

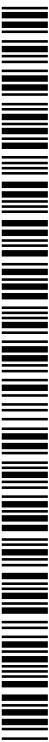


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(54) Title: AUDIO AMPLIFICATION ELECTRONIC DEVICE WITH INDEPENDENT PITCH AND BASS RESPONSE ADJUSTMENT

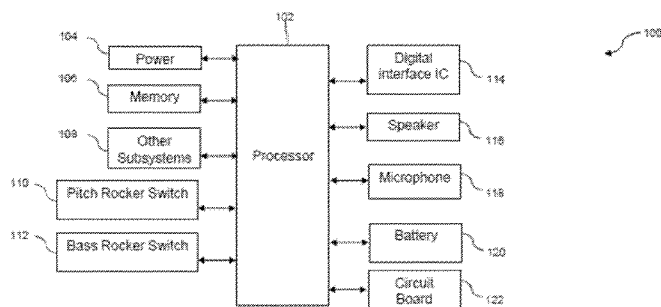


FIG. 1

(57) Abstract: Techniques used to selectively amplify audio signals are described herein in connection with audio amplification electronic devices, such as hearing aids, including over-the-ear hearing aids. A device and its operation are described to facilitate setting low and high tone/volume controls separately, using at least two selection mechanisms. In one aspect, a first selection mechanism includes a pitch frequency control rocker switch and the second selection mechanism includes a bass frequency control rocker switch disposed separately. In one aspect, the bass frequency control rocker switch causes a processor to bias the frequency response of the sound amplifier for frequencies below 1 kHz. In another aspect, the pitch frequency control rocker switch causes a processor to bias the frequency response of the hearing for frequencies above 1 kHz. In another aspect, the selection mechanism involves the separate attenuation of treble and bass adjustments in response to a user selection of a rocker switch setting for each adjustment.

**AUDIO AMPLIFICATION ELECTRONIC DEVICE WITH
INDEPENDENT PITCH AND BASS RESPONSE ADJUSTMENT**

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 62/320,672, filed April 11, 2016, the content of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to audio amplification electronic devices, and more specifically to sound amplifiers, such as hearing aid devices.

BACKGROUND

[0003] Hearing loss is a common condition within the human population and the manifestation of hearing loss can have a significant impact to the quality of human life. There are many factors that can induce hearing loss which may include disease, genetic disposition, injury, and normal aging. However, different human individuals often exhibit varying levels and manifestations of hearing loss that may change over time. Furthermore, the audio environment that the individual is placed in may have a significant impact to the ability to hear desired sounds. For example, an individual that is in a small room setting while attempting to listen to another individual speak within a relatively quiet amount of ambient background noise may have difficulty depending on the speech characteristics of the person trying to speak, while the same individual who is trying to listen is placed in a crowded room or environment, such as a restaurant, may hear a high amount of sound energy, but the ambient background noise is relatively high resulting in a poor ability for the hearing individual to hear and understand individuals who may be speaking to the hearing individual.

[0004] The hearing loss may manifest as an attenuation of hearing sensitivity across the full hearing audio spectrum range, the spectrum range comprising approximately 100 Hz to approximately 8000 Hz. Furthermore, an individual's hearing loss may manifest as an ability to hear higher frequencies (above 1000 Hz), but not lower frequencies (below 1000 Hz). The converse may also be true, wherein the hearing loss manifests as an ability to hear lower frequencies (below 1000 Hz), but not hear well above 1000 Hz.

[0005] Therefore, it is desirable for a manufacturer of hearing aids and like devices to be able to accommodate many individuals with varying degrees and type of hearing loss that can be adjusted for the individual in a compact device that can be worn on the body and is relatively low cost.

SUMMARY

[0006] The present disclosure is directed to an improved audio amplification electronic device. The device is configured to facilitate setting low and high tone/volume controls separately, using at least two selection mechanisms. In one aspect, a first selection mechanism includes a pitch frequency control rocker switch and the second selection mechanism includes a bass frequency control rocker switch disposed separately. In one aspect, the bass frequency control rocker switch causes a processor to bias the frequency response of the sound amplifier for frequencies below 1 kHz. In another aspect, the pitch frequency control rocker switch causes a processor to bias the frequency response of the hearing for frequencies above 1 kHz.

[0007] In another aspect, the selection mechanism involves the separate attenuation of treble and bass adjustments in response to a user selection of a rocker switch setting for each adjustment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1** shows a block diagram in accordance with an exemplary embodiment of an electronic device as a sound amplifier according to the present invention in the form of a hearing aid device generally designated at 100.

[0009] **FIG. 2** shows a mechanical representation, generally designated at 200, in accordance with the exemplary embodiment.

[0010] **FIG. 3** shows an example printed circuit board layout of a circuit board 122 in accordance with the exemplary embodiment.

[0011] **FIG. 4** shows the circuit diagram 300 for the hearing aid device designated at 100.

[0012] **FIG. 5** is a table showing the component count and specification for the circuit diagram 300 and the assembly of the hearing aid 100 in the current exemplary embodiment.

[0013] **FIG. 6** is a table showing the technical specification details for the hearing aid 100 in the current exemplary embodiment

[0014] **FIG. 7** shows the frequency response of adjusting pitch controls in accordance with the exemplary embodiment.

[0015] **FIG. 8** shows the frequency response of adjusting bass controls in accordance with the exemplary embodiment.

DETAILED DESCRIPTION

[0016] The techniques described herein may be used in any device that is used to selectively amplify audio signals. Desired frequency responses may be realized through digital filters such as finite impulse response (FIR) or infinite impulse response (IIR) filters. Furthermore, desired frequency responses may also be realized through use of analog filters, or the combination of digital and analog filters, as is known in the art.

[0017] **FIG. 1** shows a block diagram in accordance with the exemplary embodiment of an electronic device as a sound amplifier 100 according to the present invention. In the exemplary embodiment, the sound amplifier 100 is a hearing aid comprising multiple components, such as a processor 102 that controls the overall operation of hearing aid 100. Processor 100 is coupled to memory 106, which may be random access memory (RAM) used during operation (e.g. for manipulating output signals, processing input signals, etc.), and/or Read Only Memory (ROM) or flash memory, where software resides to instruct processor 100 to control the overall operation of hearing aid 100.

[0018] Processor 102 may also have a power control module 104 coupled to manage battery life and minimize power usage of the device. Digital interface IC 114 is coupled to processor 102 and may comprise analog audio conditioning circuitry such as Analogue to Digital (A/D) and Digital to Analogue (D/A) converters, audio power amplifiers, and may have the ability to perform digital or analog filtering of desired responses. Furthermore, digital interface IC 114 may also condition analog signals received from microphone 108. A main inventive step of hearing aid 100 is the ability for a user to independently control the frequency response of amplified ambient audio signals, depending on the user preference, alleviating the need to have a medical doctor or practitioner to perform the necessary tuning of the hearing aid device every time retuning is required. It is desirable to enable the ability to independently control pitch (frequencies above 1000 Hz) and bass (frequencies below 1000 Hz) but in a compact form factor that is easy to use. If too many external controls exist for hearing aid 100, then the device must have a larger physical footprint, which is not desirable. Therefore, hearing aid 100 further comprises pitch rocker switch 110 and bass rocker switch 112 which are coupled to processor 102 and are large enough for an average user to actuate, but small enough to not impact the overall physical footprint of hearing aid 100.

Hearing aid 100 further comprises speaker 116, microphone 108, battery 120, and circuit board 122 coupled to processor 102. Speaker 116 outputs an amplified audio signal that is heard by the user of hearing aid 100. Circuit board 122 is a compact electronic multi-layer printed circuit board as known in the art, and all electrical components of hearing aid 100 are coupled to it, using techniques known in the art. Hearing aid 100 may further comprise other subsystems 108 coupled to processor 102. Examples of other subsystems 108 may include a USB charging port, one or more light indicators (not shown), and the like.

[0019] **FIG. 2** shows a mechanical representation 200 of hearing aid 100 in accordance with the exemplary embodiment. The exterior of hearing aid 100 comprises charging light indicator 118, microphone 108, bass rocker switch 110, power switch 104 and pitch rocker switch 112. Rocker switch 110 comprises a three position switch which functions to increase bass frequency response when pressed into position 206, decrease bass frequency response when pressed into position 208, and not adjusting the frequency response from the current setting which is the middle position that is the default when rocker switch 110 is not being actuated by a user. In a similar manner, rocker switch 112 comprises a three position switch which functions to increase pitch frequency response when pressed into position 212, decrease pitch frequency response when pressed into position 214, and not adjusting the frequency response from the current setting which is the middle position that is the default when rocker switch 112 is not being actuated by a user. Rocker switches 110 and 112 are known in the art, and the configuration of which position of either rocker switches 110 and 112 corresponds to increasing or decreasing a frequency response may be reversed, as a skilled artisan would understand. Mechanically, hearing aid 100 further comprises a charging port 215 (mini USB, or micro USB, or other compact port specification), a mechanical audio coupler 220, 216, and earpiece 218 which channel audio output by speaker 116 into a user's ear. The mechanical audio coupler 220 is formed into an ear hook component for securing the hearing aid device onto its user's ear, which in turn is mechanically coupled via a tube to an ear mold 216 upon which the earpiece 218 is attached. The ear mold 216 helps the earpiece 218 be accurately positioned at the outer opening of the ear canal. Speaker 116 is located at the end of the mechanical audio coupler near or on the printed circuit board in the main body of the hearing aid 100 and away from the ear

mold 216. Hearing aid 100 is classified as an “over the ear” device, a designation known well in the art.

[0020] In a variation of the present exemplary embodiment of the invention shown in **FIG. 2**, speaker 116 may be located in the ear mold 216 and close to the ear canal outer opening. The cables connecting speaker 116 with the other electronic components of the hearing aid 100 run inside the ear hook 220 and the attached tube.

[0021] **FIG. 3** shows an example printed circuit board layout of circuit board 122 in accordance with the exemplary embodiment. Circuit board 122 demonstrates that all components comprising hearing aid 100 can be compactly put together into a functioning unit. In the alternative exemplary embodiment, previously discussed, speaker 116 is not located inside the printed circuit 122 but external to it, electrically coupled to the printed circuit by means of wires running inside the tube and ear hook 220.

[0022] **FIG. 4** shows a circuit diagram 300 for the hearing aid device designated at 100. Circuit diagram 300 comprises a number of ICs (IC1-IC4) and other electronic components, including resistors (R1-R14), capacitors (C1-C18), speaker (SPK1), microphone (MIC1), switches (SW1, S1-S4), battery (BT1), LEDs (G, R), transistor (Q1) and USB connector (USB).

[0023] Circuit diagram 300 is characterized by four main sub-circuits 310, 320, 330 and 340.

[0024] Controller sub-circuit 310 includes IC3 which is a microprocessor or similar component and is responsible for capturing user adjustments to pitch and bass frequency amplification bias via signals from switches S1-S4. Controller sub-circuit 310 also commands the sound signal amplification sub-circuit 320 to selectively amplify the sound input signal frequencies received from microphone MIC1. These components are connected via capacitors C1-C5 and resistors R1-R3 and R15.

[0025] Sound signal amplification sub-circuit 320 comprises IC4, resistors R6-10, capacitors C6-C16 and transistor Q1. Sub-circuit 320 performs the selective sound signal amplification according to the signals received from IC3.

[0026] Battery sub-circuit 330 comprises Li-Ion battery BT1 of 3.7 volts, voltage regulating IC2 (which outputs a steady DC voltage of 1.5V feeding all sub-circuits of the circuit diagram 300), and switch SW1 which when open (default position) allows uninterrupted voltage supply to the all sub-circuits.

[0027] USB charging sub-circuit 340 allows charging battery BT1 by supplying 5-6V DC to IC1. USB charging circuit 340 is also directly connected to LEDs G (Green) and R (Red) which are also connected to IC1 and are lit by IC1 when the USB charging is in progress (Green LED is on and SW1 is closed) or disconnected (Red LED is on and SW1 is open). The USB charging sub-circuit 340 also comprises capacitors C17-C18 and resistors R12-R14.

[0028] **FIG. 5** is a table showing component count and specification for the circuit diagram 300 and the assembly of the hearing aid 100 in the current exemplary embodiment. This information is presented only for exemplary purposes and it is understood that modifications to both the count and specification of the components as well as the circuit diagram 300 are possible and fall within the purpose and content of the present invention as they can be conceived and implemented by any person of ordinary skill in related art. As a result this exemplary embodiment under no circumstance limits the possible alternative embodiments that also are part of the present invention.

[0029] Similarly, **FIG. 6** is a table showing the technical specification details for the hearing aid 100 in the current exemplary embodiment.

[0030] **FIG. 7** shows the frequency response of adjusting pitch controls in accordance with the exemplary embodiment. Frequency response 402 depicts the highest pitch frequency response control setting. It can be seen that the relative amplitude frequency response 402 at approximately 1 kHz vs. 250 Hz is approximately 25 db, and the amplitude of the frequency response at higher frequencies (2 kHz) are only about 10db lower than at 1 kHz. Thus there is a bias towards the higher frequencies above 1 kHz. Frequency responses 404 and 406 correspond to alternating levels of overall amplitude frequency response that the user may select via rocker switch 110. Those skilled artisans would appreciate that the number of possible frequency responses selected may be variable and not limited to 3, simply by using multiple digital or analog filters that can be implemented easily using processor 102.

[0031] **FIG. 8** shows the frequency response of adjusting bass controls in accordance with the exemplary embodiment. Adjusting of bass controls is performed in a similar way as that of the pitch controls depicted in **FIG. 4**. Frequency response 502 depicts the highest bass frequency response control setting. It can be seen that the relative amplitude frequency response 502 at approximately 1 kHz vs. 350 Hz is

approximately 10 db, and the amplitude of the frequency response at higher frequencies (2 kHz) are only about 10db lower than at 1 kHz. Thus there is a bias towards the lower frequencies below 1 kHz. Frequency responses at 2 kHz are not as attenuated as in the pitch response case in **FIG. 4** mainly due to the human ear naturally having a decreased frequency response at 2kHz vs. low frequencies (for example 250 Hz). Frequency responses 404 and 406 correspond to alternating levels of overall amplitude frequency response that the user may select via rocker switch 112. Again, those skilled artisans would appreciate that the number of possible frequency responses selected may be variable and not limited to 3, simply by using multiple digital or analog filters that can be implemented easily using processor 102.

[0032] In accordance with an exemplary scenario, high and low volume control is set separately to address the specific and distinct needs of people with high-pitched hearing loss and low-pitched hearing loss, respectively.

[0033] From a user's perspective, the user is provided with a user manual (user guide) which instructs the user on the appropriate manner to set the device for optimum hearing. In this regard, the user may be instructed to set the hearing aid device one way, when the user suffers from high-pitched hearing loss, and a different way, when the user suffers from low-pitched hearing loss. In both instances, at initial use of operation, the user is instructed to first turn the volume to the lowest level. This is to protect the user from excessively high noise, but also because it provides a reference point to start the setting of the hearing aid device to the optimum setting.

[0034] Having minimized the volume, the user is then instructed to turn "ON" the device (via power switch 104).

[0035] The user is then guided to regulate the volume to a proper level slowly. For this step, it helps if the user is aware of his hearing loss deficiency in terms of high or low pitched hearing loss. In the case of low-pitched hearing loss, low pitch (bass) rocker switch 110 is moved or pressed to increase bass frequency response (tone/volume control) (i.e., pressed into position 206). To control (lower) the tone/volume control when the optimum setting seems to have been exceeded, the finger is moved from position 206 to position 208 and pressed (one press at a time) to set the device to the optimum tone and volume level. The default position of the rocker switch is a middle position between positions 206 and 208. In one scenario, rocker switches return to the middle position automatically when released from either position 206 or 208. In another

scenario, the rocker switch is a toggle switch and the tone/volume control is increased in predetermined time intervals up to a maximum level.

[0036] In a similar manner, in the case of high-pitched hearing loss, high pitch (treble) rocker switch 112 is moved or pressed to increase pitch frequency response (tone/volume control) (i.e., pressed into position 214).

[0037] Below are representative instructions to the user in accordance with a preferred embodiment. Each rocker switch includes (+) and (-) indications to indicate increase and decrease of tone volume control direction. Beeping is provided to provide audible indication of changes (single “beep”) as well as indication that the maximum level has been reached (double “beep”).

[0038] **User instructions: High tone/Volume Control (Fit for people who have high-pitched hearing loss)**

[0039] a) Press and hold “+” to turn up the volume and high pitch level continuously, and you will hear sound “Beep”. Number of levels: eight (8). When the sound reaches peak level (level 8), you will hear sound “Beep-Beep”.

[0040] b) Press and hold “-” to turn down the volume and high pitch level continuously, and you will hear sound “Beep”. When the sound reaches the bottom level, you will hear sound “Beep-Beep”.

[0041] **User instructions: Low tone/Volume Control (Fit for people who have low-pitched hearing loss)**

[0042] a) Press and hold “+” to turn up the volume and low pitch level continuously and you will hear sound “Beep”. Number of levels: eight (8). When the sound reaches peak level, you will hear sound “Beep-Beep”.

[0043] b) Press and hold “-” to turn down the volume and low pitch level continuously, and you will hear sound “Beep”. When the sound reaches the bottom level, you will hear sound “Beep-Beep”.

[0044] In an alternate exemplary scenario, the user instructions are provided audibly. The instructions may include guidance on how best to set rocker switch settings for people with both high and low tone deficiencies. In some instances, for users that are not sure whether they are high or low tone deficient, they may be guided to experiment toggling between the various levels and settings until a satisfactory (best) level is detected.

[0045] It should be appreciated that one benefit of the present invention is the ability of a user to set a hearing aid device to operate/amplify high or low tones in ways which until now has been traditionally performed by programmably set analog and digital hearing devices, usually under the guidance of a doctor. The latter approach is both expensive and cumbersome. The present approach addresses the need for low cost alternatives.

[0046] While some custom digital hearing aid solutions in particular allow for tone/volume control over a predefined frequency response curve, conventional devices do not have multiple bass and treble setting tone/volume control mechanisms as contemplated herein.

[0047] While the proposed multiple tone/control mechanisms provide a low cost alternative for people with hearing loss or similar deficiencies, these devices can also be used to amplify treble frequencies (bass frequencies) to improve hearing in outdoor (indoor) environments for better sound reception overall by a user. In a similar manner, low tone/volume control can also provide an ancillary benefit of improving special effects sounds/music for some listeners. In this regard, the presently proposed device can function as a personalized amplification device to accommodate a variety of uses and needs of different users.

[0048] The use of toggle switches is common in traditional hearing aid devices. The use of rocker switches to control tone/volume control has been proven to be easier to use. This is therefore another benefit of a preferred exemplary embodiment.

[0049] The presently proposed approach, as has been shown, is easily incorporated in a small form function as well, allowing its use in hearing aids with a conventional shape with which many elderly are accustomed and comfortable in terms of use, fit, look, and the like. The only difference, of course, is learning to set the two rocker switches to the appropriate levels.

[0050] Traditional amplification devices, particularly those with rotating controls or toggle switches to set volume levels, incorporate the power on/off functionality in the volume control mechanism. In the exemplary embodiment, a separate power switch is provided without compromising the small form factor design of the device.

[0051] Those of skill in the art would understand that signals may be represented using any of a variety of different techniques. For example, data, software, instructions, signals that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, light or any combination thereof.

[0052] Those of skill would further appreciate that the various illustrative radio frequency or analog circuit blocks described in connection with the disclosure herein may be implemented in a variety of different circuit topologies, on one or more integrated circuits, separate from or in combination with logic circuits and systems while performing the same functions described in the present disclosure.

[0053] Those of skill would also further appreciate that the various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the disclosure herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[0054] The various illustrative logical blocks, modules, and circuits described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0055] The steps of a method or algorithm described in connection with the disclosure herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium is coupled to the processor such that the processor may read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in a user terminal. In the alternative, the processor and the storage medium may reside as discrete components in a user terminal.

[0056] The previous description of the disclosure is provided to enable any person skilled in the art to make or use the disclosure. Various modifications to the disclosure will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not intended to be limited to the examples and designs described herein but are to be accorded the widest scope consistent with the principles and novel features disclosed herein.

CLAIMS**WHAT IS CLAIMED IS:**

1. An electronic device comprising:
 - a processor;
 - a memory;
 - a pitch frequency adjustment rocker switch coupled to the processor, the pitch frequency adjustment rocker switch, when actuated, causing the processor to bias a pitch frequency response of the electronic device for frequencies above 1 kHz; and
 - a bass frequency adjustment rocker switch coupled to the processor, the bass frequency adjustment rocker switch, when actuated, causing the processor to bias a bass frequency response of the electronic device for frequencies below 1 kHz.
2. The electronic device of claim 1, wherein the electronic device is a sound amplifier.
3. The electronic device of claim 2, wherein the sound amplifier is a hearing aid.
4. The electronic device of claim 3, wherein the hearing aid is an over-the-ear-type hearing aid.
5. The electronic device of claim 1, wherein the processor has a power control module for managing a battery life of the electronic device.
6. The electronic device of claim 4, where the over-the-ear-type hearing aid comprises a speaker located on or substantially close to a printed circuit where the processor is located, said speaker is coupled via a mechanical audio coupler to an ear piece configured for use at an outer opening of an ear canal of a user of the electronic device.

7. The electronic device of claim 4, where the over-the-ear-type hearing aid comprises a speaker located in or substantially close to an ear piece of the electronic device, said speaker is electrically coupled to a printed circuit where the processor is located.

8. A non-transitory computer program product that causes an electronic device to adjust its frequency response to pitch and bass frequencies, the non-transitory computer program product having instructions to:

bias a pitch frequency response of the electronic device for frequencies above 1 kHz when a pitch frequency adjustment rocker switch of the electronic device is actuated; and

bias a bass frequency response of the electronic device for frequencies below 1 kHz when a bass frequency adjustment rocker switch of the electronic device is actuated.

9. The non-transitory computer program product of claim 8, wherein the electronic device is a hearing aid.

10. The non-transitory computer program product of claim 9, wherein the hearing aid is an over-the-ear-type hearing aid.

11. The non-transitory computer program product of claim 10, wherein the processor has a power control module for managing a battery life of the electronic device.

12. The non-transitory computer program product of claim 10, where the over-the-ear-type hearing aid comprises a speaker located on or substantially close to a printed circuit where the processor is located, said speaker is coupled via a mechanical audio coupler to an ear piece configured for use at an outer opening of an ear canal of a user of the electronic device.

13. The non-transitory computer program product of claim 10, where the over-the-ear-type hearing aid comprises a speaker located in or substantially close to an ear piece of the electronic device, said speaker is electrically coupled to a printed circuit where the processor is located.

14. In an electronic device configured with a high tone/volume control mechanism and a low tone/volume control mechanism, a method comprising:

detecting a change in high tone/volume control level at the high tone/volume control mechanism;

detecting a change in low tone/volume control level at the low tone/volume control mechanism; and

adjusting the treble and bass frequency amplification response of the electronic device in response to the detected changes in the high tone/volume control levels.

15. The method of claim 14, further comprising identifying a maximum or minimum tone/volume control level setting and generating a first audible sound.

16. The method of claim 15, further comprising generating a second audible sound in response to a change from one tone/volume control mechanism.

17. The method of claim 16, wherein the electronic device is an over-the-ear-type hearing aid.

18. The method of claim 17, wherein each of the low and high tone/volume control mechanisms is configured to be set to one of a predetermined number of tone/volume control levels, the method further comprising identifying tone/volume control level settings, matching the settings to a corresponding frequency response curve and amplifying a received input signal into a microphone in accordance with the frequency response curve.

19. The method of claim 14, wherein each of the low and high tone/volume control mechanisms is configured to be set to one of a predetermined number of tone/volume control levels, the method further comprising identifying tone/volume control level settings, matching the settings to a corresponding frequency response curve and amplifying a received input signal into a microphone in accordance with the frequency response curve.

20. The method of claim 14, wherein the low and high tone/volume control mechanisms are two separate rocker switches.

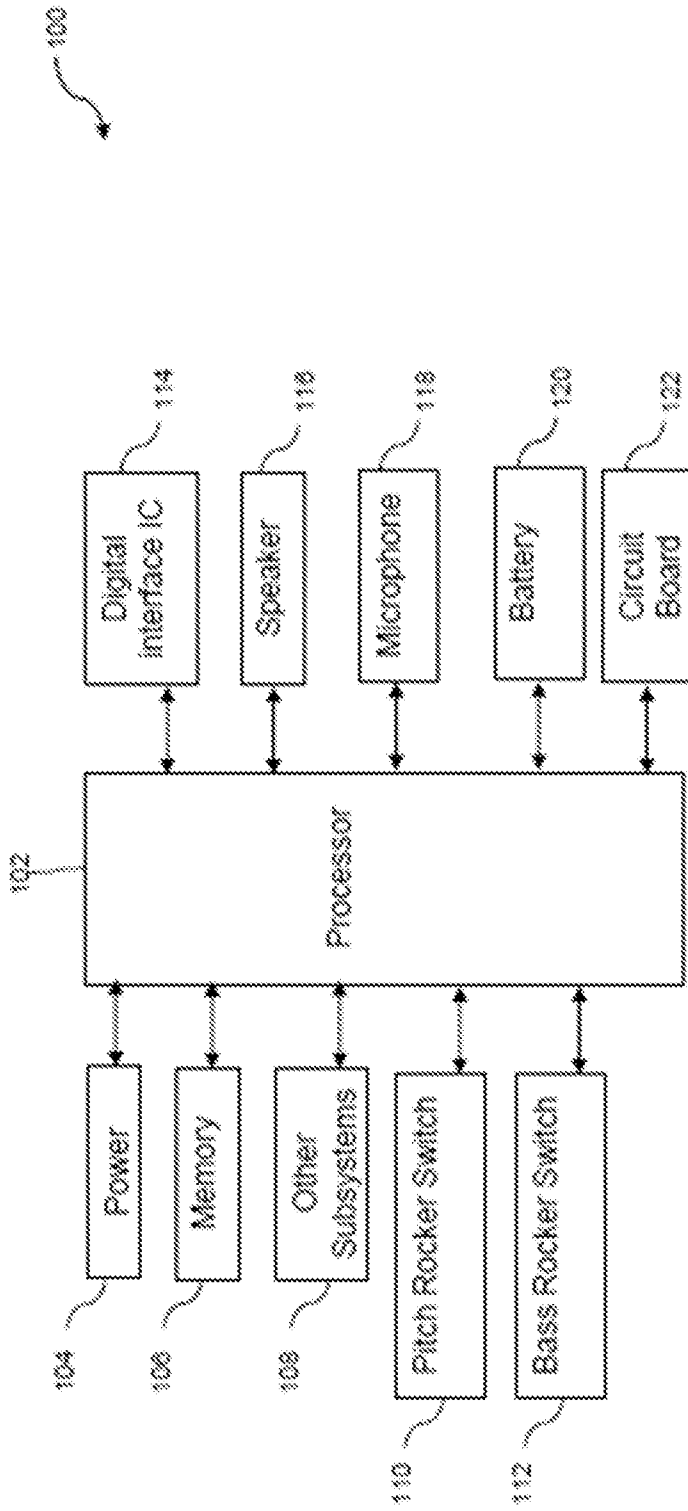


FIG. 1

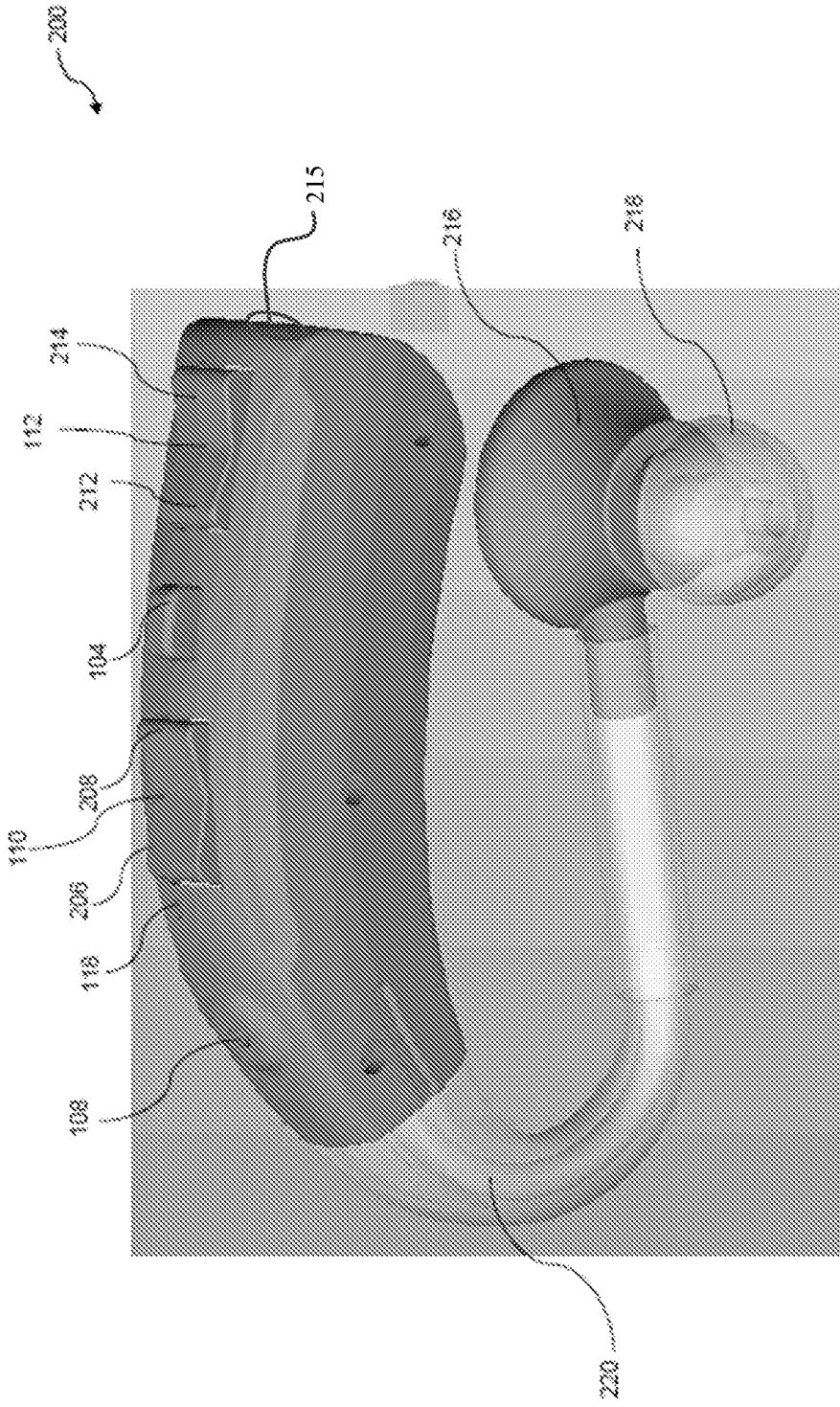


FIG. 2

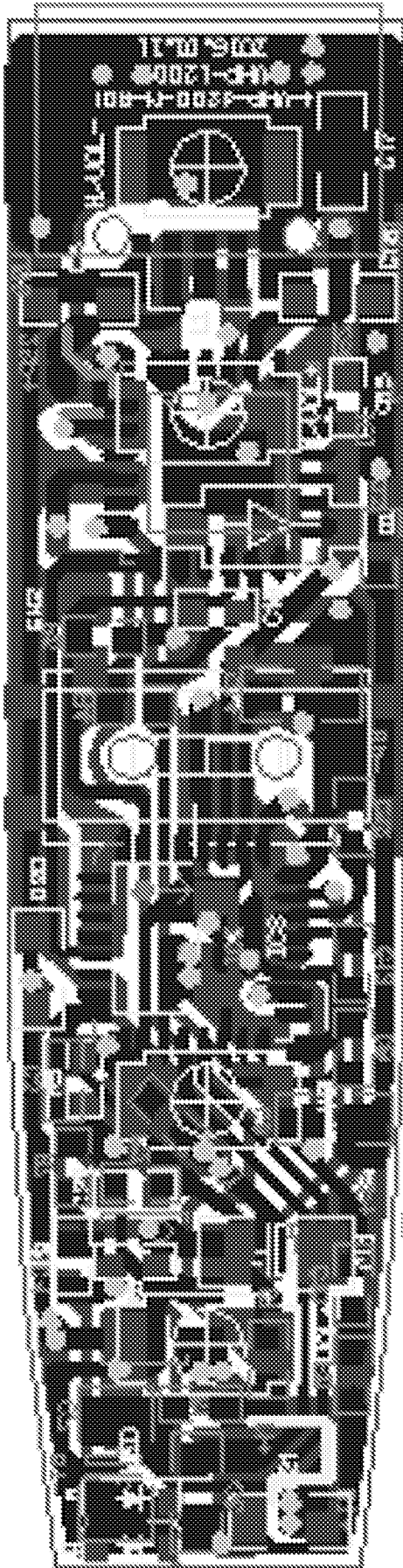


FIG. 3

300

FIG. 5

NO	PART (S)	SIZE	POSITION	QTY
1	chip Resistor	500 KΩ 2.5KΩ	R11, R9	2
2	chip Resistor	500 KΩ 10KΩ	R2	1
3	chip Resistor	500 KΩ 1KΩ	R3	1
4	chip Resistor	500 KΩ 2.7KΩ	R4, R5	2
5	chip Resistor	500 KΩ 10KΩ	R6	1
6	chip Resistor	500 KΩ 47KΩ	R7	1
7	chip Resistor	500 KΩ 10KΩ	R14	1
8	chip Resistor	500 KΩ 10KΩ	R8	1
9	chip Resistor	500 KΩ 20KΩ	R10, R11	2
10	chip Resistor	500 KΩ 10KΩ	R12, R13, R15	3
11	chip Capacitor	500 2000 CAP	C3, C4, C6, C10, C16	5
12	chip Capacitor	500 0402 CAP	C1, C2, C10, C17	5
13	chip Capacitor	500 0402 CAP	C7, C11	2
14	chip Capacitor	500 0402 CAP	C5, C13	2
15	chip Capacitor	500 0402 CAP	C9, C14	2
16	chip Capacitor	500 0402 CAP	C12	1
17	chip Capacitor	500 0603 CAP	C15	1
18	The Patch Field Effect Tube	Super film sealed by SOT	R1	1
19	IC	4028-166 IC-16PMS approx. 1.5mm	R22	1
20	IC	4028	R21	1
21	IC	4028-166 16P-16MS Super film	R24	1
22	IC	1-5V	R23	1
23	CHIP SWITCH	1A-10A	SW1	1
24	LED	500 Red/Green Light	R30	1
25	USB FANX	DC charging USB 5Pin	R38	1
26	PCB	Double-sided epoxy resin plate 0.6mm		1
27	1100V 10000K 50V	151-6615	R1, R3, R31, S4	4
28	1100V battery	with protection board		1
29	Microphone	40015 solder 200m lines, with screw	R20	1
30	earphone (speaker)	416	R25	1
31	earphone wire	Length:125 2 sides Deactivation each for 10mm, 2 sides wickling each for 2mm		1
32	plastic front shell	yellow color ABS		1
33	plastic back shell	yellow color ABS		1
34	Plastic Bottom (100-10100-1)	yellow color ABS (100-10100-1)		1
35	Plastic Touch (100-10100-1)	plastic touch yellow ABS		1
36	Plastic Switch	yellow color ABS		1
37	earphone long pin	White ABS diameter 0.5mm		1
38	Speaker Plastic front shell	yellow color ABS		1
39	Speaker Plastic back shell	yellow color ABS		1
40	EVA pad	Single with glue 0.2 5x4	Stick behind speaker	1
41	EVA pad	Single with glue 0.2 5x10mm thickness 1.1 0mm	Stick front speaker	1
42	foam	1.1 0.5 5.0	back shell	1
43	Transparent Plastic tube	1.5*3*20mm	earphone wire	1

1	Max. saturation sound pressure level(OSPL90)	$\leq 129+3\text{dB}$
2	Full on Acoustic Gain	$38\pm 5\text{ dB}$
3	Total Harmonic Distortion(THD)	$\leq 10\%$
4	Equivalent Input Noise	$\leq 32\text{dB}$
5	Frequency Response	$450\sim 3000\text{Hz}$
6	Current Drain	$\leq 1.5\text{mA}$

FIG. 6

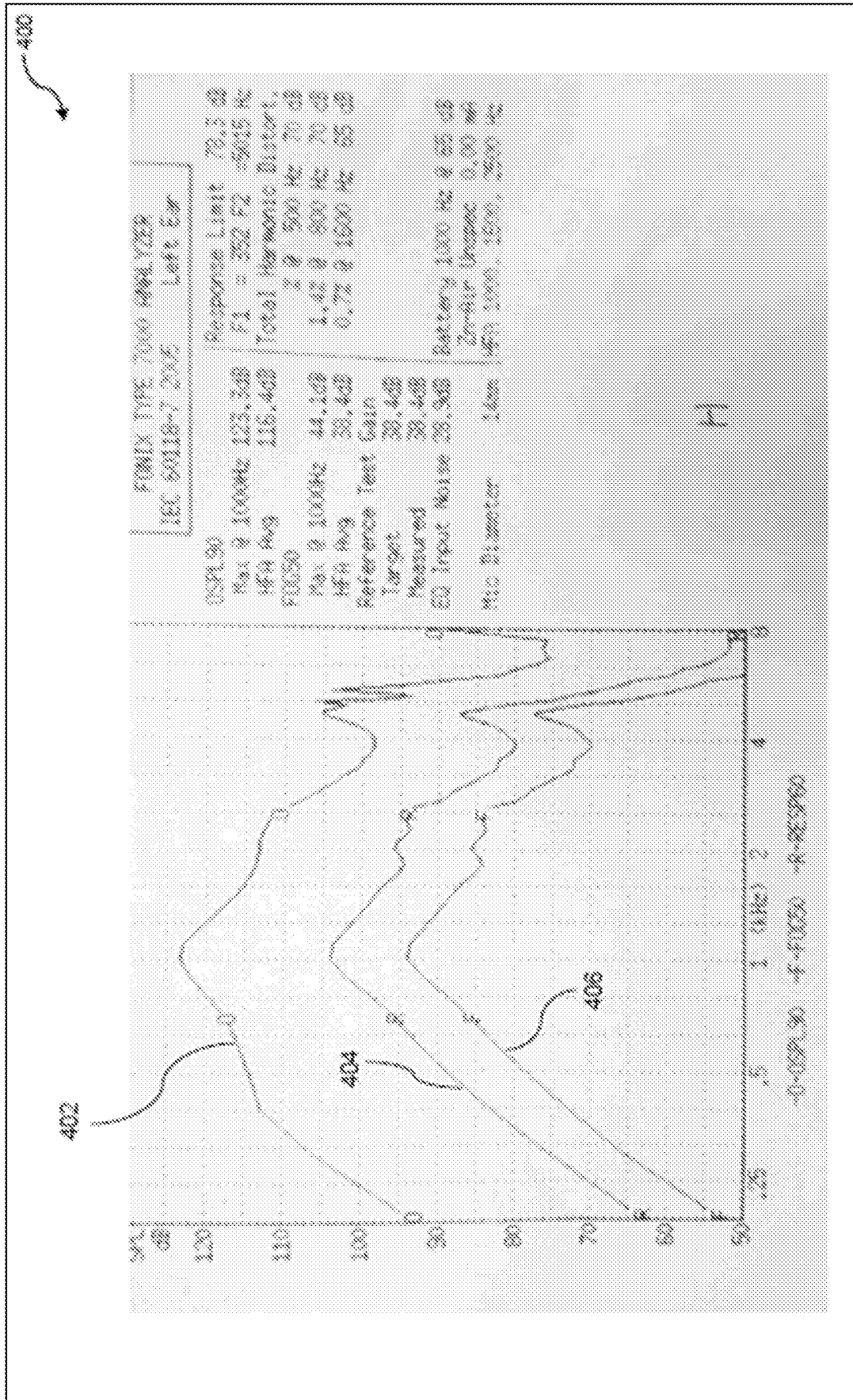


FIG. 7

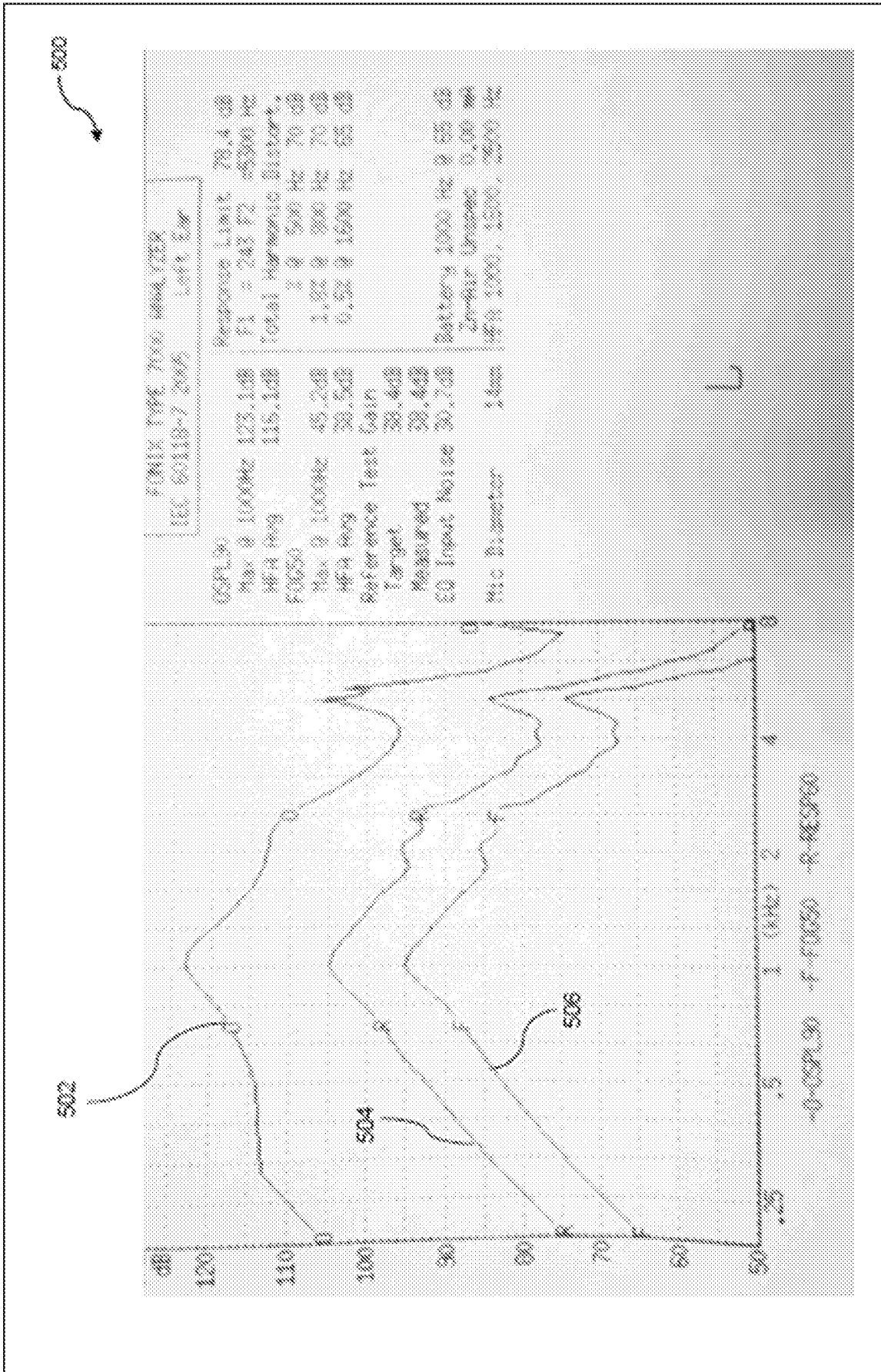


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 17/26864

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - H04R 3/04 (2017.01)
 CPC - H04R 1/1041; H04R 1/105; H04R 3/04; G10H 1/34; H03G 5/165

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)

See Search History Document

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

See Search History Document

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

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 7,634,097 B2 (NIEDERDRANK) 15 December 2009 (15.12.2009), entire document, especially; col 3, ln 54 to col 5, ln 8.	1-13
A	US 6,937,738 B2 (ARMSTRONG et al.) 30 August 2005 (30.08.2005), entire document, especially; col 1, ln 35-55, col 2, ln 35-45, col 8, ln 11-16.	1-13
A	US 2015/0332660 A1 (FENDER MUSICAL INSTRUMENTS CORP) 19 November 2015 (19.11.2015), entire document, especially; para [0096]-[0099].	1-13
A	US 2008/0044042 A1 (LIU et al.) 21 February 2008 (21.02.2008), entire document.	1-13
A	US 4,991,484 A (KAWASHIMA) 12 February 1991 (12.02.1991), entire document.	1-13
A	US 7,151,838 B2 (GALLER et al.) 19 December 2006 (19.12.2006), entire document.	1-13
A	US 8,542,858 B2 (FLAIG et al.) 24 September 2013 (24.09.2013), entire document.	1-13

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier 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

02 August 2017

Date of mailing of the international search report

16 AUG 2017

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
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 Facsimile No. 571-273-8300

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 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 17/26864

Box No. II 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 No. III 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:

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

Group I: claims 1-13: drawn to an electronic device and a non-transitory computer program product that causes an electronic device to adjust its frequency response.

Group II: claims 14-20: drawn to an electronic device configured with a high tone/volume control mechanism and a low tone/volume control mechanism.

-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 additional fees, this Authority did not invite payment of additional fees.
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.:
1-13

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

Continuation of Box No. III Observations where unity of invention is lacking

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

Special technical features:

Group I requires a pitch frequency adjustment rocker switch when actuated causing the processor to bias a pitch frequency response of the electronic device for frequencies above 1kHz; and a bass frequency adjustment rocker switch coupled to the processor, the bass frequency adjustment rocker switch, when actuated, causing the processor to bias a bass frequency response of the electronic device for frequencies below 1kHz, not found in the other groups.

Group II requires a detecting a change in high tone/volume control level at the high tone/volume control mechanism; detecting a change in low tone/volume control level at the low tone/volume control mechanism; and adjusting the treble and bass frequency amplification response of the electronic device in response to the detected changes in the high tone/volume control levels, not found in the other groups.

Shared Features:

The only technical features shared by Groups I and II that would otherwise unify the groups are a frequency adjustment control for adjusting treble and bass frequency responses for an electronic device.

However, these shared technical features do not represent a contribution over prior art, because the shared technical features are disclosed by US 2015/0332660 A1 A1 to Adams et al. (hereinafter 'Adams') 19 November 2015 (19.11.2015), which discloses a frequency adjustment control for adjusting treble and bass frequency responses for an electronic device (para [0096]-[0099] -Controller 170 sends the increase treble frequency control signal because the electrical signals received from touchpad 30 are representative of contact made in control region 64a. -Next, guitarist 198 wants amplifier 200 to change the emphasis of bass frequencies. Guitarist 198 slides a finger over region 64b away from strings 16. Touchpad 30 senses the initial contact of the finger in control region 64b and sends an electrical signal corresponding to the point of contact being located in region 64b to controller 170.).

As the shared technical features were known in the art at the time of the invention, they cannot be considered special technical features that would otherwise unify the groups.

Groups I and II therefore lack unity under PCT Rule 13.