic comprising sound pressure level or speech rate and that said improved communication characteristic continues following the removal of system from the user for a period of at least one month.

6. A system for training patients exhibiting hypophonic speech conditions as a result of age or disease state to have improved communication, said system comprising:
 - an activation device responsive to movement or vibrations in a patient during speech, and which is relatively unresponsive to unrelated air-based sound waves, and upon sensing the patient's speech movement or vibration produces an output signal;
 - a presentation assembly comprising an ear fitting that transmits noise to the ear of a patient during a noise enabling condition; and
 - a control arrangement coupled to said activation device for receiving said output signal, said control arrangement comprising a signal processor having a prescribed threshold that is analyzed against said output signal such that one or more output signals above said threshold generates said noise enabling condition resulting in noise transmission from said control arrangement to said presentation assembly.
7. The system of claim 6 wherein at least a portion of said device is externally located on the patient's epidermis.
8. The system of claim 6 wherein said noise enabling condition continues only while said output signal remains above said prescribed threshold.
9. The system of claim 6 wherein said noise enabling condition continues for a prescribed duration once the output signal drops below said prescribed threshold.
10. The system of claim 6 wherein said signal processor further comprises an amplifier, band-pass filter, and comparator.
11. The system of claim 6 wherein said control arrangement further comprises a microcontroller having memory for communicating said noise to said presentation assembly during said noise enabling condition.
12. The system of claim 6 wherein said activation device is one of an accelerometer and transducer.
13. The system of claim 6 wherein said noise is white noise, non-communicative noise, and/or random noise.
14. The system of claim 11 wherein said memory further records usage information of said system by a patient.

15. The system of claim 6 wherein said ear fitting further comprises a non-occlusive ear fitting.
16. The system of claim 9 wherein said prescribed duration for the continuation of noise enabling condition once the output signal drops below said prescribed threshold occurs for a time period ranging between about 500 and about 750 milliseconds.
17. A method for training a patient to have at least one improved communication characteristic, the method comprising:
 - positioning a non-occlusive ear fitting in a patient's ear that transmits noise to the ear of the patient during a noise enabling condition;
 - positioning externally an accelerometer on a patient at a location that moves or vibrates during speech;
 - transmitting an output signal from the accelerometer to a control arrangement upon sensing movement or vibration experienced during speech of the patient;
 - analyzing the output signal with a signal processor within said control arrangement against a prescribed threshold; and
 - transmitting audio noise to the ear fitting from said control arrangement when the output signal is above the threshold generating said noise enabling condition.
18. The method of claim 17 further comprising positioning said control arrangement on the patient.
19. The method of claim 18 further comprising positioning said control arrangement in contact with the patient's ear.
20. The method of claim 17 further comprising:
 - removing the non-occlusive ear fitting and accelerometer from the patient;
 - wherein the patient continues at least one improved communication characteristic following the removal of the non-occlusive ear fitting and accelerometer.
21. The method of claim 20 wherein said at least one improved communication characteristics are sound pressure level and speech rate.

22. The method of claim 21 wherein said at least one improved communication characteristic comprising sound pressure level and speech rate continue for a one-month period following the removal of the non-occlusive ear fitting and accelerometer.

23. The method of claim 17 wherein said at least one improved communication characteristic comprises one of increased sound pressure level, reduced speech rate, improved breath support, and improved articulation.

24. A system for training patients exhibiting hypophonic speech conditions associated with at least one of Parkinson's disease, normal pressure hydrocephalus, vascular dementia, and presbylaryngis to have improved communication, said system comprising:

a mobility arrangement forming said system comprising an activation device, a presentation assembly, and a control arrangement that is portable and positioned on a patient during training and said activation device and said assembly being worn in close proximity to a patient's ear during training;

the activation device being enabled to produce an output signal substantially in response to sensing speech movement by a patient or skin vibrations resulting from a patient's facial or neck movement that occurs during speech or attempted speech;

the presentation assembly comprising an ear fitting that transmits unintelligible noise to the ear of a patient during a noise enabling condition; and

the control arrangement is coupled to said activation device for receiving said output signal, said control arrangement comprising a signal processor having a prescribed threshold that is analyzed against said output signal such that a value of said output signal above said threshold generates said noise enabling condition resulting in a noise signal being transmitted from said control arrangement to said presentation assembly, generating said unintelligible noise to the ear of a patient.

25. The system of claim 24 wherein said mobility arrangement is worn in close proximity to a patient's ear during training.

26. A training arrangement for improving communications in patients exhibiting hypophonic speech conditions associated with at least one of Parkinson's disease, normal pressure hydrocephalus, vascular dementia, and presbylaryngis, said arrangement comprising:

a portable assembly fixedly positioned in close proximity to a patient's ear during use or training;

said portable assembly comprising an actuating device for converting mechanical movement of the patient's body to an electrical output signal generated at an initiation and throughout a duration of the patient's speech, a microcontroller capable of receiving said electrical output signal from said actuating device, and an output presentation system in communication with said microcontroller;

said output presentation system comprising a non-occlusive ear fitting that presents unintelligible noise at a level less than 85dB that is unrelated to audible frequencies or intonation of the patient's current speech, the unintelligible noise being generated from said microcontroller during a noise enabling condition that occurs substantially throughout a detected duration of the patient's speech, but substantially not at other times;

said microcontroller comprising a signal processor establishes a prescribed threshold that is analyzed against said electrical output signal such that a value of said electrical output signal above said threshold generates said noise enabling condition resulting in said unintelligible noise being transmitted from said microcontroller to said output presentation system; and

a memory for storing patient information during use or training based on the operation of the microcontroller.

27. The arrangement of claim 26 wherein said patient information further comprises at least one of ON/OFF occurrences of the output presentation system and elapsed time that the output presentation system was in use.

28. The arrangement of claim 26 wherein said patient information further comprises at least one of the relative sound output of the microprocessor and the relative intensity of the vibration sensed by the accelerometer.

29. The training arrangement of claim 26 wherein said memory is memory internal to said microcontroller.

30. The training arrangement of claim 26 further comprising training a patient to have an improved speech rate through slowed speech for at least a one-month period following the removal of and completion of a training period with said training arrangement.

31. The training arrangement of claim 26 further comprising training a patient to have an improved speech loudness and clarity for at least a one-month period following the removal of and completion of a training period with said training arrangement.

32. The training arrangement of claim 30 wherein said training period comprises a duration of at least one month.

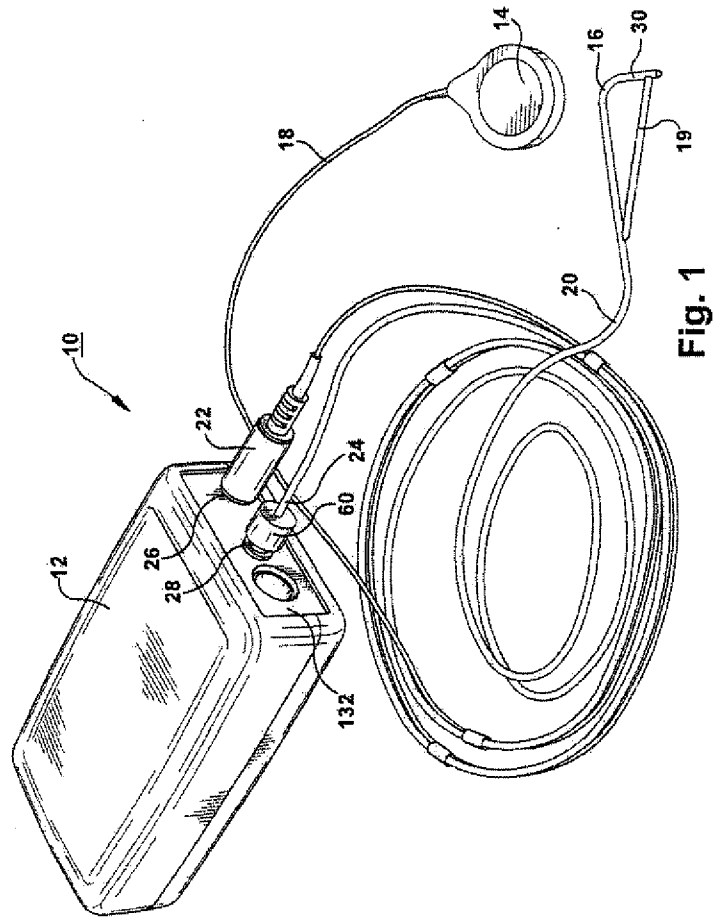
33. The training arrangement of claim 30 wherein said training period of at least one month comprises at least eight months and further comprises four to six hours of training per day.

34. The training arrangement of claim 26 further comprising an input device for measuring a patient's SPL.

35. The training arrangement of claim 35 wherein said input device is one of an accelerometer and microphone.

36. The training arrangement of claim 26 further comprising a plurality of settings for adjusting the level of said unintelligible noise either manually or automatically.

1/15



2/15

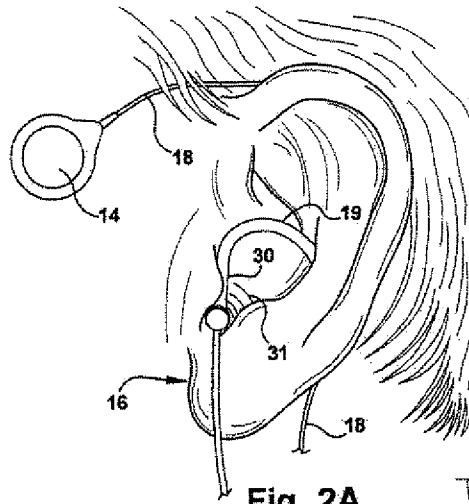


Fig. 2A

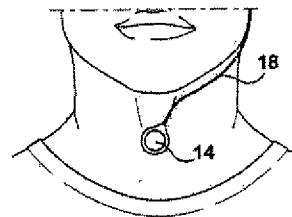


Fig. 2B

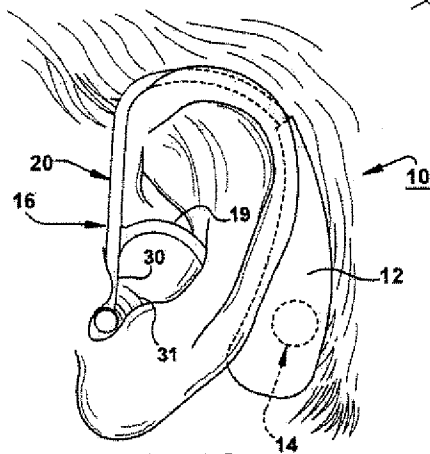
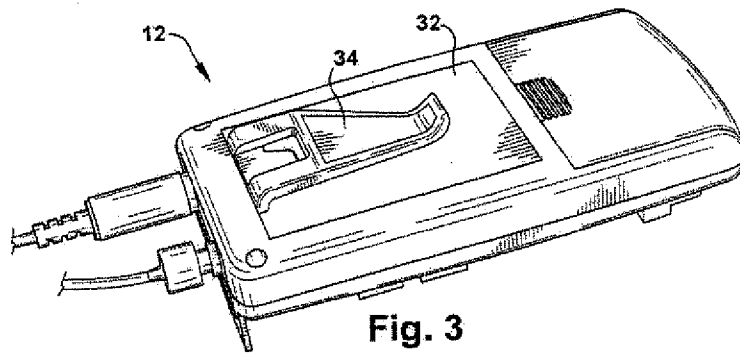


Fig. 2C

3/15



4/15

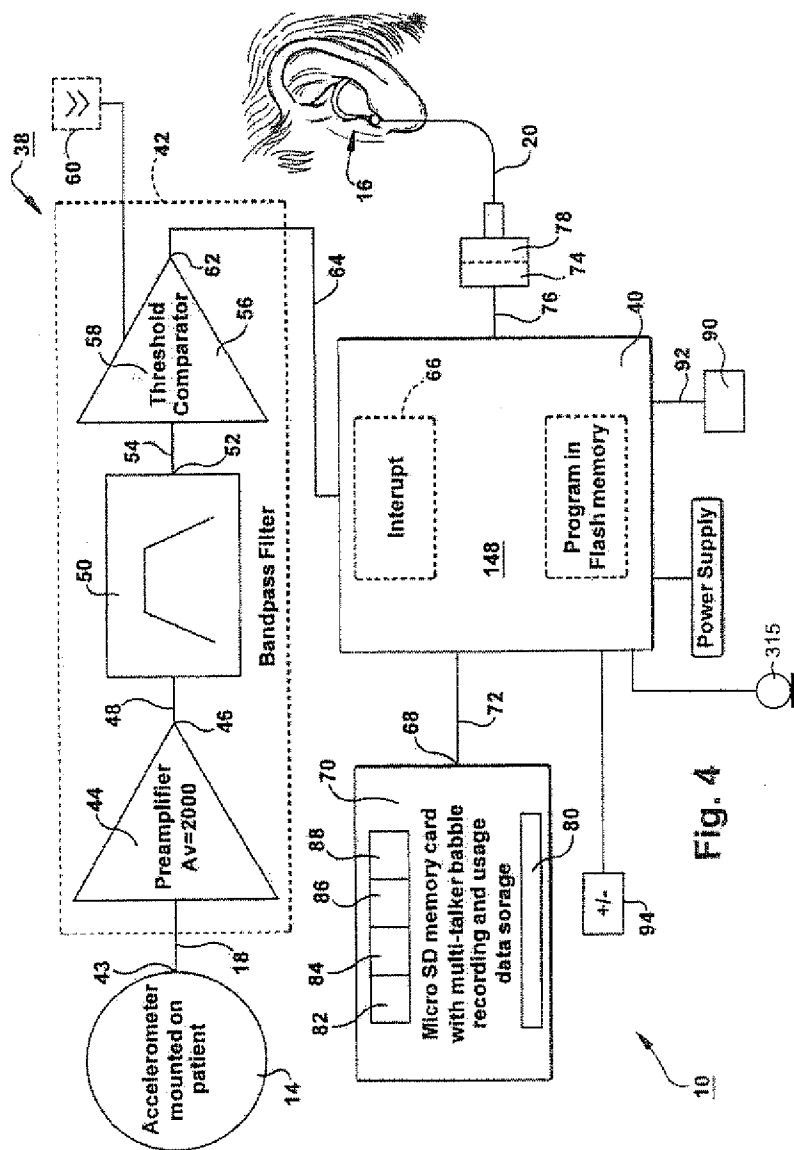


Fig. 4

5/15

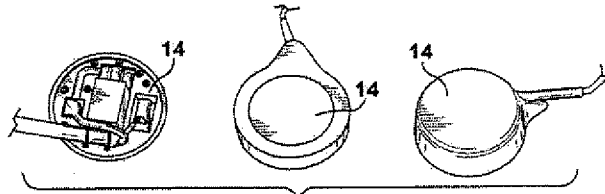


Fig. 5

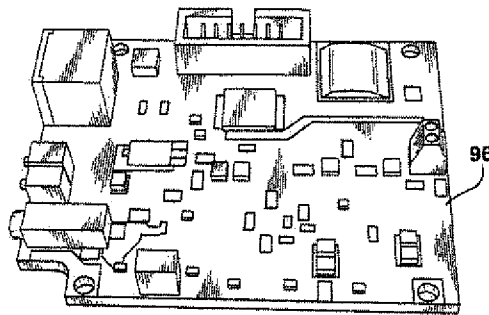


Fig. 6

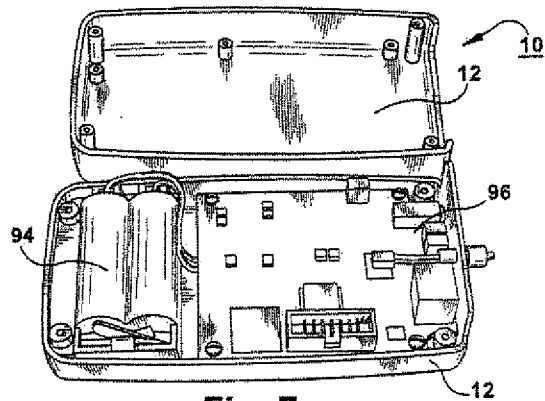


Fig. 7

6/15

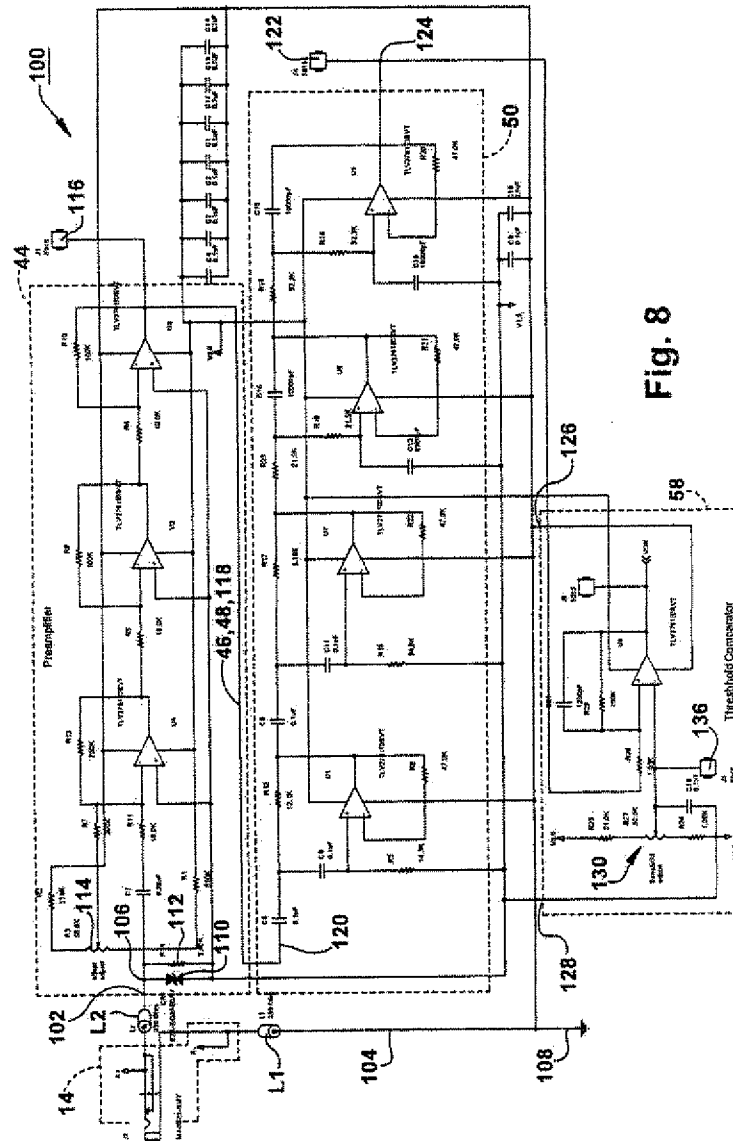
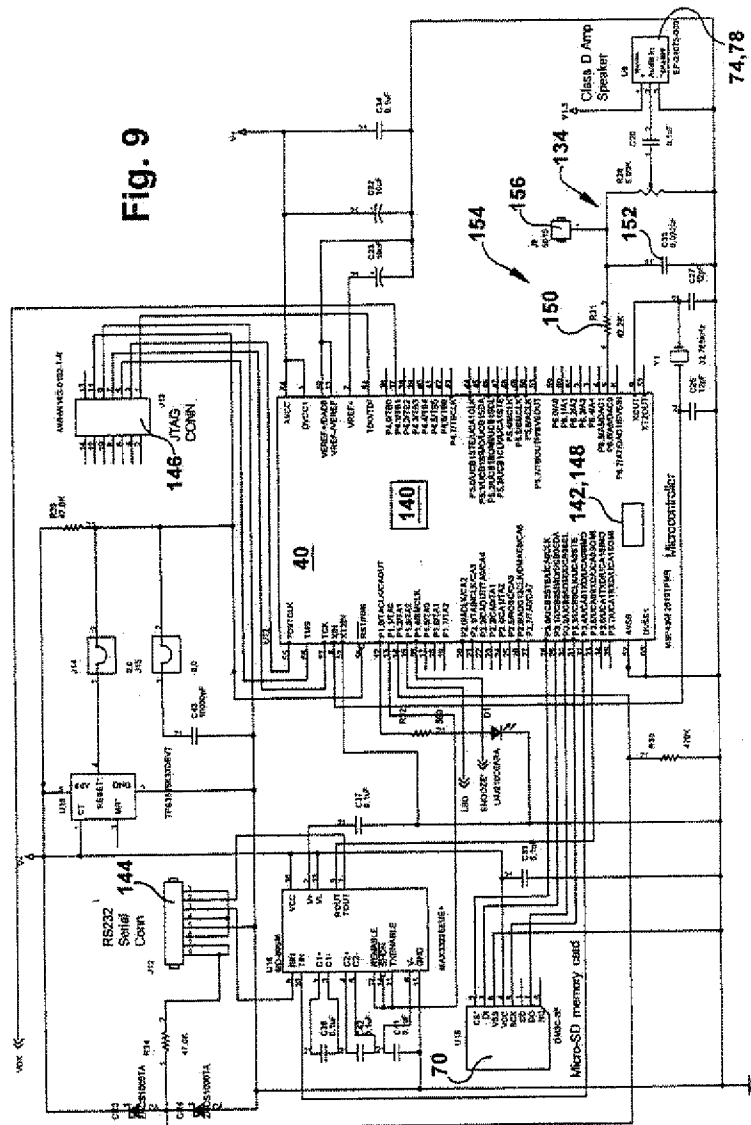


Fig. 8

7/15

Fig. 9



74,78

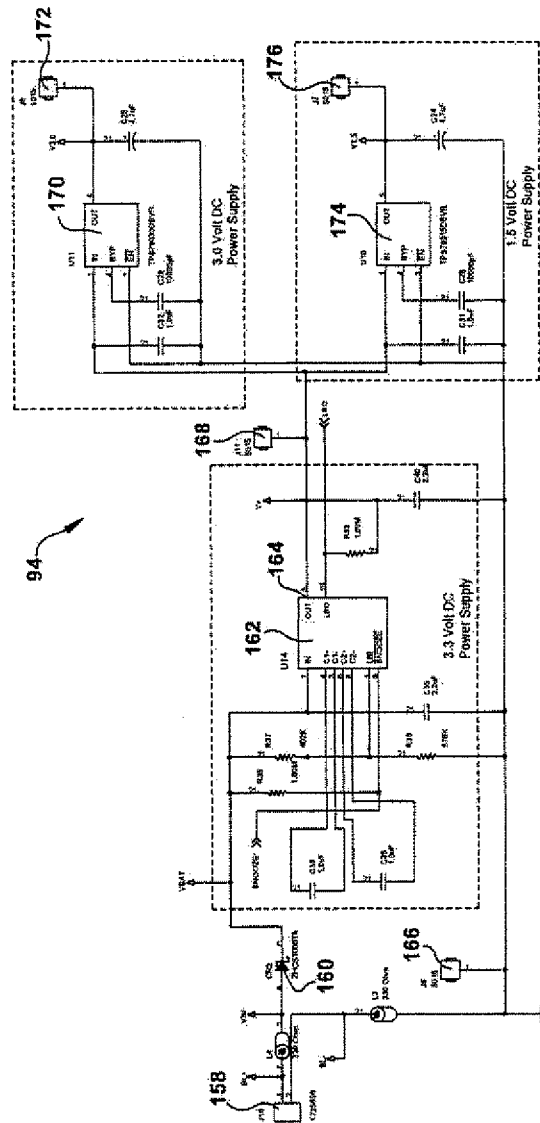


Fig. 10

9/15

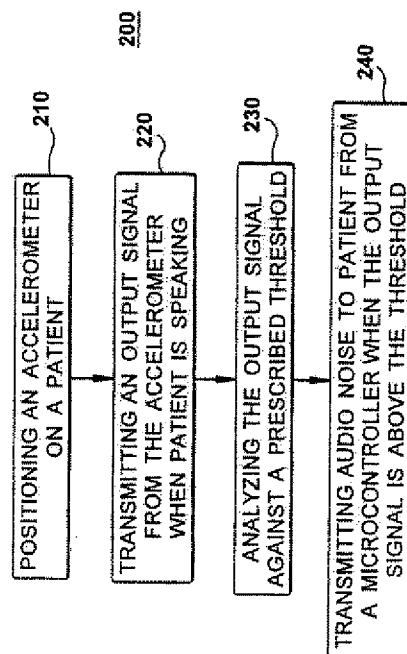


Fig. 11

10/15

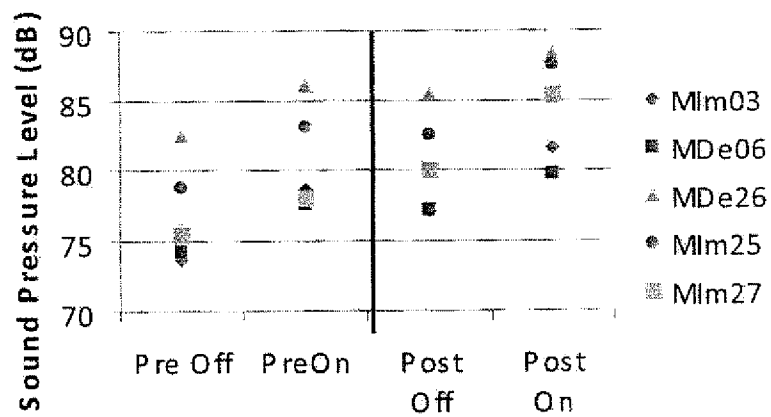


Fig. 12

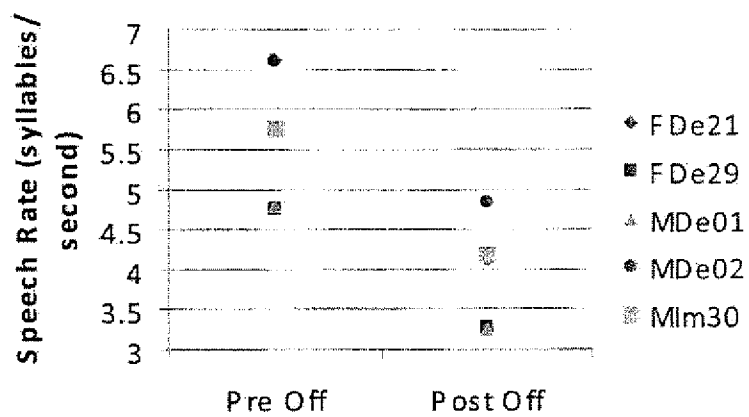


Fig. 13

11/15

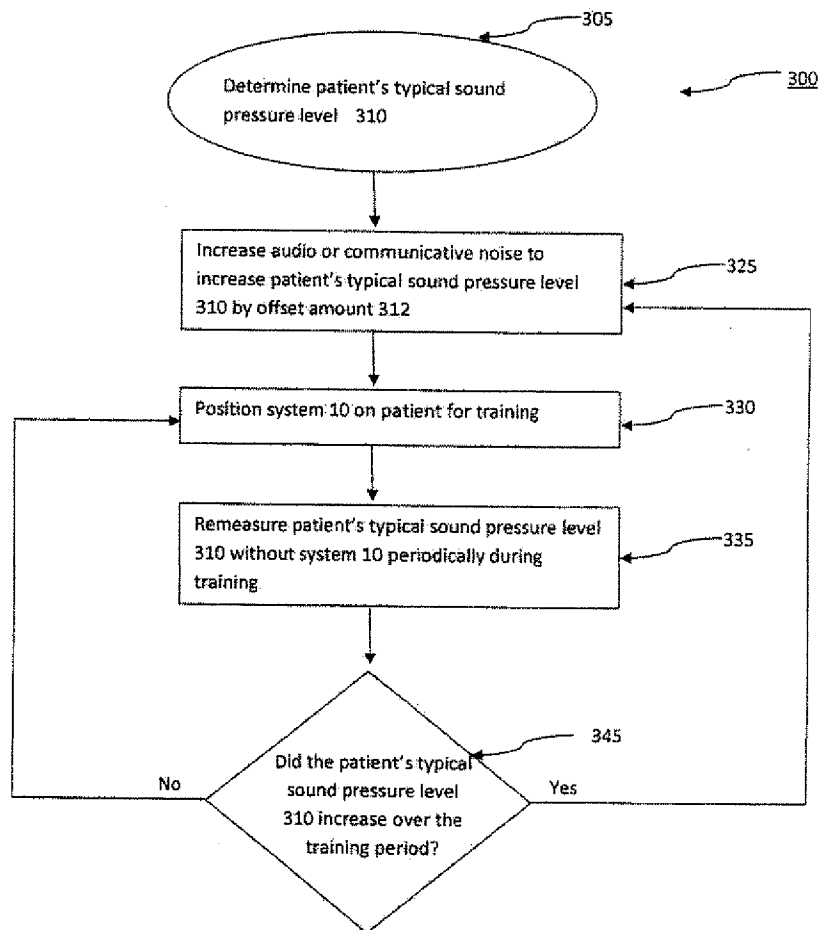


Fig. 14

12/15

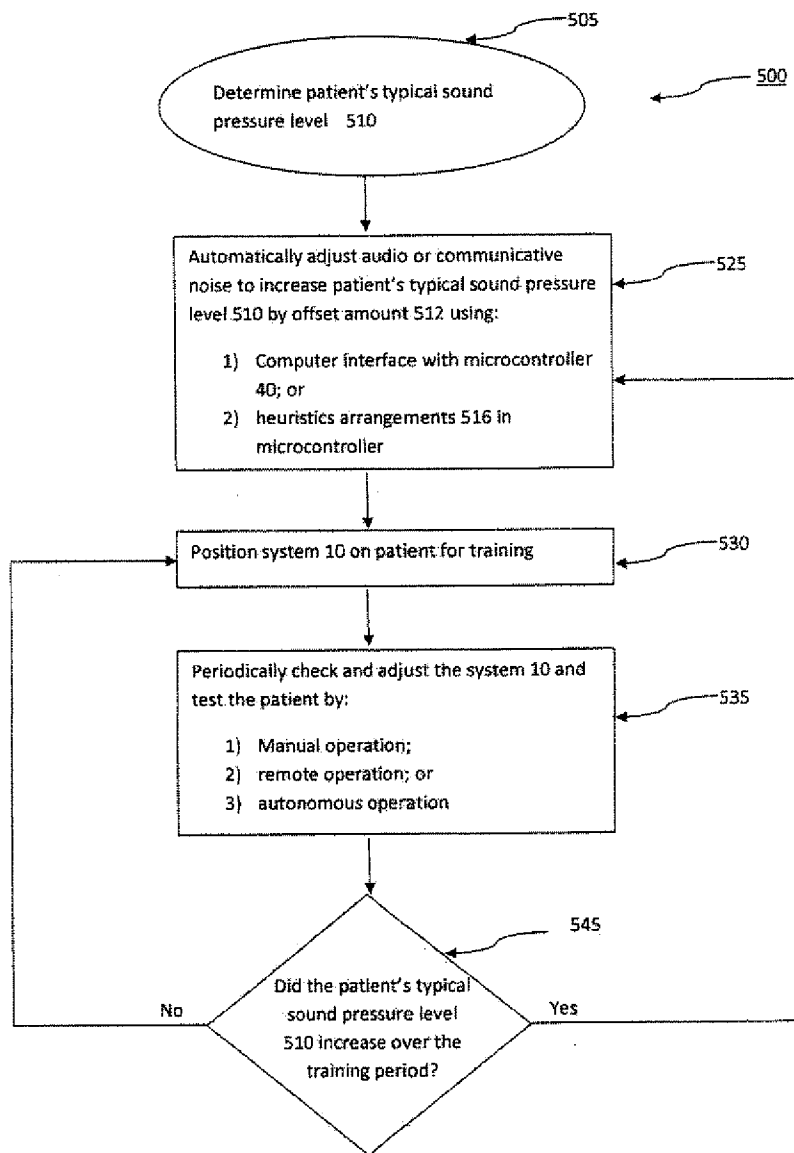


Fig. 15

13/15

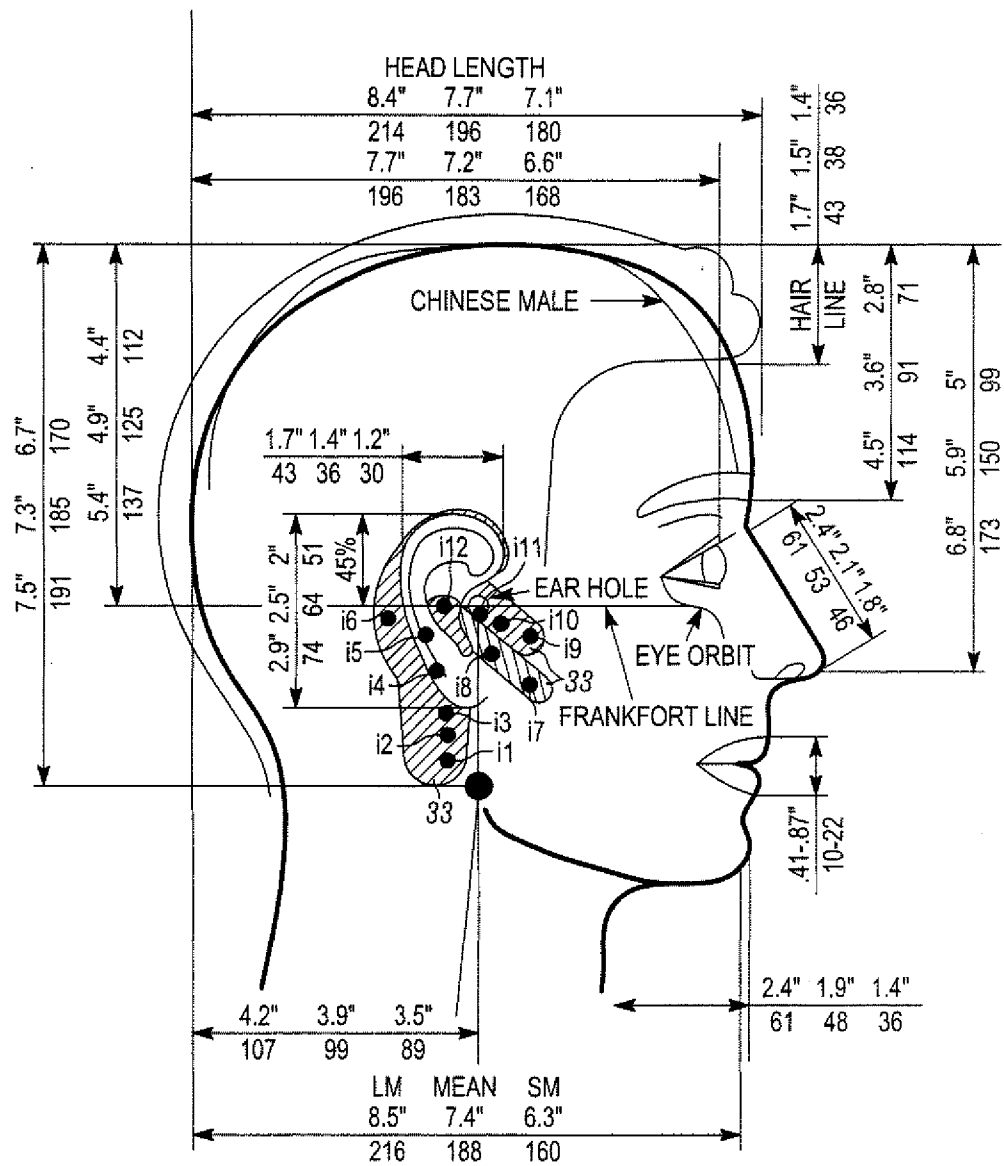


Fig. 16

14/15

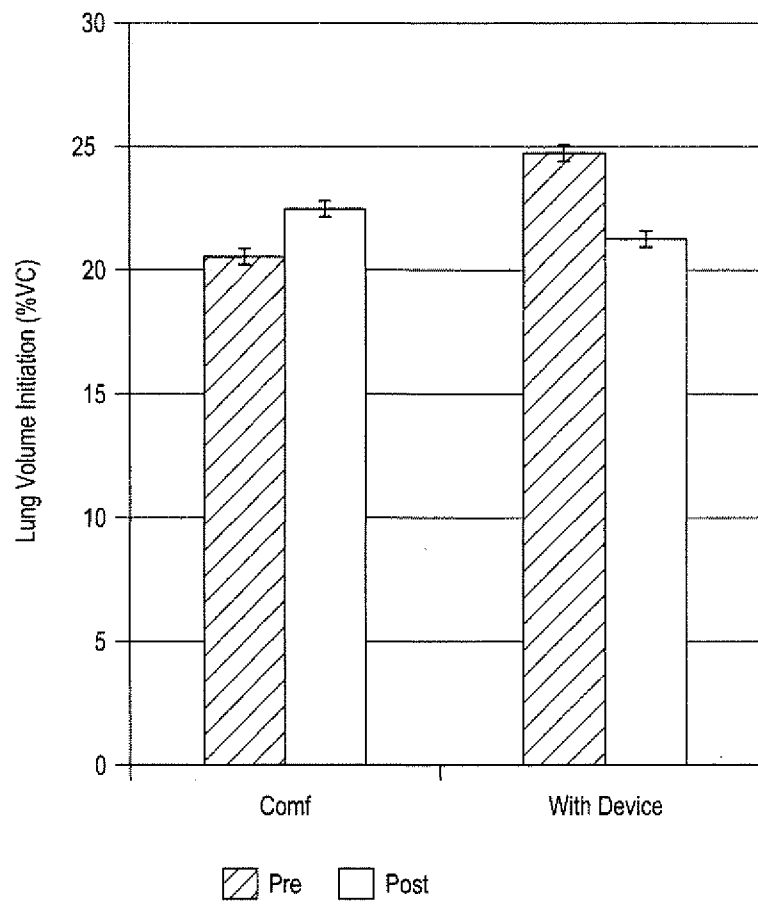


Fig. 17

15/15

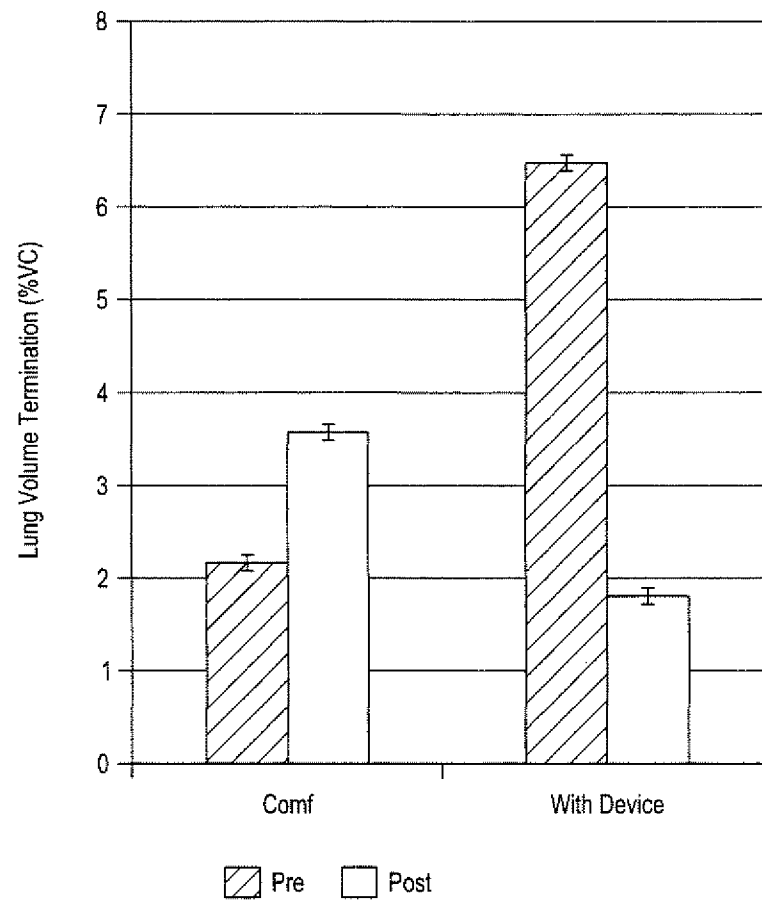


Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/26033

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G06F 15/00 (2012.01)

USPC - 704/200

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)

USPC - 704/200; IPC(8) - G06F 15/00 (2012.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 704/200, 201, 226, 258; 381/71.1, 71.6; IPC(8) - G06F 15/00 (2012.01) (Keyword limited; terms below)

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

PubWEST(PGPB,USPT,USOC,EPAB,JPAB); Google Scholar. Terms: Lombard effect Parkinson hypophonic patient information disease accelerometer memory processor decibel microphone comparator threshold ear controller noise speech vibrate microprocessor microcontroller use history store storage record etc.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2010/0100388 A1 (Kehoe) 22 April 2010 (22.04.2010) entire document, particularly abstract, Fig 1, para [0012], [0015], [0020], [0023], [0024], [0026], [0034], [0038], [0049], [0050], [0051], [0053], [0054], [0060], [0062], [0063], [0069]	6-8, 10, 11, 15, 24, 25 ----- 1-5, 9, 12-14, 16-23, 26-36
Y	US 3,566,858 A (Larson et al.) 02 March 1971 (02.03.1971) col 1, ln 73, col 2, ln 3-16, col 3, ln 2-5	4, 9, 16, 19
Y	US 2009/0264789 A1 (Molnar et al.) 22 October 2009 (22.10.2009) para [0043], [0099], [0125], [0215], [0248]	1-5, 12, 14, 17-23, 26-36
Y	Quedas et al. "Lombard's effect's implication in intensity, fundamental frequency and stability on the voice of individuals with Parkinson's disease." In: Brazilian Journal of Otorhinolaryngology, 3568 - vol. 73 / ed 5 / September/October 2007, pp 657-683 [on-line] [retrieved on 2012-06-14]. Retrieved from the Internet at URL: <http://www.rborl.org.br/conteudo/acervo/print_acervo_english.asp?id=3568> "Procedures / Voice capture" paragraph, p 2 of 13	1-5, 13, 26-36
Y	Pinto et al. "Treatments for dysarthria in Parkinson's disease." In: The Lancet Neurology, vol. 3, September 2004, pp 547-556 [on-line] [retrieved on 2012-06-24]. Retrieved from the Internet at URL: <http://aune.lpl.univ-aix.fr/~fulltext/3022.pdf> p 550, col 1, para 2, p 551, col 1, para 2, 4	5, 20-23, 30-35
Y	US 5,659,620 A (Kuhlman) 19 August 1997 (19.08.1997) Fig 1, 2, 4, col 2, ln 46-53	19

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"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

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Date of the actual completion of the international search

16 June 2012 (16.06.2012)

Date of mailing of the international search report

29 JUN 2012

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/26033

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,143,648 A (Cohen et al.) 13 March 1979 (13.03.1979) col 2, ln 42-col 3, ln 21, col 4, ln 11-50, col 4, ln 64-col 5, ln 6	3, 6-8, 17, 24, 26
A	Adams et al. "Can the Lombard effect be used to improve low voice intensity in Parkinson's disease?" In: International Journal of Language & Communication Disorders, vol. 27, no. 2, pp 121-127, April 1992 [on-line] [retrieved on 2012-06-13]. Retrieved from the Internet at URL:< http://informahealthcare.com/doi/abs/10.3109/13682829209012034 >, abstract	1, 13, 16
A	US 2010/0280336 A1 (Giftakis et al.) 04 November 2010 (04.11.2010) para [0199]	14, 26-29