(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 March 2015 (05.03.2015)

WIPO | PCT

(10) International Publication Number
WO 2015/031684 A1

(51) International Patent Classification:
H04R 1/02 (2006.01) *A63F 13/285* (2014.01)
H04R 25/00 (2006.01)

(21) International Application Number:
PCT/US2014/053277

(22) International Filing Date:
28 August 2014 (28.08.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/871,101 28 August 2013 (28.08.2013) US
61/919,020 20 December 2013 (20.12.2013) US
61/991,831 12 May 2014 (12.05.2014) US

(71) Applicant: **STUDIOFEED USA, LLC** [US/US]; 1608 Argyle Ave., #101, Los Angeles, CA 90028 (US).

(72) Inventors: **ALEXIOU, John**; c/o 1608 Argyle Ave., #101, Los Angeles, CA 90028 (US). **CHERNECKI, Todd**; c/o 1608 Argyle Ave., #101, Los Angeles, CA 90028 (US). **KHWAJA, Sarosh, S.**; c/o 1608 Argyle Ave., #101, Los Angeles, CA 90028 (US).

(74) Agents: **HUGHET, William, N.** et al.; Rothwell, Figg, Ernst & Manbeck, P.C., 607 14th Street, N.W., Suite 800, Washington, DC 20005 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: MULTISTAGE TACTILE SOUND DEVICE

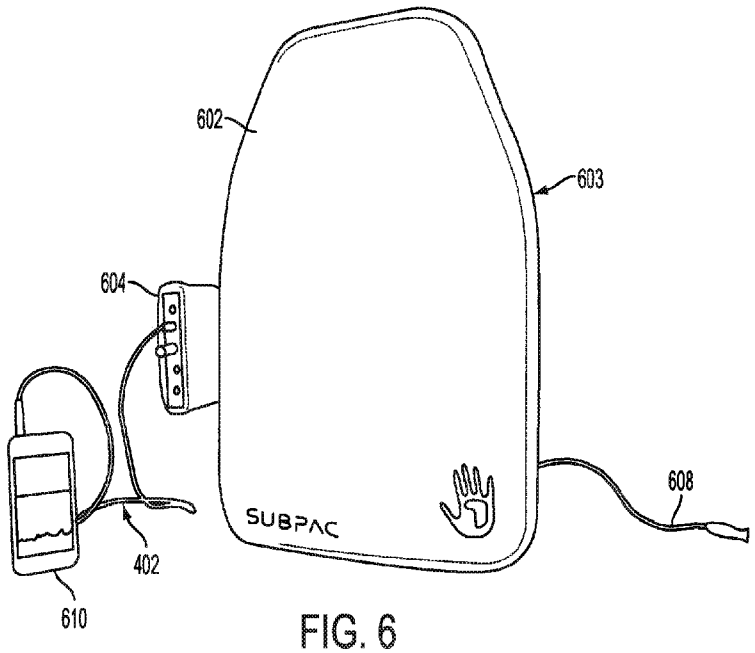

FIG. 6

(57) Abstract: A tactile sound device in proximate contact with a user, comprising a multistage arrangement of vibrotactile materials to impart visceral sensations to a user. The device imparts a physical sensation via a multistage arrangement of vibrotactile materials embodied in a wearable or seated configuration, in response to a wired or wireless signal input.

WO 2015/031684 A1

Published:

— *with international search report (Art. 21(3))*

MULTISTAGE TACTILE SOUND DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority benefit under 35 U.S.C. §119(e) of U.S. Provisional Patent Application No. 61/871,101, entitled "Tactile Sound Device," filed August 28, 2013, the contents of which are incorporated herein by reference in their entirety; of U.S. Provisional Patent Application No. 61/919,020, entitled "Wearable Tactile Sound Device," filed December 20, 2013, the contents of which are incorporated herein by reference in their entirety; and of U.S. Provisional Patent Application No. 61/991,831, entitled "Wearable Tactile Sound Device," filed May 12, 2014, the contents of which are incorporated herein by reference in their entirety.

TECHNICAL FIELD

[0002] The present invention relates generally to a tactile sound device. More particularly, the present invention relates to a tactile sound device comprising a multistage arrangement of vibrotactile materials to impart visceral sensations to a user. Specifically, the present invention relates to imparting a physical sensation via a multistage arrangement of vibrotactile materials embodied in wearable or seated setups in response to a wired or wireless electrical signal input.

BACKGROUND

[0003] For literally hundreds of years, people have enjoyed music, both playing the music and listening to the music. In recent years, the types of music available for listening has expanded exponentially, as has the equipment by which the user can listen to the music. Often, the equipment by which a user can hear, or listen to, the music can be located in the same room where the user is located and the playback of the music can be controlled by the user.

SUMMARY

[0004] According to certain embodiments, there is provided a tactile sound device aimed at providing a visceral sensation via a multistage vibrotactile membrane. The inventors of the present invention have discovered that the type, density, shape and arrangement of various materials employed as vibrotactile membranes in a tactile sound device greatly affects the transfer of a visceral sensation and the overall subjective user experience, despite the fact that the same electroactive transducers, electrical components and other settings may remain constant. Particular embodiments therefore comprise specific arrangements and types of vibrotactile materials that optimize the vibratory field of a tactile sound device to provide the highest level of subjective user experience. Certain embodiments provide for an optimal vibratory field for users who have their back placed against the tactile sound device.

[0005] In one embodiment, a tactile sound device is provided intended for use in a seated position, wherein of the tactile sound device is a textile, polymer or plastic enclosure. Other embodiments include straps to secure the sound device or enclosure to a chair, and clasps to integrate into seats specifically designed for the sound device or enclosure. In another embodiment, a self-contained tactile sound device is provided that can be embedded inside a seat (for instance a computer chair or a car seat), either during the time of manufacture or after sale of the sound device.

[0006] In a particular embodiment, a tactile sound device is provided for use with the user in a standing position, the tactile sound device having a textile, polymer or plastic enclosure with straps. Another embodiment provides a tactile sound device integrated into a backpack on the side proximal to the wearer's back. Yet another embodiment is provided wherein a tactile sound device can be inserted into the sleeve of a backpack. A further embodiment is provided wherein a tactile sound device can be snapped onto a backpack or garment on the side of the backpack or garment that is proximal to the wearer's back, utilizing clasps designed for that purpose. Another embodiment is provided wherein a purpose-built bag containing a tactile sound device has a mechanism to snap on a storage compartment to form a full backpack. A further embodiment provides a tactile sound device that can strap onto any backpack.

[0007] In certain embodiments, a tactile sound device vest is provided, including one or more units of multistage tactile membranes to provide a visceral sensation on the front, back and/or sides of the wearer. Another embodiment is provided where one or more multistage

tactile membranes can be incorporated into multiple positions in or on a garment. Yet another embodiment is a multipurpose tactile sound device insert that can be integrated into other garments, devices, or products.

[0008] In accordance with certain embodiments, there is provided a visceral sensation to the user through the sound device in response to output of bass frequencies at a live event. Additional embodiments for providing a visceral sensation is a wearable tactile audio device that receives input signals from integrated or modular wireless connections, or via a wired I/O connection, such as USB protocol.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings, which are incorporated herein and form part of the specification, illustrate various embodiments of the present disclosure and, together with the description, further serve to explain the principles of the disclosure and to enable a person skilled in the pertinent art to make and use the embodiments disclosed herein. In the drawings, like reference numbers indicate identical or functionally similar elements.

[0010] Figure 1 illustrates s a side view of the multistage vibrotactile membrane assembly.

[0011] Figure 2 illustrates a top view of a multistage vibrotactile membrane assembly for a seated configuration.

[0012] Figure 3 illustrates a top view of a multistage vibrotactile membrane assembly for a wearable configuration.

[0013] Figure 4 is a flowchart illustrating the flow of signals processed by a tactile sound device to provide visceral sensation to the user in response to audio input.

[0014] Figure 5 illustrates a perspective view of a circuit board in accordance to the embodiment in Figure 4.

[0015] Figure 6 illustrates a perspective view of a tactile sound device for use in a seated configuration.

[0016] Figure 7 illustrates a perspective view of a tactile sound device for use in a wearable configuration.

[0017] Figure 8 illustrates a perspective view of a tactile sound device for use in a backpack configuration.

[0018] Figure 9 illustrates a perspective view of a tactile sound device for use in a vest configuration.

[0019] Figure 10 is a flowchart illustrating the flow of signals processed by a tactile sound device to provide visceral tactile sensations to the user in response to sound at a live event.

DETAILED DESCRIPTION

[0020] Particular embodiments are directed to the type, density, shape and arrangement of various materials employed as vibrotactile membranes in a tactile sound device for affecting the transfer of a visceral sensation for providing an overall subjective user experience, despite the fact that the same electroactive transducers, electrical components and other settings may remain constant. Present embodiments therefore comprise a specific arrangement and types of vibrotactile materials that optimize the vibratory field of a tactile sound device to provide the highest level of subjective user experience. The present invention thereby facilitates providing an optimal vibratory field for users who have their back placed against the tactile sound device.

[0021] The key to a sought-after improved user experience is the use of a multistage vibrotactile membrane **100** as shown in Figure 1. The conduction of vibration commences with the electroactive transducer **102**, which can be a tactile transducer, a piezoelectric transducer or any mechanism that translates an electric signal into motion. The electroactive transducer **102** directly attaches to the secondary membrane **104** or can be embedded in it. The secondary membrane attaches to the primary membrane **106** which is the side proximal to the user. The vibrations from the electroactive transducer **102** are dampened by the secondary membrane **104** and dissipated across its surface area. The primary membrane **106** then collects and transfers the vibrations to the user's back through the cover or coating material.

[0022] The primary membrane **106** comprises a large, rigid membrane that takes up approximately the same surface area as the side of the tactile sound device proximal to the user's back and also serves a structural role in the invention. Primary membrane **106** may be made of any of a number of thermoplastics, such as polypropylene, HDPE, PVC, and the like, or of composite materials, such as carbon-fibre; but a preferred material is polypropylene. It is important to note that only textiles, thin foams, silicone or other such coatings should be placed between primary membrane **106** and the user's body to minimize any interference or undesirable vibrational dampening between the user and the primary membrane **106**.

[0023] This secondary microcellular polymer membrane **104** may be made of microcellular elastomers (EVA), urethanes (PU), rubbers, and the like; but is preferably comprised of microcellular polyurethane, which has a greater dampening effect on vibrations (vis-à-vis the primary membrane **106**). Such dampening effect is desirable to reduce the harsh vibrations of the electroactive transducer **102** to a level that is comfortable to the user and that distributes them across the area of the microcellular foam. The secondary microcellular polymer membrane **104** should contain less surface area than the primary membrane **106** and is preferably provided in an inverted "T" shape **202** as shown in Figure 2 if the device is to be used in a seated orientation (i.e. the horizontal portion goes across the user's pelvis/posterior pelvis, with the vertical portion up the user's spine and in between the shoulder blades). Ideally, at least one electroactive transducer **204** should be placed on each axis of the inverted "T" **202** (however one tactile electroactive transducer **204** could be used). This arrangement **202** concentrates the transfer of motion along the user's spine and lower back. If, however, the tactile sound device is to be used in a standing position, then the secondary microcellular polymer membrane **104** is preferably provided in an "I" shape **302** as shown in Figure 3 (such that it fits along the spine and in between the shoulder blades of a user). In the "I" shape, a single electroactive transducer **304** can be attached, but preferably two electroactive transducers **304** are utilized. This arrangement **302** concentrates the transfer of motion along the user's back.

[0024] Note that the primary membrane **106** and the secondary membrane **104** can be combined with one or more layers of similar materials or into a composite material to provide a more controlled gradient of dissipation and transmission. Another layer of materials similar to the primary membrane **106** larger in surface area than the electroactive transducer **102** be used in order to alter the vibratory field of the electroactive transducer **102**. The membranes and the electroactive polymers should be attached using a strong adhesive, such as VHB tape.

[0025] The multistage vibrotactile membrane **100** can be run off an external amplifier; however, in a preferred embodiment, the tactile sound device is supplied with its own circuit assembly. This assembly of the multistage tactile membrane and circuit assembly is hereinafter referred to as **500**. This circuit assembly **400** is shown in Figure 4 and Figure 5. The unit receives a wired **402** or wireless **404** audio signal input **406**. An I/O Port **405** can be used to provide input from other sources, for instance USB audio input. One part of this signal is either processed or directly passed **407** through to a headphone output **408**. Another part of this signal

409 is filtered **410** (for example using a low pass filter) to remove frequencies above the frequency response range of the electroactive transducers **412**. This signal is sent to an amplifier **411** (for example an Class D amplifier) which then powers one or more electroactive transducers **412**. The vibrotactile response can is attenuated or amplified using a control either on the unit or on a remote **414**. The unit is powered via a battery which is charged via a DC power input. This embodiment of the tactile sound device containing the tactile sound device and its own circuit assembly **500** can be used in seated and wearable configurations.

[0026] To provide an accurate representation of sound information, for example for music production, the signal **409** is passed from the Digital Signal Processor **407** to **410** unprocessed. To provide an enhanced representation of sound information, compression and bass-boost effects, for gaming and entertainment applications for instance, can be applied in **407** to be passed into **410**. To provide car-engine feedback sounds, for instance to simulate the sensation of driving a combustion-engine car in an electric car, an electrical signal based on environmental criteria via external processing can be sent to **405** and effects can be applied **407** to further enhance that experience.

[0027] Figure 6 shows an embodiment, for a seated configuration where the tactile sound device can be placed on any chair. The main body **602** comprises the vibrotactile membrane assembly **100** (not shown) inside a textile cover **603.** This circuit assembly **604, 414** is outside the unit; however it can be integrated in the main unit **602** as well. Signal input is provided via a wired connection **402** from a portable media player **610**. The unit is powered via a DC power connector **608.** In another embodiment (not shown) of tactile sound device **500**, the rear the unit has buckles that can snap into a chair with matching clasps designed to accommodate such a unit. In another embodiment, (not shown), the tactile sound device **500** is integrated into the back of a chair with the tactile sound device **500** (not shown) on the side of the chair back **802** proximal to the user's back.

[0028] Figure 7 shows an embodiment of the tactile sound device **500** (not shown) incorporated in a purpose built wearable bag **700** with straps **702**. A control module **704** is configured to attenuate or amplify the vibrotactile response. Headphones are plugged into the headphone out **408**. Figure 8 shows an embodiment of the tactile sound device **500** (not shown) is sealed into a backpack **800** on the side proximal to the wearer's back **802**. Various embodiments and details of features of tactile sound device backpacks are discussed in U.S.

Provisional Application Serial Number 61/991,831. Figure 9 shows a tactile sound device vest **900** incorporating four units of multistage tactile membrane **100** (not shown) and a circuit assembly **400** to power the device.

[0029] Figure 10 shows the circuit block diagram of an embodiment of a wearable tactile sound device to be used at a live event. This unit receives a source signal, via an integrated or a modular receiver, and translates the low frequencies contained therein directly to the wearer's/audience member's body. The audience member thus experiences the visceral sensation of loud sub-woofers, without experiencing the pressure waves caused by sound. This allows all audience members who wear the device of the present invention to experience the same visceral experience, regardless of physical proximity to the sound source. The method for providing visceral tactile sensations to the user in response to sound at a live event are found in U.S. Provisional Application Serial Number 61/919,020 and U.S. Provisional Application Serial Number 61/871,101. A display, **1220** is present on the exterior shell of tactile sound device and can take signals from **1320, 1321, 1322, 1323,** via **405** to create a centrally controlled light-show (for instance controlled by a DJ), a pre-programmed light-show (for instance using information from **405**) or a light show based on characteristics of input signal **406** or output signal **412**.

CLAIMS

WHAT IS CLAIMED IS:

1. A multistage vibrotactile assembly, comprising:

one or more layers of primary membrane;

one or more layers of secondary membrane attached adjacent to said primary membrane; and

one or more discrete or continuous electroactive components that translate an electrical signal into motion,

wherein the electroactive componets attach along or are embedded into a portion of the secondary membrane and comprise one or more of tactile transducers and piezoelectric transducers.

2. The multistage vibrotactile assembly according to claim 1, wherein the primary membrane comprises a thermoplastic or composite material.

3. The multistage vibrotactile assembly according to claim 1, wherein the primary membrane comprises one or more of polypropylene, HDPE, PVC, or carbon-fibre.

4. The multistage vibrotactile assembly according to claim 1, wherein the primary membrane comprises polypropylene.

5. The multistage vibrotactile assembly according to claim 1, wherein the secondary membrane comprises a microcellular elastomer, urethane, or rubber.

6. The multistage vibrotactile assembly according to claim 1, wherein the secondary membrane comprises polyurethane.

7. The multistage vibrotactile assembly according to claim 1, wherein the secondary membrane dampens and dissipates motion from the electroactive component along the surface area of the multistage vibrotactile assembly.

8. The multistage vibrotactile assembly according to claim 1, wherein the primary membrane collects and conducts vibrations from the secondary membrane.

9. The multistage vibrotactile assembly according to claim 1, wherein the primary membrane is proximal to a user of the multistage vibrotactile assembly.

10. The multistage vibrotactile assembly according to claim 1, wherein an additional layer similar to the primary membrane is placed between the electroactive component and the secondary membrane.

11. The multistage vibrotactile assembly according to claim 1, wherein the electroactive component is powered by an amplifier.

12. The multistage vibrotactile assembly according to claim 1, wherein the electroactive component is controlled by a wired electrical signal.

13. The multistage vibrotactile assembly according to claim 1, wherein the electroactive component is controlled by an electrical signal transmitted wirelessly.

14. The multistage vibrotactile assembly according to claim 1, wherein the electroactive component comprises an active or passive filter to control the frequency response range of the multistage vibrotactile assembly.

15. The multistage vibrotactile assembly according to claim 1, wherein the multistage vibrotactile assembly is controlled by a circuit assembly that processes and amplifies an audio or electric signal into a control signal to activate the electroactive component.

16. The circuit assembly according to claim 15, wherein the circuit assembly comprises:

one or more wired or wireless audio or electrical signal input; and

a signal amplifier to control providing power to the circuit assembly and the multistage vibrotactile assembly.

17. The circuit assembly according to claim 15, wherein the circuit assembly attenuates the amplifier output for the electroactive component.

18. The circuit assembly according to claim 15, wherein the circuit assembly comprises at least one microprocessor to control function of the circuit assembly.

19. The circuit assembly according to claim 15, wherein the circuit assembly comprises at least one digital signal processor to alter all or certain portions of the electrical signal.

20. The circuit assembly according to laim 15, wherein the circuit assembly comprises at least one filter, wherein the filter comprises a low pass, high pass, notch filter or band pass filter.

21. The circuit assembly according to claim 15, wherein the circuit assembly comprises at least one filter for processing the control signal to remove distortion or noise.

22. The circuit assembly according to claim 15, wherein the circuit assembly receives an infrared or a wireless signal input using but not limited to WiFi , Bluetooth, , UHF, and ISM protocols.

23. The circuit assembly according to claim 15, wherein the circuit assembly comprises a wired signal input and a processor to decode input from another device in an encoded format.

24. The circuit assembly according to claim 15, wherein the circuit assembly accepts a microphone input.

25. The circuit assembly according toclaim 15, wherein the circuit assembly provides a wired or wireless audio signal output.

26. The circuit assembly according to claim 15, wherein the circuit assembly attenuates or amplifies a wireless or wired audio signal output.

27. The circuit assembly according to claim 15, wherein the circuit assembly comprises a primary cell or secondary cell assembly.

28. The circuit assembly according to claim 15, wherein the circuit assembly comprises a charging circuit for a secondary cell assembly.

29. The circuit assembly according to claim 15, wherein the circuit assembly comprises an I/O port to which internal or external accessories can be attached.

30. The circuit assembly according to claim 15, wherein the circuit assembly comprises an I/O port that can power or charge external devices and accessories.

31. The circuit assembly according to claim 15, wherein the circuit assembly comprises a system to separate the control signal used to activate the electroactive component from a signal to control other components and functions of the circuit assembly.

32. The system according to claim 31, wherein the intensity of the control signal to activate the electroactive component can be controlled via an external signal.

33. The multistage vibrotactile assembly according to claim 15, further comprising a tactile sound device that provides visceral sensations to the user.

34. The tactile sound device according to claim 33, wherein the tactile sound assembly is situated inside a textile, synthetic, leather, polymer or foam cover.

35. The tactile sound device according to claim 34, wherein the cover comprises straps to secure the device to a seat, wherein the seat comprises a computer chair, a theatre chair, a car seat, or an airplane seat.

36. The tactile sound device according to claim 34, wherein the cover includes a mechanism to snap the device to any seat designed to accommodate such a device.

37. The tactile sound device according to claim 34, wherein the tactile sound device is embedded inside a seat such as a computer chair, theatre chair, car seat, or airplane seat on the side proximal to the user's back.

38. The tactile sound device according to claim 34, wherein the secondary membrane is in the form of a generalized inverted when the tactile sound device is used in a seated position.

39. The tactile sound device according to claim 33, wherein the tactile sound device is situated inside a purpose-built bag having a pair or more of straps or a single cross-strap, the bag to be worn by the user.

40. The tactile sound device according to claim 33, wherein the tactile sound device is sealed inside a backpack on the side proximal to the wearer's back.

41. The tactile sound device according to claim 33, wherein the tactile sound device is situated to be inserted into an unsealed pocket of a backpack on the side proximal to the wearer's back.

42. The tactile sound device according to claim 33, wherein the tactile sound device can be snapped onto the exterior of a backback on the side of the backback proximal to the wearer's back.

43. The tactile sound device according to claim 39, wherein the purpose-built bag has a mechanism to snap on a storage compartment to form a full backpack.

44. The tactile sound device according to claim 39, wherein the tactile sound device is configured to be strapped onto any backpack.

45. The tactile sound device according to claim 39, wherein the secondary membrane is in the form of a generalized I shape when the tactile sound device is configured to be worn.

46. The tactile sound device according to claim 33, wherein the tactile sound device is configured to be worn by the user as a vest or within a vest.

47. The tactile sound device according to claim 33, wherein the tactile sound device is configured to be worn by the user as a garment.

48. The tactile sound device according to claim 33, wherein the tactile sound device is configured as an insert to be inserted into any garment worn by the user.

49. The tactile sound device according to claim 33, wherein the tactile sound device is configured to display visualizations via a display on its cover or enclosure, wherein the visualizations are either generated on the device or are received from wired or wireless signal, and wherein the display comprises an OLED screen, flexible OLED screen, LED grid, LED screen, LCD screen, or electroluminescent display.

50. The tactile sound device according to claim 33, wherein the digital signal processor in the circuit assembly provides a faithful representation of audio input by not modifying the input signal.

51. The tactile sound device according to claim 33, wherein the digital signal processor in the circuit assembly provides an enhanced representation of certain sound information by applying compression and bass-boost effects.

52. The tactile sound device according to claim 33, wherein the digital signal processor in the circuit assembly in conjunction with a signal from the I/O port provides car-engine feedback

sounds to simulate the sensation of driving a combustion-engine-car or the sensation for safety alerts.

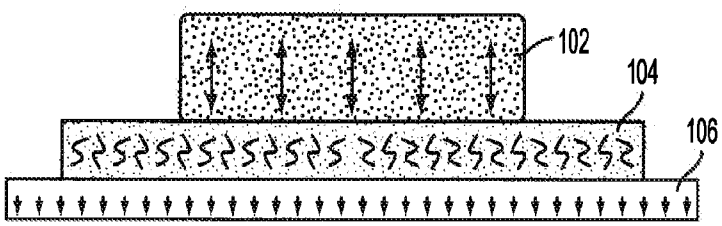

FIG. 1

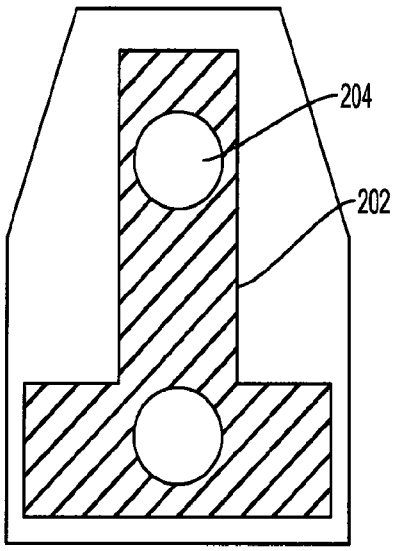

FIG. 2

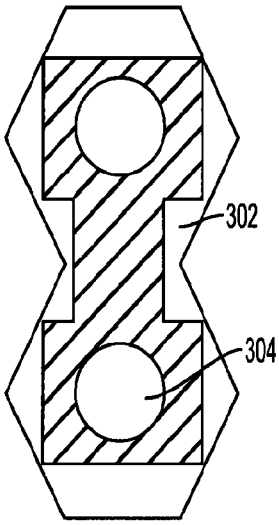

FIG. 3

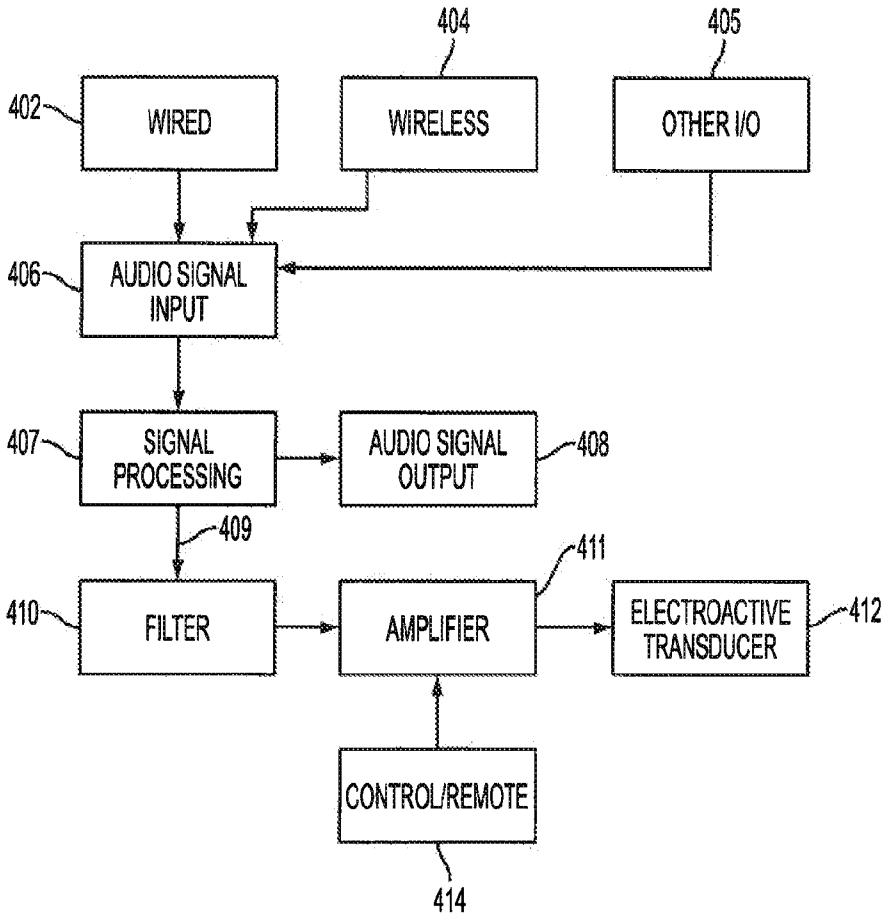
404
405
402
WIRED
WIRELESS
OTHER I/O
406
AUDIO SIGNAL INPUT
407
SIGNAL PROCESSING
AUDIO SIGNAL OUTPUT
408
409
411
410
FILTER
AMPLIFIER
ELECTROACTIVE TRANSDUCER
412
CONTROL/REMOTE
414

FIG. 4

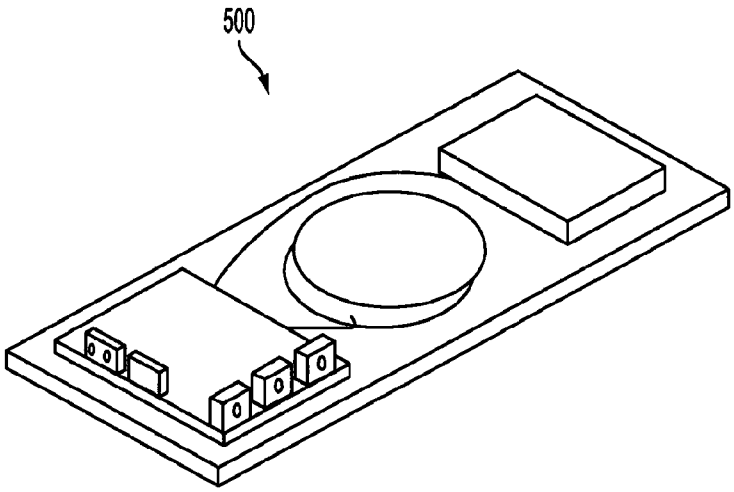

FIG. 5

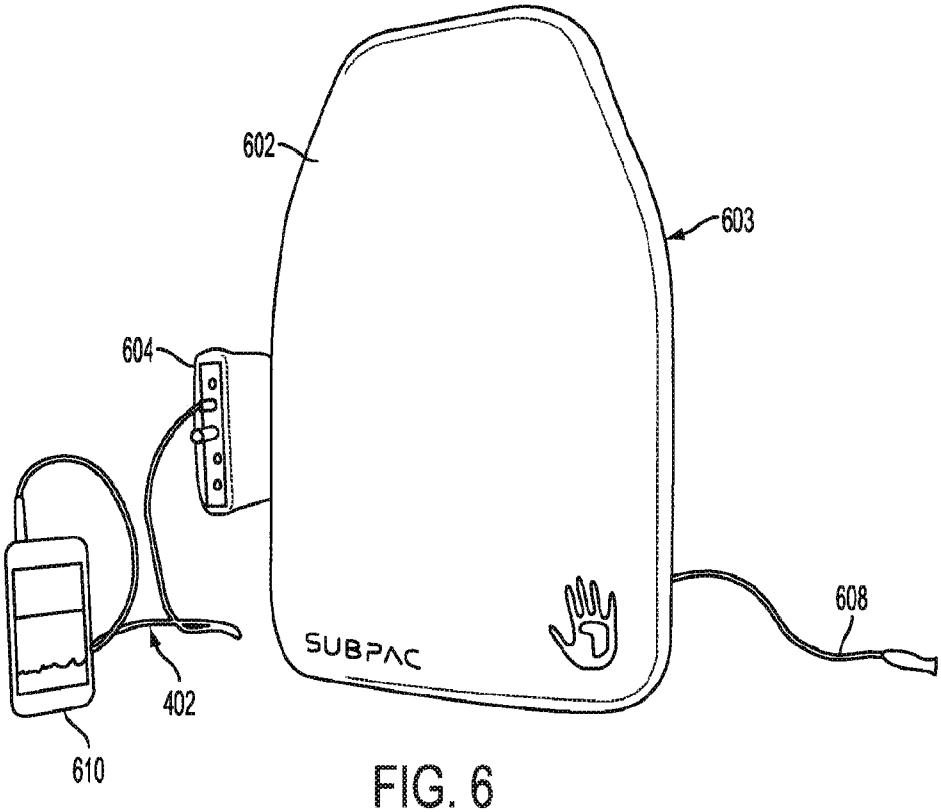

FIG. 6

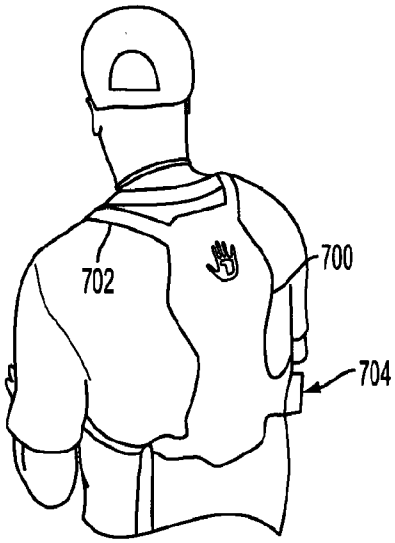

FIG. 7

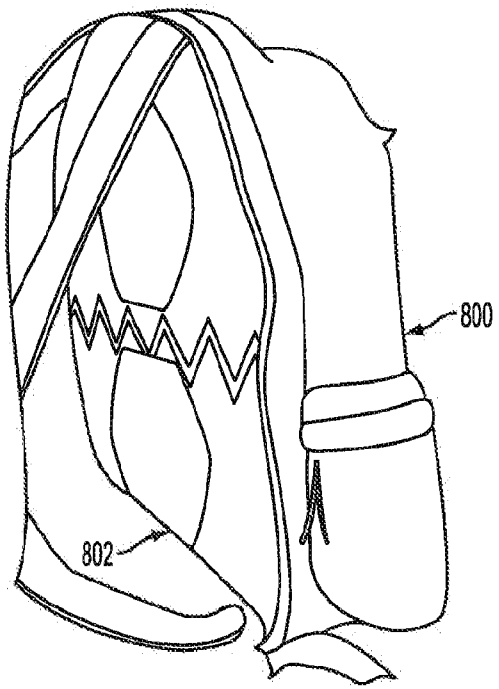

FIG. 8

FIG. 9

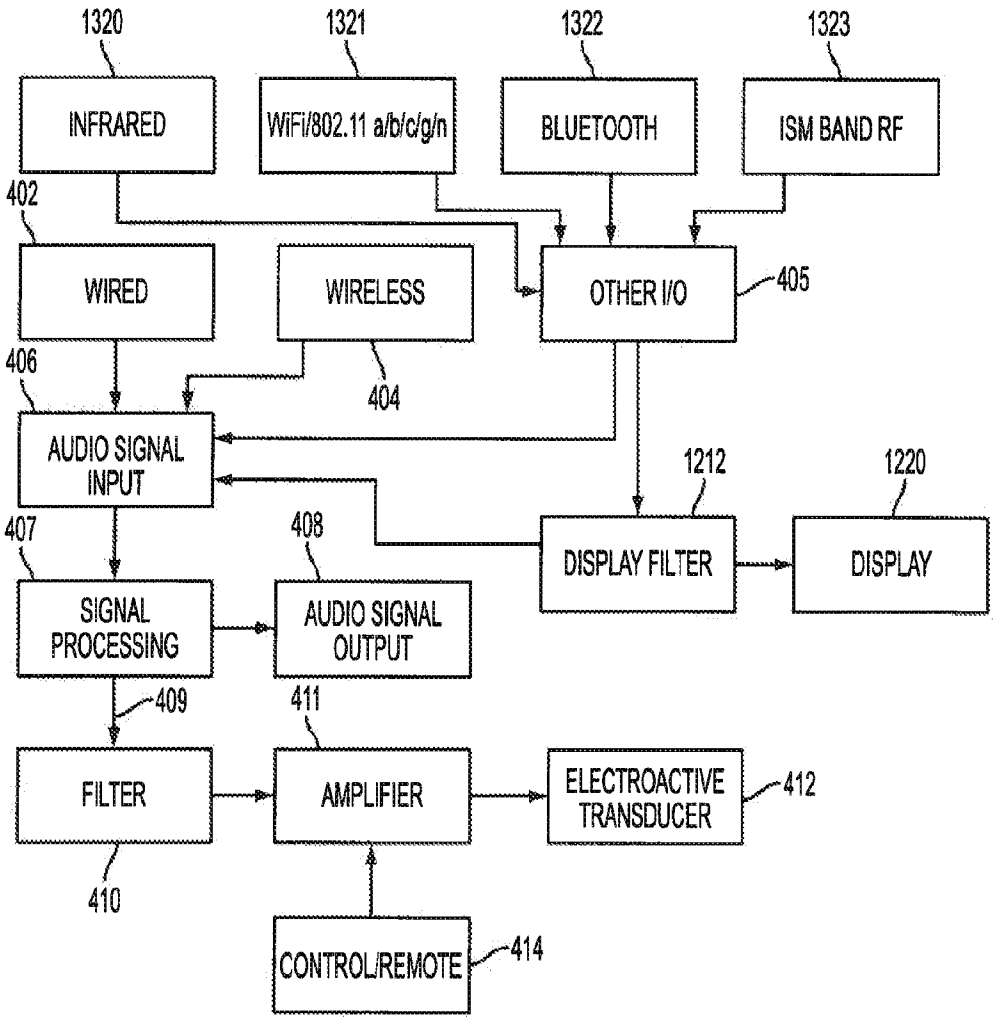
1320
1321
1322
1323
INFRARED
WiFi/802.11 a/b/c/g/n
BLUETOOTH
ISM BAND RF
402
WIRED
WIRELESS
OTHER I/O
405
406
404
AUDIO SIGNAL INPUT
1212
1220
407
408
DISPLAY FILTER
DISPLAY
SIGNAL PROCESSING
AUDIO SIGNAL OUTPUT
409
411
FILTER
AMPLIFIER
ELECTROACTIVE TRANSDUCER
412
410
CONTROL/REMOTE
414

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/53277

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H04R 1/02, 25/00; A63F 13/285 (2014.01)
CPC - B06B 1/045; H04R 5/023, 9/06
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)
IPC(8): H04R 1/02, 25/00; A63F 13/285 (2014.01) USPC: 381/151, 152, 326, 333, 388, 396
CPC: B06B 1/045, 1/0662, 3/00; H04R 5/023, 9/06, 9/066, 2400/03; A61H 2201/0138, 2201/0149, 23/0236, 23/0245

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent (US Granted, US Applications, EP-A, EP-B, WO, JP, DE-G, DE-A, DE-T, DE-U, GB-A, FR-A); Google; Google Scholar; ProQuest; tactile, haptic, low frequency, bass, infrasonic, tactile, piezo, piezoelectric, generator, transducer, speaker, tweeter, layers, plies, sheets, membranes, fabric, foam, web, polyester, polypropylene, rubber, elastomer, thermoplastic, polyurethane, HDPE, PVC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3674945 A (HANDS, E) July 4, 1972; column 3, lines 1-45; column 4, lines 1-5	1-6
X -- Y	US 2011/0251535 A1 (BENDER, EL) October 13, 2011; figures 1, 10-11; paragraphs [0057], [0094]-[0096]	1, 7-9, 11-23, 25-26, 29, 31-34, 37, 41-42, 46-48, 51 -- 24, 27-28, 35-36, 39-40, 44, 49-50, 52
X	US 2011/0257468 A1 (OSER, RB et al.) October 20, 2011; figure 15; paragraphs [0035], [0047], [0059]	1, 10
X	US 2012/0051579 A1 (COHEN, DE) March 1, 2012; paragraphs [0259]-[0263]	1, 15, 30
Y	US 6694035 B1 (TEICHER, M et al.) February 17, 2004; column 2, lines 60-67	24
Y	US 2007/0217644 A1 (LEDONNE, RD) September 20, 2007; paragraphs [0065], [0086]	27, 28, 49
Y	HORTON, D. AVSIM Hardware Review: Aura Interactor. AVSIM Online. 2004 [retrieved on 5 November 2014]. Retrieved from the Internet: <URL: http://www.avsim.com/pages/0604/aura/aura_interactor.htm>; figure 3; page 2, paragraphs 1-5; page 3, paragraphs 1-4; page 4, paragraph 3	35-36, 39-40, 44, 50, 52
A	US 4807294 A (IWATA, Y et al.) February 21, 1989; entire document	1-52
A	US 8317734 B1 (REDFIELD, R) November 27, 2012; entire document	1-52

☒ Further documents are listed in the continuation of Box C. ☐

* 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	Date of mailing of the international search report
8 November 2014 (08.11.2014)	21 NOV 2014
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/53277

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 2012/0035513 A1 (AFSHAR, S. S.) February 9, 2012; entire document	1-52
A	US 5060527 A (BURGESS, L. E.) October 29, 1991; entire document	1-52
A	WO 1999/062295 A1 (SAJIC, P et al.) December 2, 1999; entire document	1-52
A	RAYNER, B. Subpac Music Gadget Shakes Up Music-Listening Experience. Toronto Star. 7 April 2013 [Retrieved on 4 November 2014]. Retrieved from the Internet: <URL: http://www.thestar.com/life/technology/2013/04/07/subpac_music_gadget_shakes_up_musiclistening_experience.html>; entire document.	1-52