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(54) APPARATUS FOR GENERATING VIBRATIONAL STIMULI ON THE BODY OF A USER AND SUPPORT STRUCTURE COMPRISING SUCH APPARATUS

(57) An apparatus (1) for generating vibrational stimuli on the body of a user is described, comprising: a first vibrational stimulation unit (2) having vibrating sound emitters (20) capable of reproducing an audio track and generating vibrations based on said audio track; a second vibrational stimulation unit having eccentric vibration generating devices (3), each of which comprises a casing (34), an electric motor (30) accommodated in the casing (34) and an eccentric mass arranged to be driven into rotation by the electric motor (30) so as to generate a mechanical vibration transmitted to the casing (34) and, consequently, to the part of the user's body in contact with the eccentric vibration generating device (3); and a central control unit (4) communicating with the vibrating sound emitters (20) and the eccentric vibration generating devices (3) and configured to drive the electric motor (30) of each eccentric vibration generating device (3) so as to generate vibrations at a given frequency and to drive each vibrating sound emitter (20) based on said audio track.

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Description

Technical field of the invention

[0001] The present invention relates to an apparatus for generating vibrational stimuli on the body of a user, as well as to a support structure for a person comprising such an apparatus. The relevant field is that of devices for well-being and rehabilitation of a user.

State of the art

[0002] It is known that vibrations can provide therapeutic benefits to a user's body. For this purpose, it is known to use one or more vibrating units placed in contact with the user's body resting on a support element, so as to generate a mechanical vibration that is transmitted to the user's body. Depending on the position in which the vibrating unit is placed on the user's body, as well as the frequency, intensity and duration of the vibration, different effects are obtained on the user's body.

[0003] Vibrations can, for example, improve proprioception and postural balance, maintain and optimise muscle tone and trophism, increase physical endurance, improve muscle coordination, reduce pain and rehabilitation time, activate specific muscle units, and activate and relax the body.

[0004] EP3991612, US2015/305974 and US2017/290436 describe apparatuses for generating vibrational stimuli on a user, which apparatuses make use of sound vibration generators, so as to combine the mechanical stimulation produced by the vibration with the sound stimulation produced by the sound. However, the type of vibration generator used in such apparatuses does not allow high-energy vibrations to be produced and is therefore not suitable for the vibrational stimulation of parts of the body that typically benefit from higher-energy stimulation, for example the pelvis and limbs.

Summary of the invention

[0005] It is an object of the present invention to overcome the drawbacks of the prior art, by providing an apparatus for generating vibrational stimuli on a user which enables vibrational stimuli with different characteristics to be delivered to different parts of the user's body, so as to increase the beneficial effect on the user obtained by means of the vibrational stimulation.

[0006] A further object of the present invention is to provide an apparatus for generating vibrational stimuli on a user which is practical and convenient to use and which can be easily installed and operated by the user.

[0007] These and other objects are achieved according to the invention by virtue of an apparatus as defined in the appended independent claim 1.

[0008] Preferred embodiments of the apparatus according to the present invention are defined in the dependent claims, the subject-matter of which is to be understood as an integrating part of the following description.

[0009] In summary, the invention is based on the idea of providing an apparatus comprising:

- a first vibrational stimulation unit with at least one vibrating sound emitter configured to generate vibrations based on an audio track;
- a second vibrational stimulation unit with at least one eccentric vibration generating device comprising a casing, an electric motor housed in the casing and an eccentric mass arranged to be rotated by the electric motor to generate a mechanical vibration transmitted to the casing and, consequently, to the part of the user's body on which the eccentric vibration generating device is arranged; and
- a central control unit configured to control the electric motor of each eccentric vibration generating device so as to generate vibrations at a given frequency and to control each vibrating sound emitter based on a given audio track.

[0010] Thanks to the use of both eccentric vibration generating devices and vibrating sound emitters, the apparatus according to the invention allows to appropriately treat the different parts of the user's body by using for each of them an eccentric vibration generating device or a vibrating sound emitter depending on the most appropriate vibrational stimulus to be imparted, according to the type of body part to be treated by vibrational stimulation and/or according to the effect to be obtained by means of the vibrational stimulation treatment.

[0011] Moreover, thanks to the use of vibrating sound emitters, it is possible to combine the beneficial effect given by listening to the audio track with the beneficial effect given by the vibrational stimulation based on the audio track that the user is listening to. The apparatus thus allows to act not only on the user's body through the generation of vibrational stimuli, but also on the user's psyche through the reproduction of an audio track that the user can both hear at a sound level and feel at a tactile level (the so-called "tactile sound").

[0012] Preferably, the central control unit has, stored in its memory, at least one vibrational stimulation program which provides, for each vibrating sound emitter and each eccentric vibration generating device, a respective audio channel, which in the case of the vibrating sound emitters is an audio track, in particular at low frequencies (for example between 2 and 200 Hz), whereas in the case of the eccentric vibration generating devices it is a sequence of sine waves at fixed frequencies (between 20 and 110 Hz, for example). Depending on the selected vibrational stimulation programme, the central control unit drives each vibrating sound emitter directly on the basis of its associated audio track and, in addition, drives each eccentric vibration generating device from

its associated audio track by preliminarily converting the latter into a pulse-width modulation (PWM) via an internal algorithm.

[0013] Further features and advantages of the present invention will be apparent from the following detailed description, given purely by way of non-limiting example.

Brief description of the drawings

[0014] In the following detailed description of the invention, reference will be made to the figures of the accompanying drawings, wherein:

- Fig. 1 is a side view of a support structure provided with an apparatus for generating vibrational stimuli according to the invention;
- Fig. 2 is a block diagram illustrating an example of the architecture of the apparatus according to the invention; and
- Fig. 3 shows a table with an example of a vibrational stimulation programme stored in the central control unit of the apparatus according to the invention.

Detailed description

[0015] With reference to Fig. 1, a support structure capable of supporting a user is generally indicated with 100.

[0016] The support structure (100) is advantageously a portable massage table, capable of being closed for transport. The support structure (100) comprises a platform (6) intended to support the user. Advantageously, the platform (6) comprises a wooden base and a plurality of cushions arranged above said wooden base.

[0017] The support structure (100) comprises a support frame (7) connected to the bottom of the platform (6) and intended to be placed on the ground to support said platform (6). Advantageously, the support frame (7) comprises foldable legs.

[0018] The support structure (100) is provided with an apparatus (1) for generating vibrational stimuli on the body of a user lying on the support structure (100).

[0019] The apparatus (1) basically comprises a first vibrational stimulation unit (2) and a second vibrational stimulation unit.

[0020] The first vibrational stimulation unit (2) is preferably arranged above the platform (6) of the support structure (100) and is movable on the platform to be positioned in the desired position under the user's body. The first vibrational stimulation unit (2) might however also be arranged in use above the user's body. The first vibrational stimulation unit (2) is intended in particular to transmit vibrational stimulations to the central part of the user's body when the user is lying on the platform (6), but it is however advantageously possible to vary the position of at least part of the first vibrational stimulation unit (2) depending on the areas of the user's body to be treated and/or the type of treatment to be performed. The first vibrational stimulation unit (2) comprises one or more vibrating sound emitters (20), also commonly known with the terms "bass shaker" or "sound exciter". These are devices capable of reproducing an audio track and generating a sound vibration from that audio track when placed in contact with a hard surface (which thus performs the same function as the diaphragm in a common loudspeaker). The sound vibration generated by the vibrating sound emitters (20) has the same frequency as the emitted audio track. The first vibrational stimulation unit (2) may comprise, for example, 2 to 6 vibrating sound emitters (20). The first vibrational stimulation unit (2) may comprise one or more housings (21), for example of plastic or metal, which are fixed to the platform (6) of the support structure (1) and in which one or more vibrating sound emitters (20) are accommodated.

[0021] The second vibrational stimulation unit comprises one or more eccentric vibration generating devices (3) intended to be arranged in contact with the user's body. In the case where, as in the example illustrated herein, several eccentric vibration generating devices (3) are provided, they are arranged in different positions from each other so that each of them acts on a respective part of the user's body. Advantageously, the eccentric vibration generating devices (3) are intended to be positioned on fascial lines and/or muscle parts and/or specific fascial points of the user's body, either above the user's body or between the user's body and the platform (6) of the support structure (100). Advantageously, the second vibrational stimulation unit comprises up to 10 eccentric vibration generating devices (3), independent of each other.

[0022] With reference also to Fig. 2, the apparatus (1) further comprises a central control unit (4) communicating with both the vibrating sound emitters (20) and the eccentric vibration generating devices (3). The central control unit (4) also communicates with a control panel (5), through which the user of the apparatus or an operator can select a vibrational stimulation programme preloaded in a memory of the central control unit. The central control unit (4) is configured to appropriately control each vibrating sound emitter (20) and each eccentric vibration generating device (3) based on the vibration stimulation programme selected by the user or operator.

[0023] Advantageously, each vibrational stimulation programme provides, for each vibrating sound emitter (20) and each eccentric vibration generating device (3), a respective audio channel, which in the case of the vibrating sound emitters is an audio track, in particular at low frequencies (between 2 and 200 Hz, for example), whereas in the case of the eccentric vibration generating devices it is a sequence of sine waves at fixed frequencies (between 20 and 110 Hz, for example). Depending on the selected vibrational stimulation programme, the central control unit (4) drives each vibrating sound emitter (20) directly on the basis of its associated audio track and, in addition, drives each eccentric vibration generat-

ing device (3) from its associated audio track by preliminarily converting the latter into a pulse-width modulation (PWM) by means of an internal algorithm. Using a computer connected to the central control unit (4), new vibrational stimulation programmes can be created and loaded into the memory of the central control unit (4) and/or programmes already loaded into the memory of the central control unit (4) can be modified. The user or operator can thus set the most suitable vibrational stimulation programme depending on the desired effect on the user's body, either by selecting a programme already loaded into the memory of the central control unit (4) or by specially creating a new programme and loading it into the memory of the central control unit (4). The control panel (5) may be mounted on board of the support structure (100) or may be a smart device comprising a software application to allow the user or operator to choose the desired vibrational stimulation programme. Advantageously, the central control unit (4) is mounted below the platform (6) of the support structure (100).

[0024] Advantageously, the central control unit (4) includes a wireless communication module, for example a Bluetooth communication module, to communicate with the control panel (5).

[0025] Each vibrating sound emitter (20) is capable of reproducing the respective audio track (which will typically be different from that associated with each one of the other vibrating sound emitters) received from the central control unit (4) and generating, based on said audio track, a vibration intended to be transmitted to the user's body. The vibrating sound emitters (20) are, in fact, capable of both emitting an audio track and generating a vibration based on said audio track.

[0026] Thanks to the emission of the audio track, it is also possible to generate a beneficial effect on the user's psyche. The vibration generated by the vibrating sound emitters (20) is transmitted from the casing (21), if any, to the user's body.

[0027] Advantageously, each vibrating sound emitter (20) comprises a wireless communication module, for example a Bluetooth communication module, in communication with the wireless communication module of the central control unit (4). In this way, the central control unit (4) communicates in wireless mode with all the vibrating sound emitters (20). Advantageously, the central control unit (4) is configured to determine the volume of each of the vibrating sound emitters (20) based on the selected vibrational stimulation programme.

[0028] Each eccentric vibration generating device (3) is designed to generate a mechanical vibration at a given frequency, based on the command received from the central control unit (4), intended to be transmitted to the user's body.

[0029] Each eccentric vibration generating device (3) comprises a casing (34) housing an electric motor (30) and an eccentric mass keyed to a shaft of the electric motor (30) so that, due to the rotation of the shaft, the eccentric mass generates a mechanical vibration which is transmitted to the casing (34) and, consequently, to the body of the user on which the eccentric vibration generating device (3) is arranged. Each eccentric vibration generating device (3) may be provided with a band, in particular made of neoprene, to enable this device to be adhered to the user's body in the desired position and to prevent this device from moving during use.

[0030] As mentioned above, the central control unit (4) drives each eccentric vibration generating device (3) on the basis of its associated audio track, namely by preliminarily converting this audio track into a pulse-width modulation (PWM) by means of an internal algorithm. The electric motor (30) of each eccentric vibration generating device (3) is thus caused to rotate at a certain number of revolutions per minute corresponding to the frequency of the audio track (which, as mentioned, in the case of the eccentric vibration generating devices is a sequence of fixed-frequency sine waves) associated with said device. Advantageously, the vibrational stimulation programmes loaded into the memory of the central control unit (4) provide for sending a different vibration command to each eccentric vibration generating device (3), depending on the position of the eccentric vibration generating device (3) on the user's body and depending on the desired beneficial effect to be obtained.

[0031] It is, however, possible to operate the vibrating sound emitters (20) and the eccentric vibration generating devices (3) on the basis of an audio track supplied by the user to the central control unit (4), for example via an appropriate input port provided in the control panel (5). In this case, the central control unit (4) will appropriately drive the vibrating sound emitters (20) and the eccentric vibration generating devices (3) based on the audio track provided by the user.

[0032] It is also possible for the user to manually control one or more of the vibrating sound emitters (20) and the eccentric vibration generating devices (3), for example by directly setting the number of revolutions of the electric motors (30) of one or more of the eccentric vibration generating devices (3) depending on the stimulation effect to be achieved.

[0033] Each eccentric vibration generating device (3) may be connected to the central control unit (4) via cables (33). Alternatively, each eccentric vibration generating device (3) may comprise a wireless communication module, for example a Bluetooth communication module, so as to communicate with the wireless communication module of the central control unit (4) for transmitting the vibration command.

[0034] Preferably, each eccentric vibration generating device (3) includes a rechargeable battery (32) for supplying power to the electric motor (30).

[0035] In the example of Fig. 2, the apparatus (1) comprises two vibrating sound emitters (20) and seven eccentric vibration generating devices (3). In addition, according to this embodiment, the apparatus (1) further comprises two loudspeakers (36), left and right respectively, which are also connected independently of each

other to the central control unit (4). In this case, therefore, eleven audio channels will be provided, for each of which the vibrational stimulation programme currently selected will provide for the transmission of a given audio track.

[0036] As shown in the table of Fig. 3, where the two channels associated with the two loudspeakers (36) are indicated by the numbers 1 and 2, respectively, the channels associated with the two vibrating sound emitters (20) are indicated by the numbers 3 and 4, respectively, and the channels associated with the seven eccentric vibration generating devices (3) are indicated by the numbers 5, 6, 7, 8, 9, 10 and 11, respectively, channels 1 and 2 each contain a respective audio track in an extended frequency range (e.g. from 20 to 20.000 Hz), channels 3 and 4 each contain a respective low-frequency audio track (e.g. from 2 to 200 Hz), and channels 5 to 11 each contain a sequence of sine waves with a respective fixed frequency, e.g. from 20 to 110 Hz. In this way, the two loudspeakers (36) will reproduce the audio tracks corresponding to channels 1 and 2, respectively, the two vibrating sound emitters (20) will reproduce the audio tracks corresponding to channels 3 and 4 and at the same time generate corresponding sound vibrations, while the electric motors of the eccentric vibration generating devices (3) will be driven to rotate at a respective number of revolutions per minute corresponding to the frequency of the sine-wave sequence of the respective channel 5 to 11.

[0037] As is evident from the above description, the apparatus according to the invention makes it possible to obtain a beneficial effect on both the body and the psyche of the user. In fact, thanks to the eccentric vibration generating devices it is possible to obtain a beneficial effect due to the vibrational stimulation imparted to the various points of the user's body where such devices are positioned. Thanks to the vibrating sound emitters it is possible to emit an audio track during a therapy session, allowing the user to obtain beneficial psychological effects from listening to the audio track. In addition, the vibrating sound emitters also generate a vibration from the audio track, which is transmitted to the user's body, amplifying the beneficial effect of listening to the audio track on the user's psyche.

[0038] The eccentric vibration generating devices (3) and the vibrating sound emitters (20) may be positioned at different points on the user's body. Depending on the position of these devices and depending on the audio track and the vibration commands that are set, different beneficial effects can be achieved on the user's body and psyche. For example, it is possible to generate a calming effect, help the user meditate, improve circulation and breathing, cool down the body and relax the user's mind after a workout, or help the user during a workout or warm-up.

[0039] In particular, the eccentric vibration generating devices (3) are preferably positioned on the pelvis and peripheral parts of the user's body, while the vibrating sound emitters (20) are preferably positioned on the central part of the user's body. As mentioned, it is however possible to vary the position of both the eccentric vibration generating devices (3) and the vibrating sound emitters (20) according to specific requirements.

[0040] The apparatus may further comprise sensors capable of detecting a number of physiological parameters of the user and transmitting to the central control unit (4) signals representative of the detected values of such physiological parameters. Based on the detected values of such physiological parameters, the central control unit (4) determines appropriate commands for driving the eccentric vibration generating devices (3) and the vibrating sound emitters (20). In this manner, therefore, the user receives vibrational and sound stimulation whose frequency varies according to the physiological parameters read by the sensors. The physiological parameters read can be the heart rate variability (HRV), the blood pressure, the electrical activity of the brain, the respiratory rate, the blood oxygenation, etc. The vibrational stimulations applied to the user's body by the apparatus can change the detected physiological parameters, in particular, they can influence the heart rate, the nervous system, the blood pressure, the body temperature, the blood oxygenation, the respiration, etc.

[0041] The above-described apparatus can be part of a broader sensory stimulation system, which in addition to generating vibrational and sound stimulation by means of the eccentric vibration generating devices (3) and the vibrating sound emitters (20), uses a 3D visor for virtual reality and/or augmented reality to deliver videos or colours in rhythmic coordination with the music, and/or infrared light emitters to perform photobiomodulation treatments, and/or phototonic neurostimulators with stroboscopic lamps for therapeutic purposes, and/or electromagnetic radiation emitters.

[0042] The present invention has been described herein with reference to some embodiments thereof. It is to be understood that other embodiments may be envisaged, which share with those described herein the same inventive core, as defined in the following claims. For example, although the apparatus of the present invention has been described and illustrated herein in the condition of installation on a support structure resting on the floor, such as a massage table, it can also be mounted on a suspended support structure, with the aid of ropes or hanging fabrics. Apart from that, the above description still applies, including the possibility of using sensors and the possibility of integrating the apparatus into a broader sensory stimulation system.

Claims

1. Apparatus (1) for generating vibrational stimuli on the body of a user, the apparatus (1) comprising:

   - a first vibrational stimulation unit (2) with one or more vibrating sound emitters (20) capable

of reproducing an audio track and generating vibrations based on said audio track;
- a second vibrational stimulation unit with one or more eccentric vibration generating devices (3), each comprising a casing (34), an electric motor (30) accommodated in the casing (34), and an eccentric mass arranged to be driven into rotation by the electric motor (30) so as to generate a mechanical vibration that is transmitted to the casing (34) and, consequently, to the part of the user's body in contact with the eccentric vibration generating device (3);
- a central control unit (4) communicating with said vibrating sound emitter(s) (20) and with said eccentric vibration generating device(s) (3) and configured to drive the electric motor (30) of each eccentric vibration generating device (3) to generate vibrations at a given frequency and to drive each vibrating sound emitter (20) based on said audio track.

2. Apparatus according to claim 1, wherein the central control unit (4) is configured to implement at least one vibrational stimulation programme comprising, for each vibrating sound emitter (20) and for each eccentric vibration generating device (3), a respective audio channel, which for each vibrating sound emitter (20) is an audio track while for each eccentric vibration generating device (3) is a sequence of sine waves at fixed frequencies, and wherein, depending on the vibrational stimulation programme to be implemented, the central control unit (4) is configured to drive each vibrating sound emitter (20) directly based on the audio track associated therewith and to drive each eccentric vibration generating device (3) by rotating the respective electric motor (30) at a number of revolutions per minute corresponding to the frequency of the sequence of sine waves associated with said device (3).

3. Apparatus according to claim 2, wherein the central control unit (4) is configured to drive the electric motor (30) of each eccentric vibration generating device (3) by converting the audio track associated therewith into pulse-width modulation.

4. Apparatus according to claim 2 or claim 3, further comprising at least one loudspeaker (36) connected to the central control unit (4) so as to be driven by it to play a given audio track based on the selected vibrational stimulation programme.

5. Apparatus according to any one of the preceding claims, further comprising a plurality of sensors capable of detecting physiological parameters of the user and transmitting to the central control unit (4) signals representative of the detected values of said physiological parameters, wherein the central control unit (4) is configured to determine, based on the signals received from said plurality of sensors, appropriate commands for driving each eccentric vibration generating device (3) and each vibrating sound emitter (20).

6. Apparatus according to claim 5, wherein said plurality of sensors comprises sensors capable of detecting at least one of the following parameters: heart rate variability (HRV), blood pressure, electrical activity of the brain, respiratory rate, and blood oxygenation.

7. Sensory stimulation system comprising an apparatus (1) according to any one of the preceding claims, and one or more of the following devices: a 3D viewer for virtual and/or augmented reality, an infrared light emitter for performing photobiomodulation treatments, a phototonic neurostimulator device with stroboscopic lamps for therapeutic purposes, and an electromagnetic radiation emitter.

8. Support structure (100) comprising a platform (6) intended to support a user, a support frame (7) connected to the bottom of said platform (6) and intended to rest on the ground to support said platform (6), and an apparatus (1) according to any one of claims 1 to 6 for generating vibrational stimuli on the body of the user lying on said platform (6).

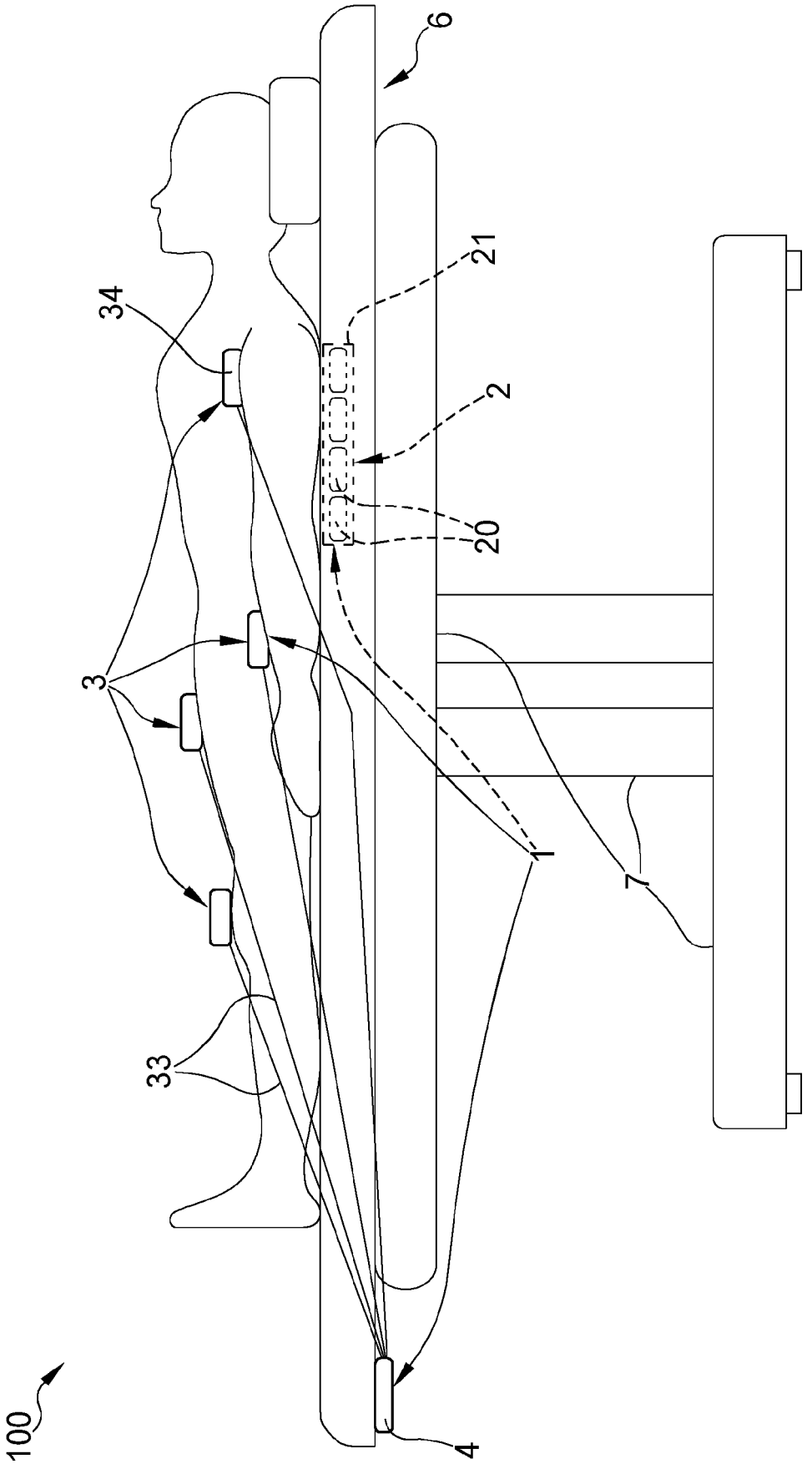


FIG.1

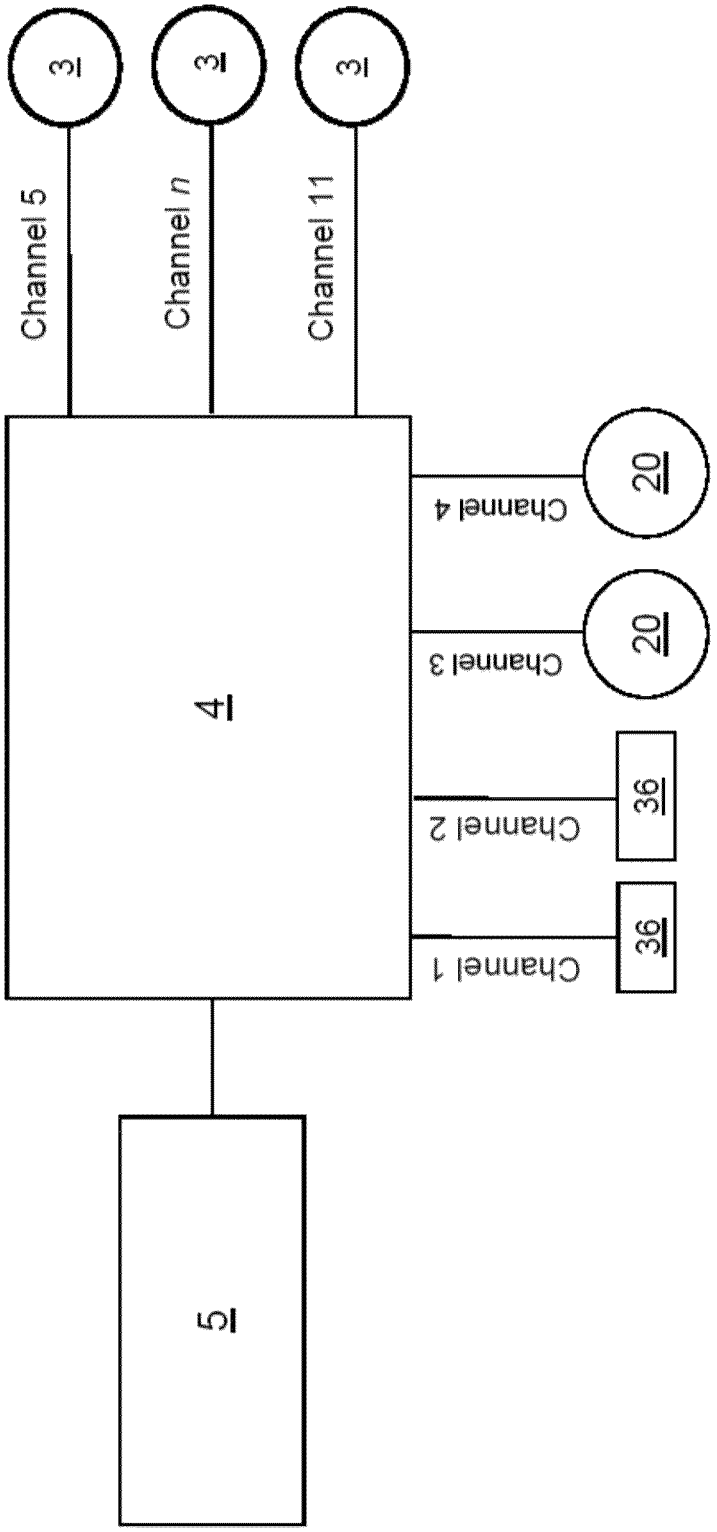

3
3
3
Channel 5
Channel n
Channel 11
4
Channel 4
20
Channel 3
20
Channel 2
36
Channel 1
36
5

FIG.2

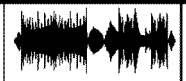
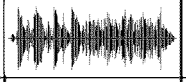
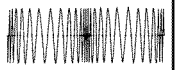
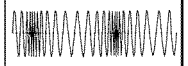
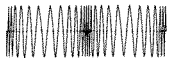
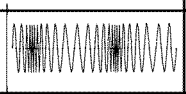
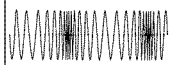
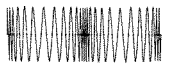
CHANNEL		CHANNEL CONTENT IN EDITING FORMAT	PILOTED TRANSDUCER
1		Music track extended range (20/20.000 Hz)	Speaker R
2		Music track extended range (20/20.000 Hz)	Speaker L
3		**Music track low frequencies (2/200 Hz)**	**Bass Shaker 1**
4		**Music track low frequencies (2/200 Hz)**	**Bass Shaker 2**
5		Sine wave sequences at fixed frequences (20/110 Hz)	Motor 1
6		Sine wave sequences at fixed frequences (20/110 Hz)	Motor 2
7		Sine wave sequences at fixed frequences (20/110 Hz)	Motor 3
8		Sine wave sequences at fixed frequences (20/110 Hz)	Motor 4
9		Sine wave sequences at fixed frequences (20/110 Hz)	Motor 5
10		Sine wave sequences at fixed frequences (20/110 Hz)	Motor 6
11		Sine wave sequences at fixed frequences (20/110 Hz)	Motor 7

FIG.3

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Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 17 4951

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2022/117837 A1 (NORTHEN MICHAEL [US] ET AL) 21 April 2022 (2022-04-21) * paragraph [0014] * * paragraph [0016] * * paragraph [0087] - paragraph [0088] * * paragraph [0091] * * paragraph [0133] * * paragraph [0201] * * paragraph [0218] * * paragraph [0223] * * paragraph [0251] * -----	1-8	INV. A61H23/02 A61H1/00
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	6 October 2024	Squeri, Michele

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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