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(54) **BODY MOVEMENT FEEDBACK SYSTEM AND METHOD**

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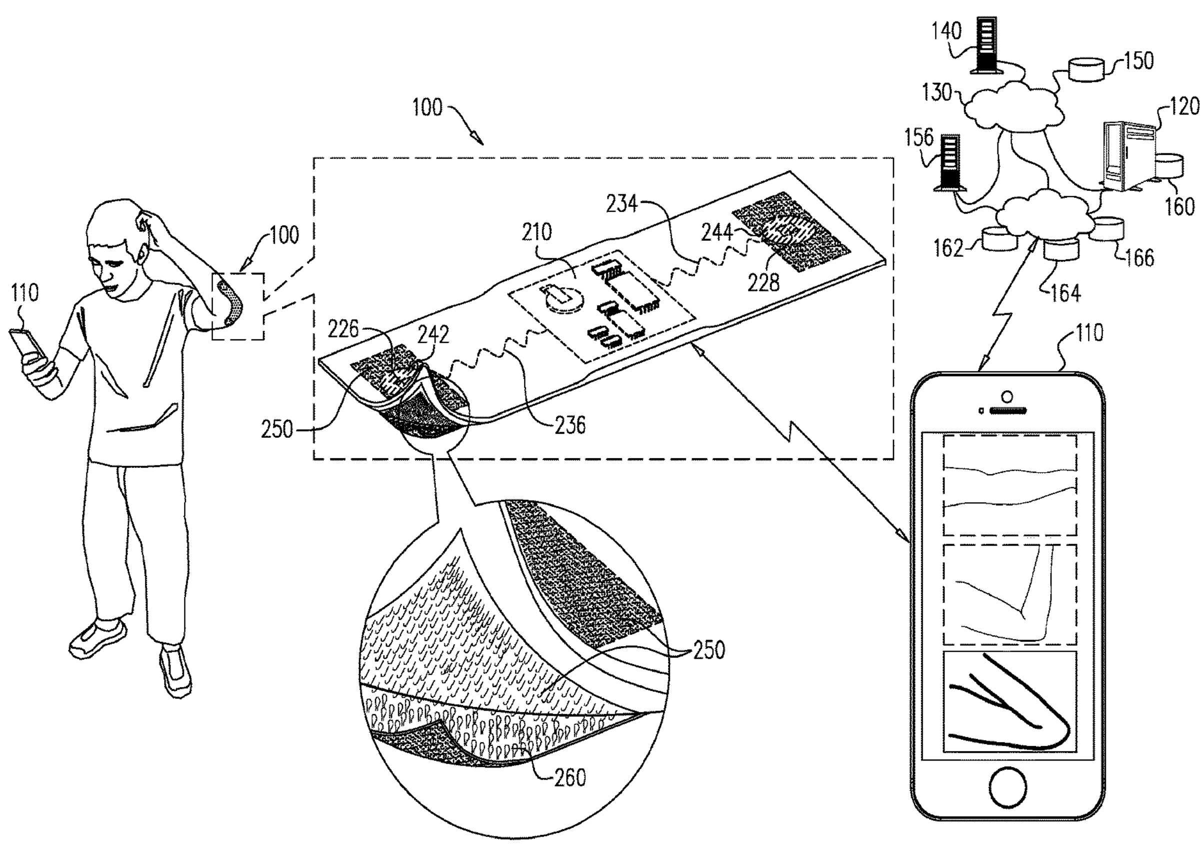
(57) **ABSTRACT**

A body movement feedback system including at least one position sensor operative to sense at least relative positions of mutually articulated body portions of a user in real time and providing sensor outputs, a mutually articulated body portion position processor, receiving the sensor outputs of the at least one position sensor and providing processor outputs representing relative movements of the mutually articulated body portions and a real time user feedback generator operative to generate predetermined feedback to the user in response to predetermined selected movements of the mutually articulated body portions.



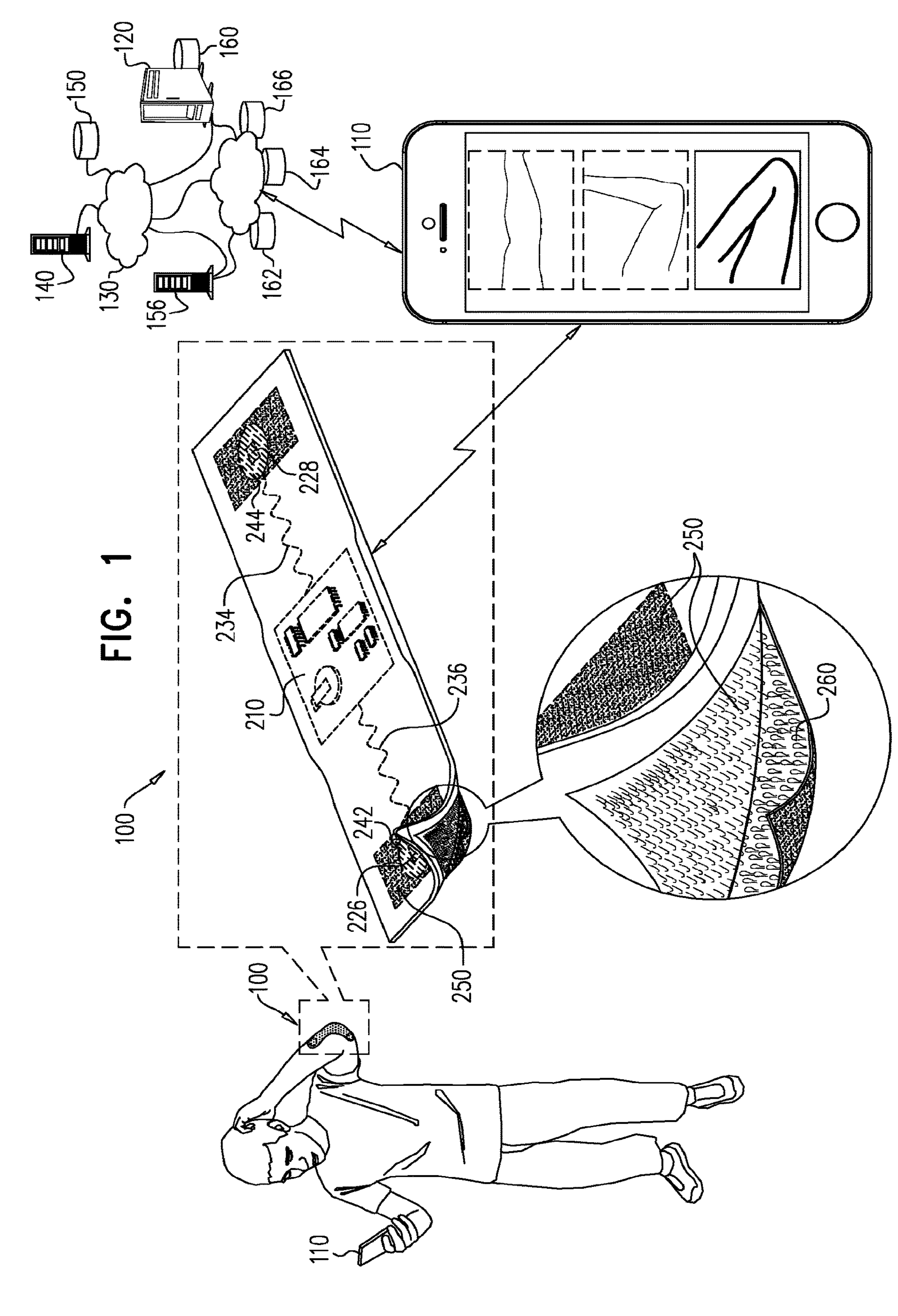


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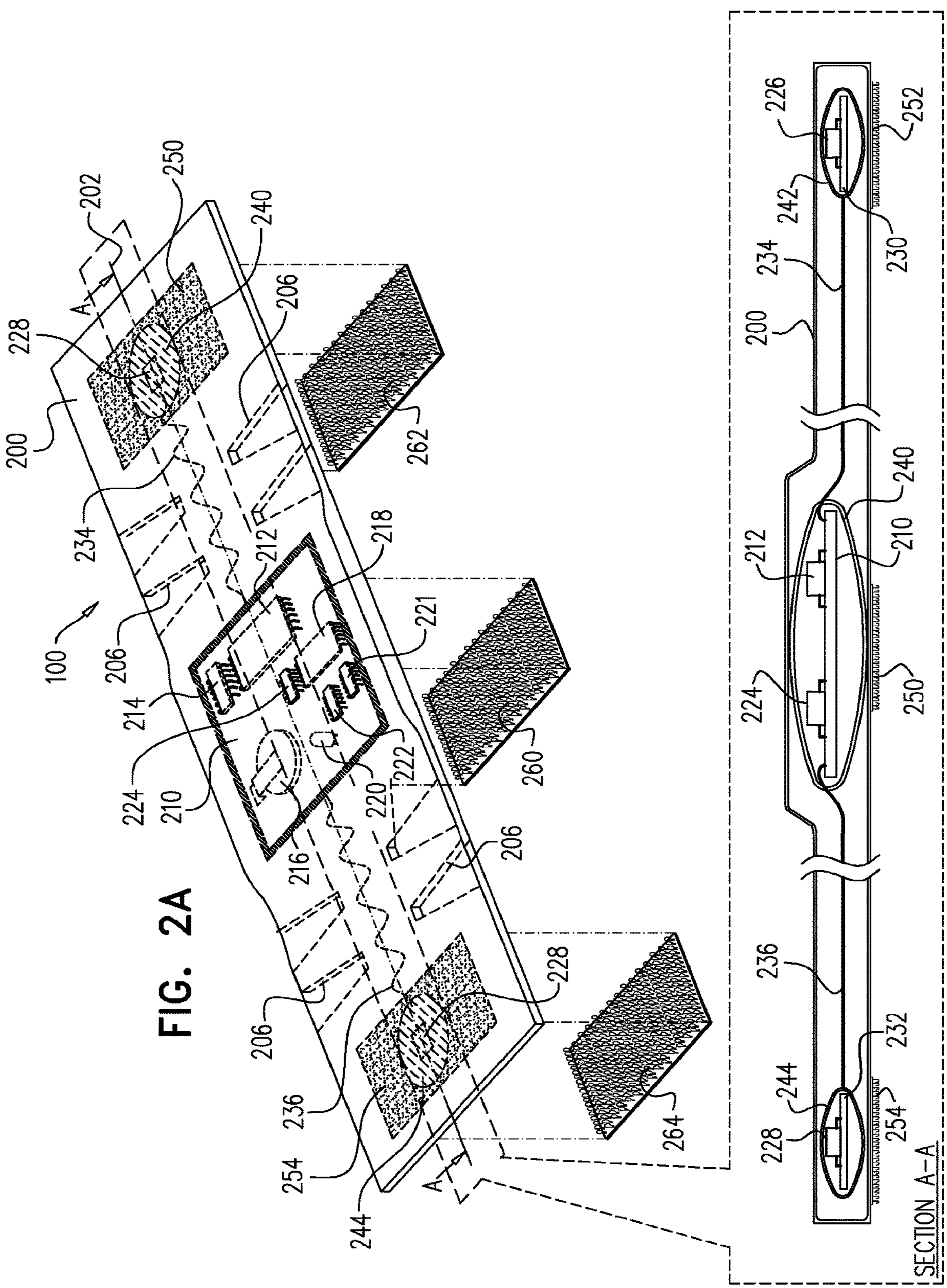
FIG. 1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SECTION A–A
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252

FIG. 2A

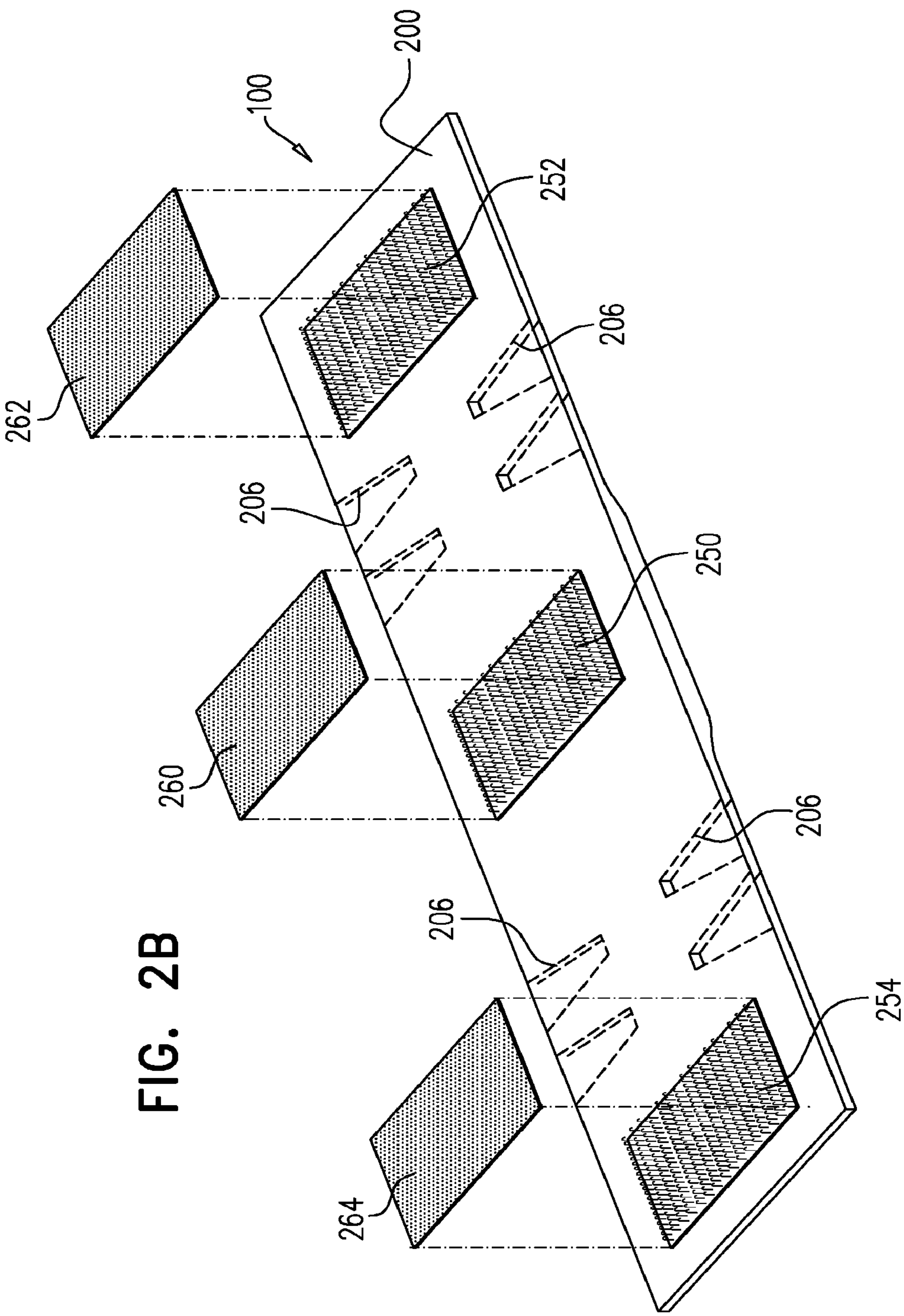
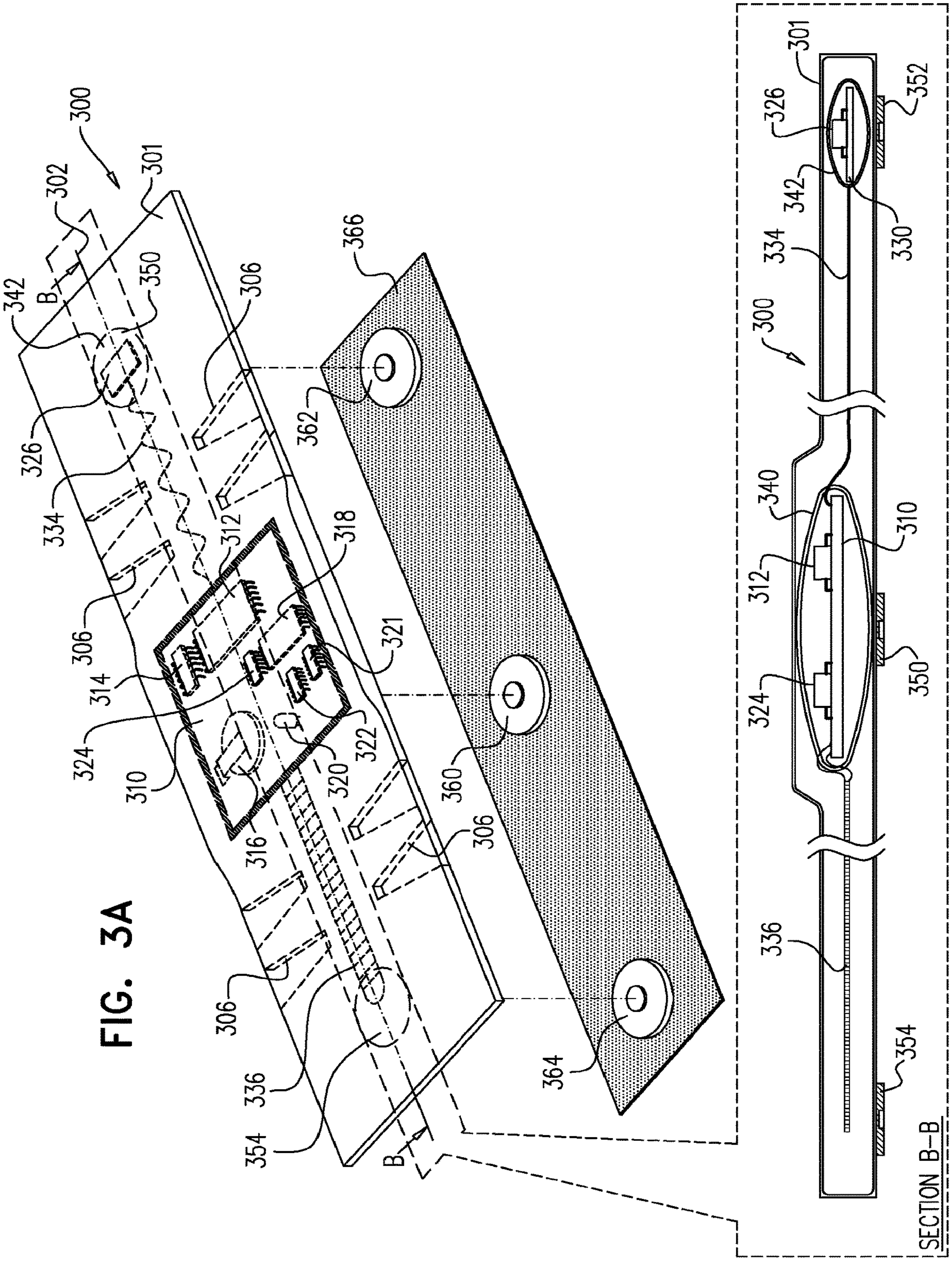


FIG. 2B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336
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SECTION B–B

FIG. 3A

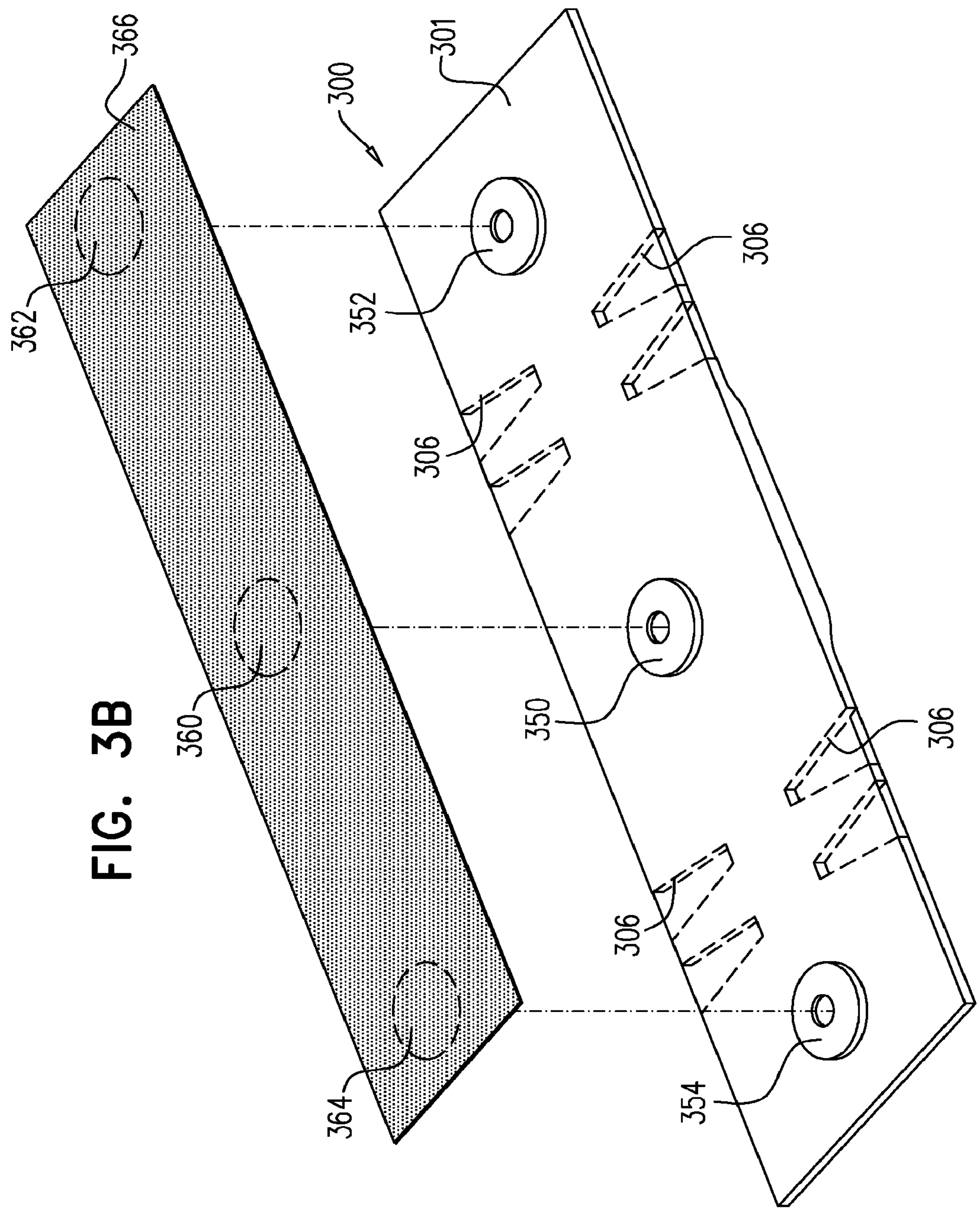
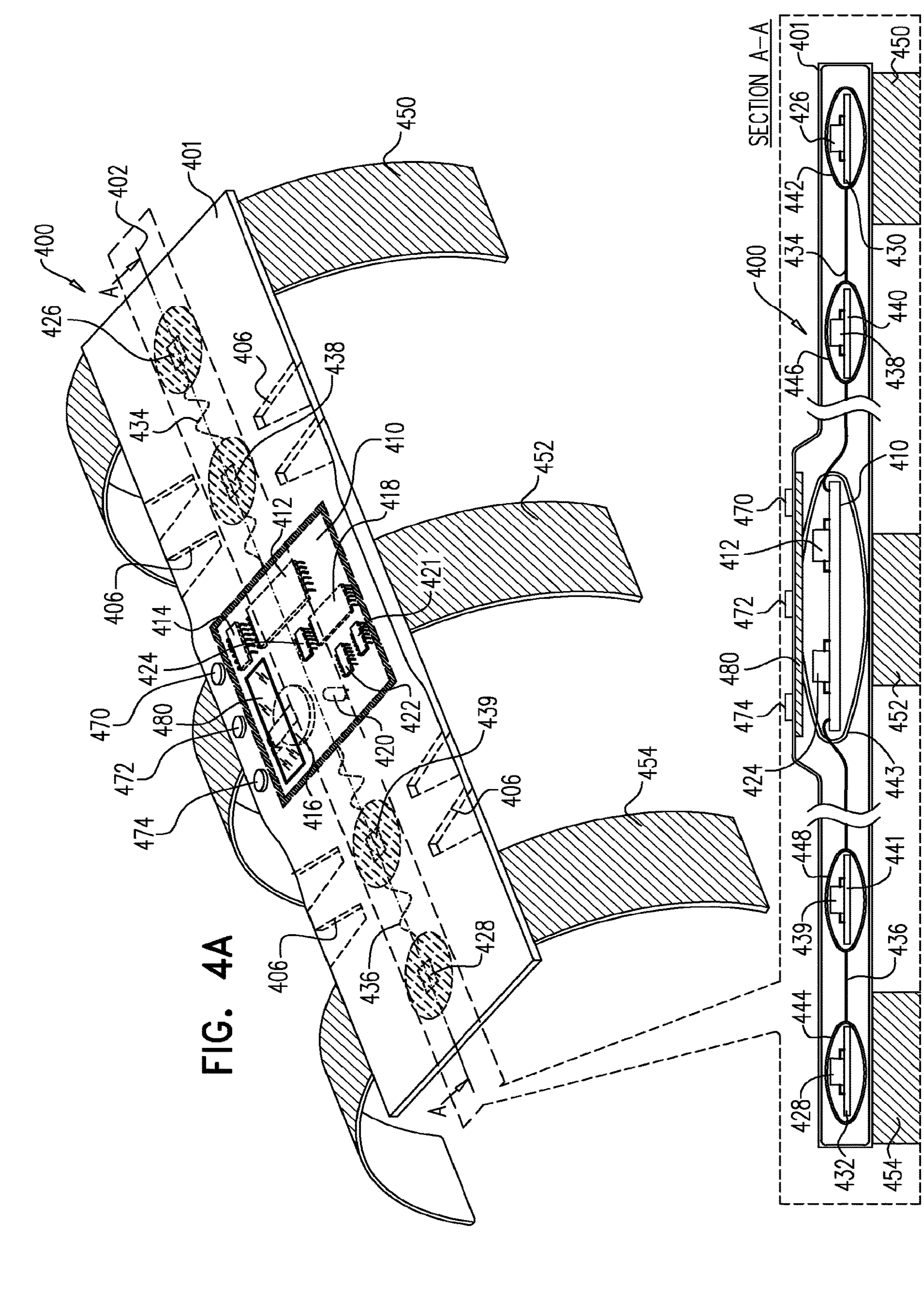


FIG. 3B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SECTION A–A
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FIG. 4A

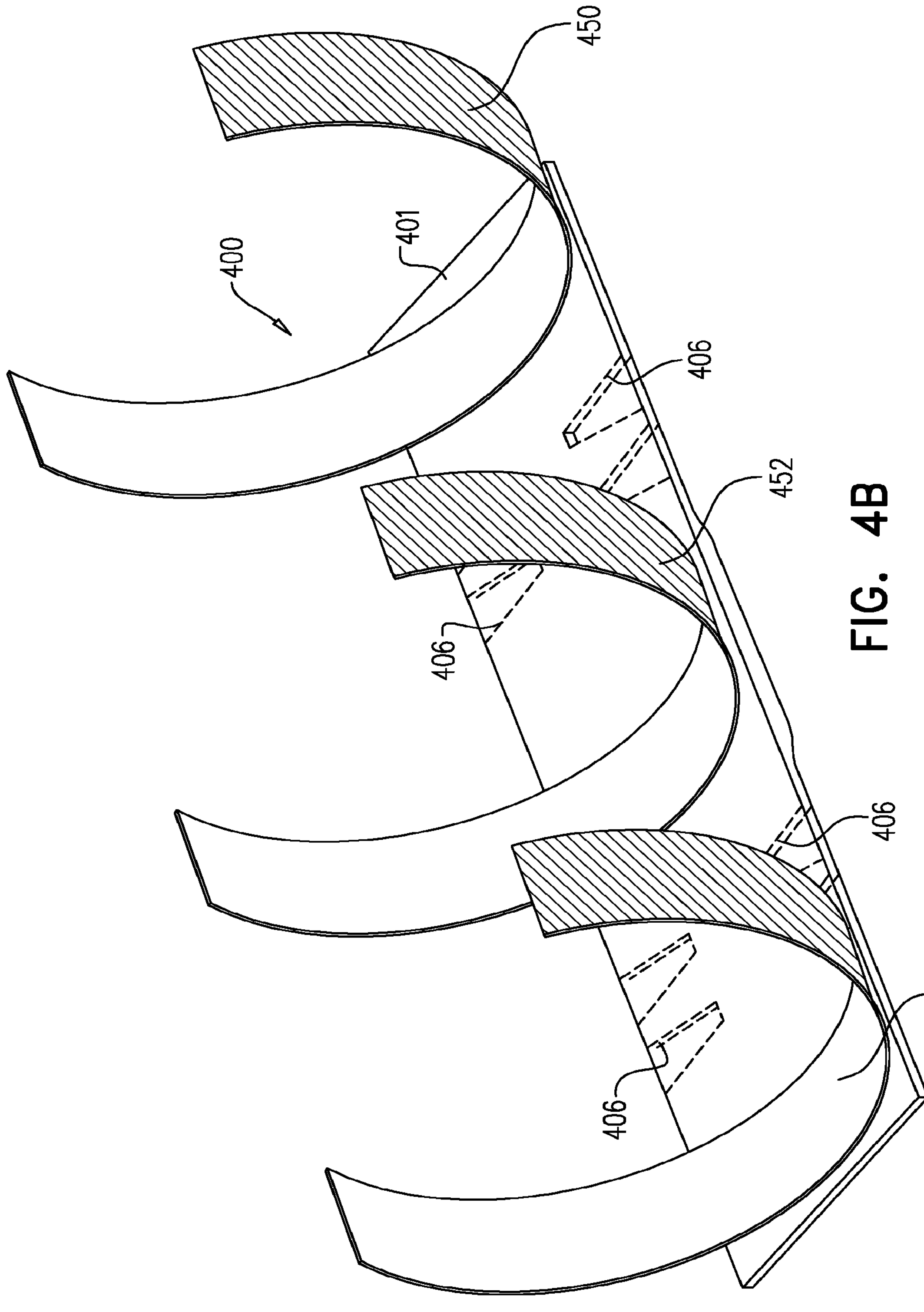


FIG. 4B

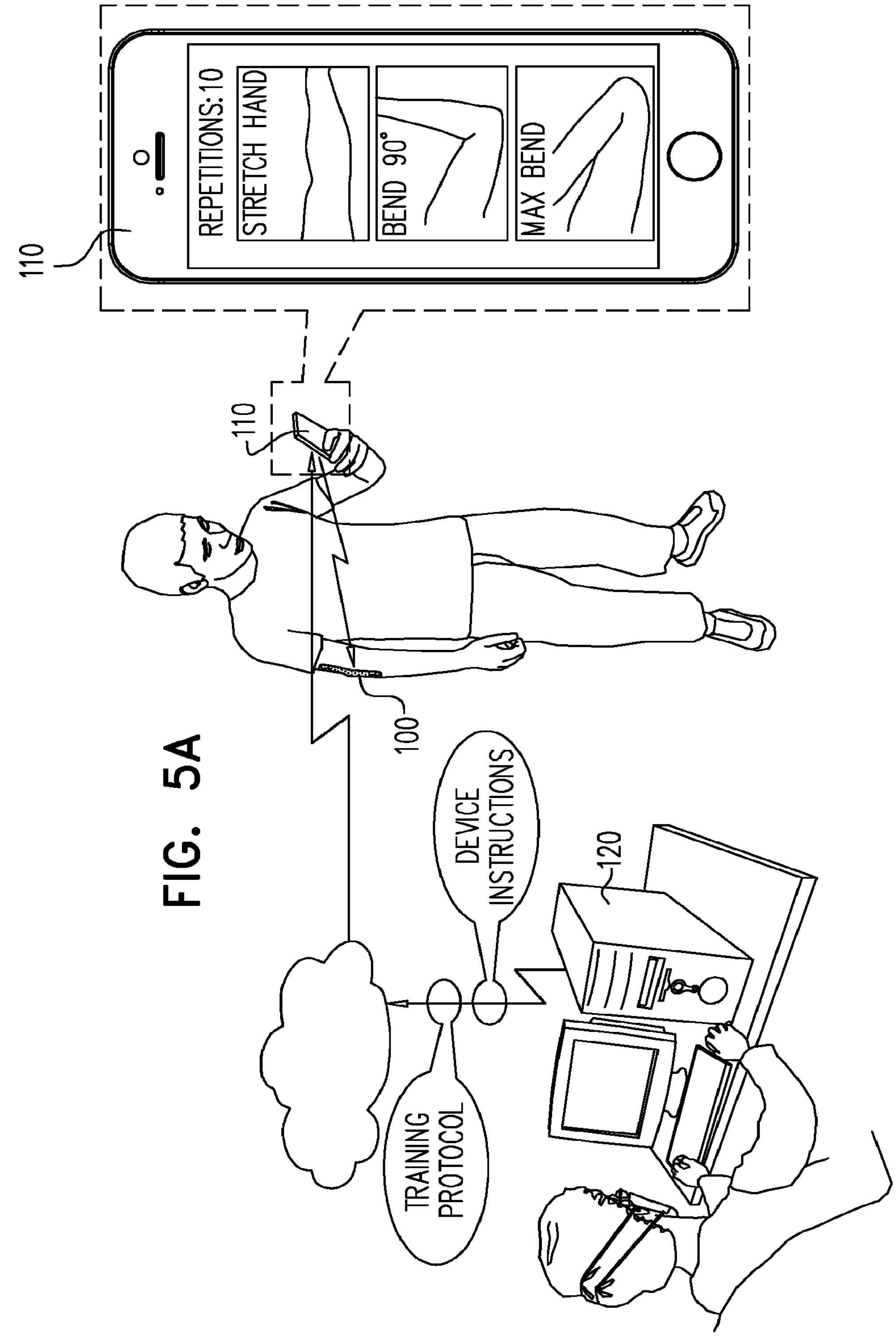
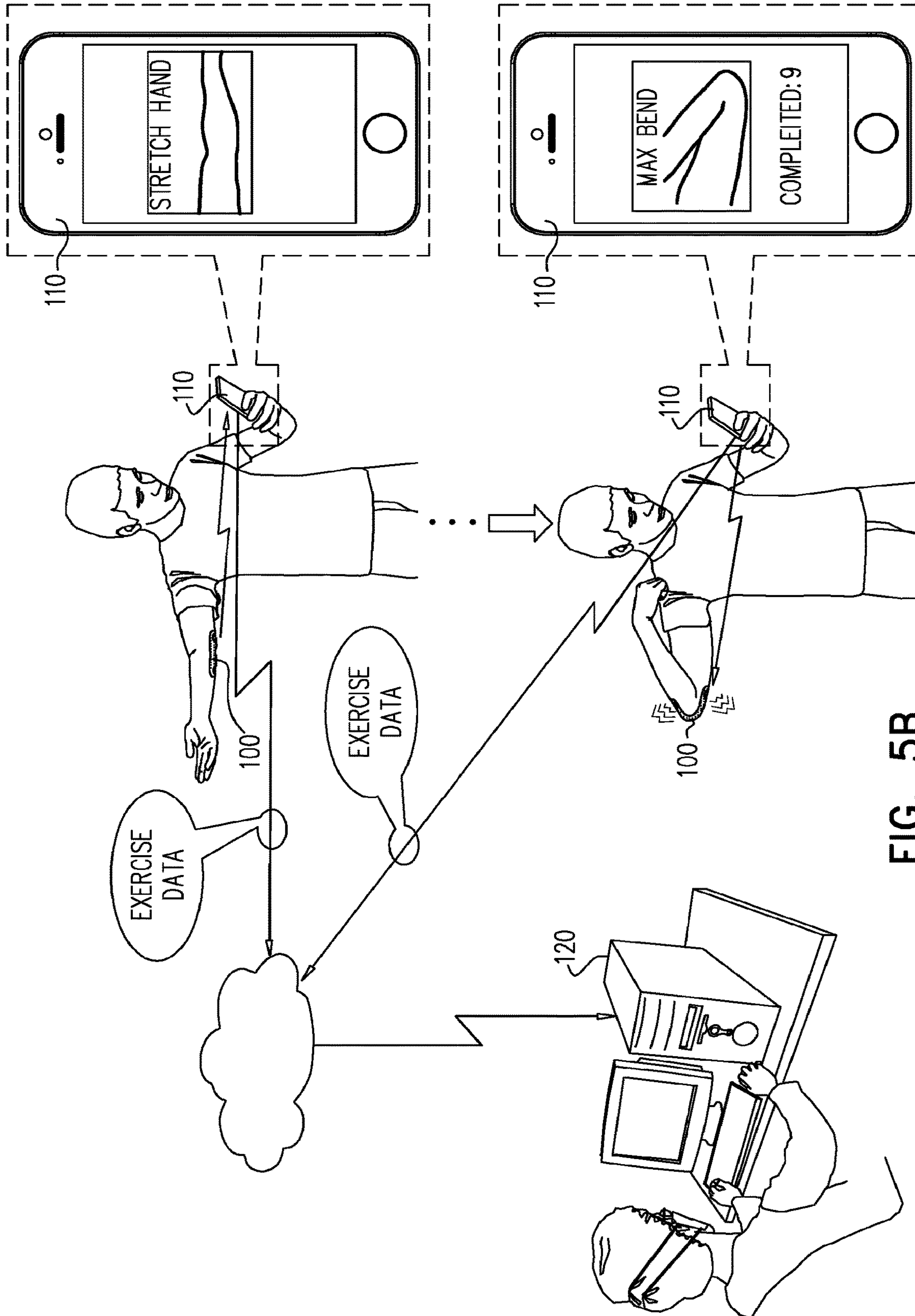

110
REPETITIONS:10
STRETCH HAND
BEND 90°
MAX BEND
110
100
DEVICE INSTRUCTIONS
120
TRAINING PROTOCOL

FIG. 5A



110
STRETCH HAND
110
MAX BEND
COMPLEITED: 9
110
110
100
100
EXERCISE DATA
EXERCISE DATA
120

FIG. 5B

FIG. 6A

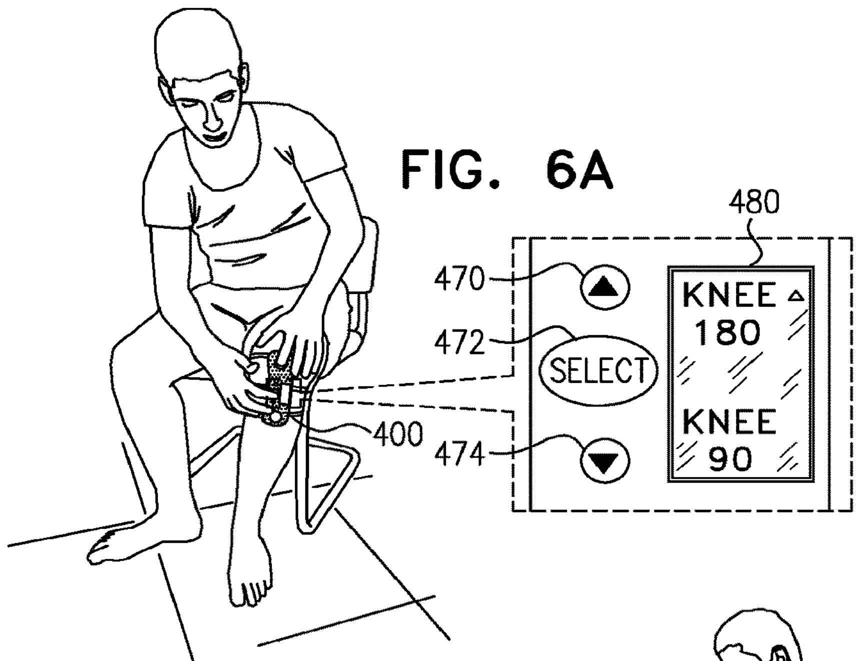


FIG. 6B

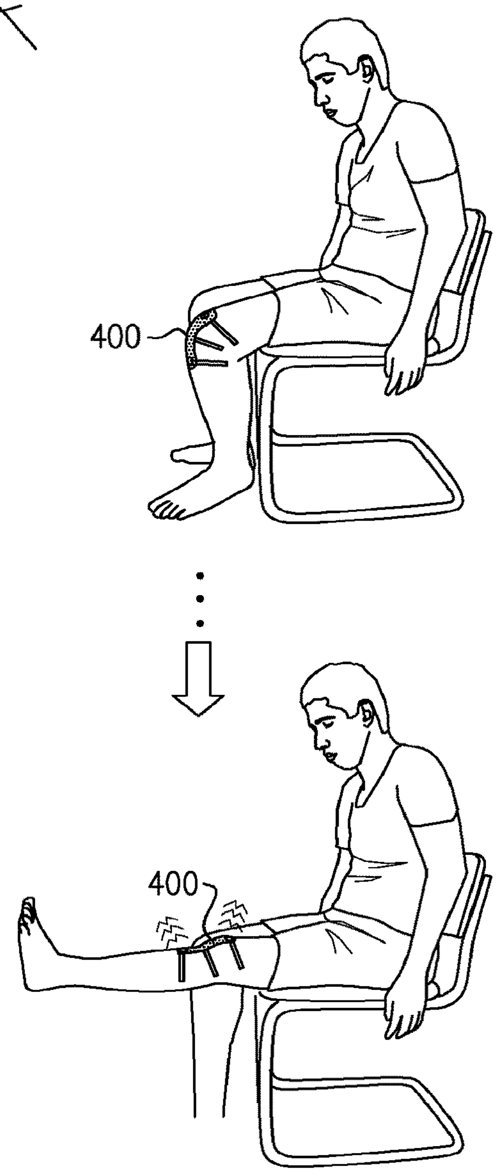


FIG. 7A

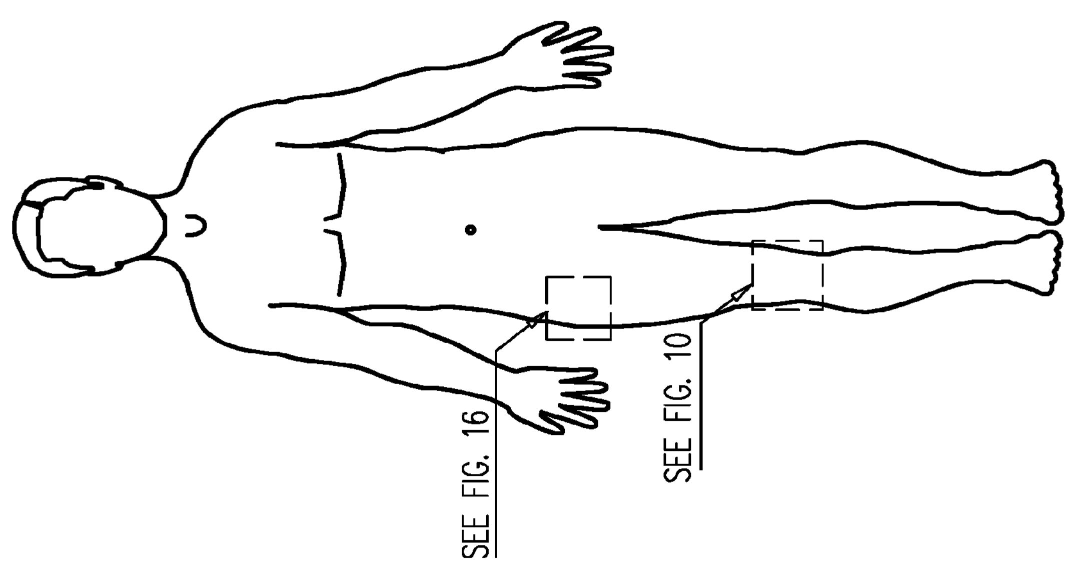
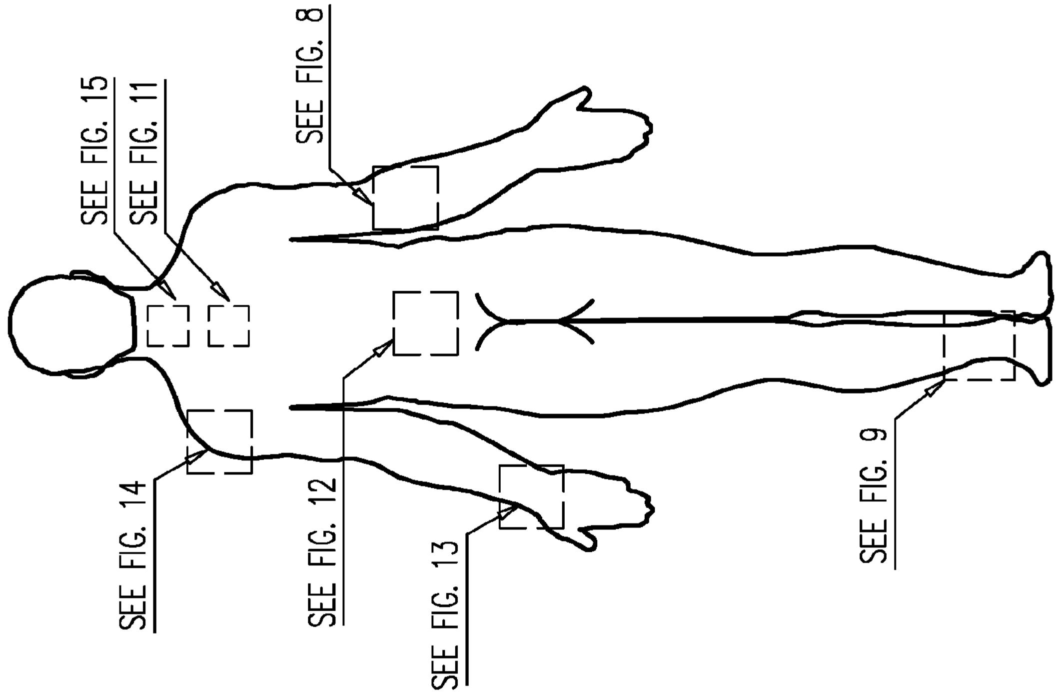

SEE FIG. 16
SEE FIG. 10

FIG. 7B


SEE FIG. 15
SEE FIG. 11
SEE FIG. 8
SEE FIG. 14
SEE FIG. 12
SEE FIG. 13
SEE FIG. 9

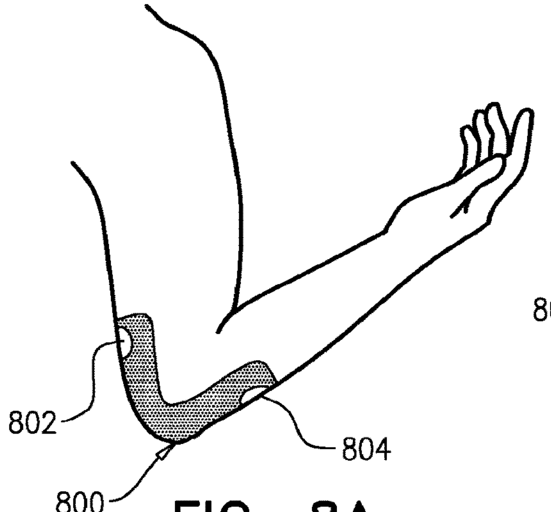


FIG. 8A

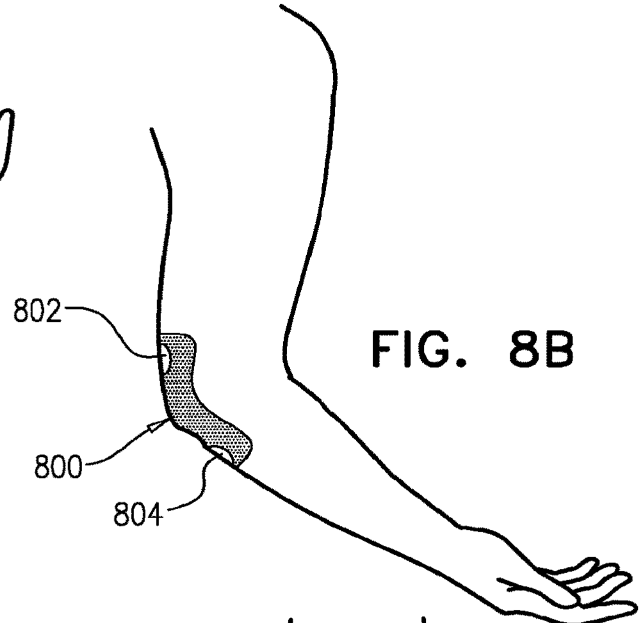


FIG. 8B

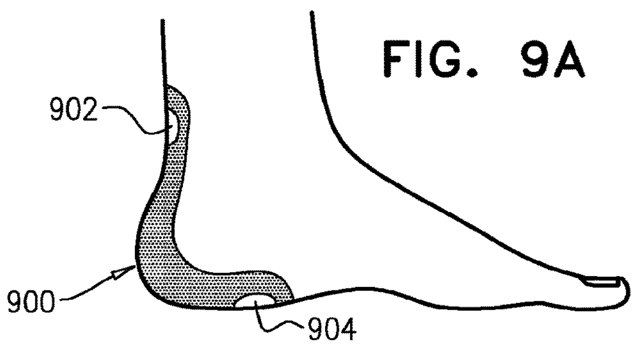


FIG. 9A

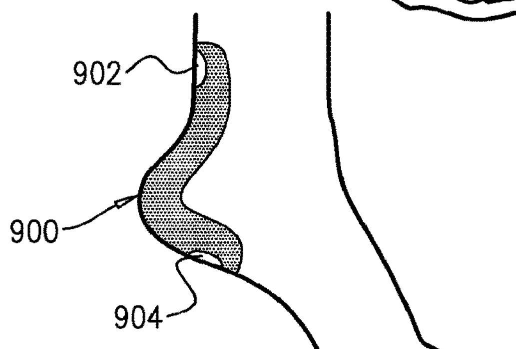


FIG. 9B

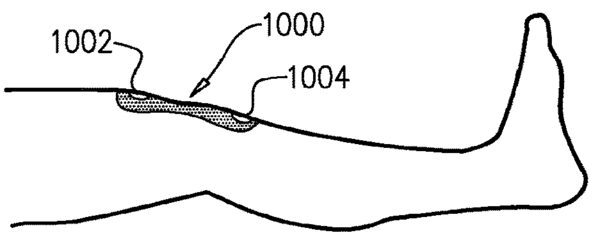


FIG. 10A

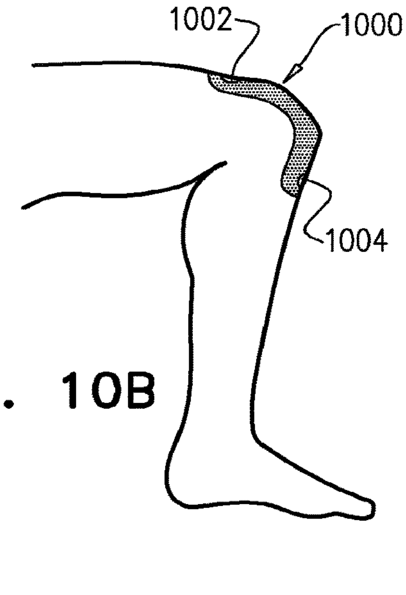


FIG. 10B

FIG. 11A

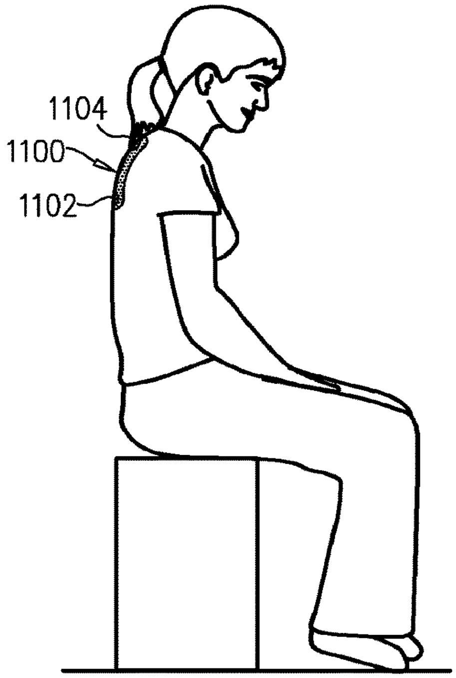


FIG. 11B

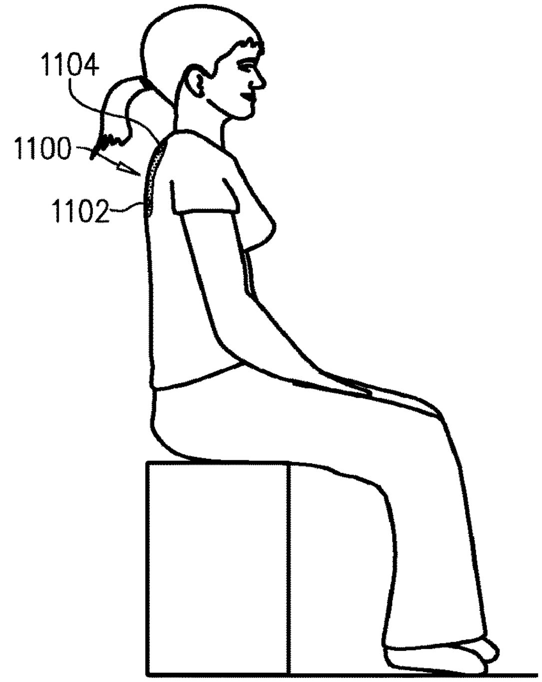


FIG. 12A

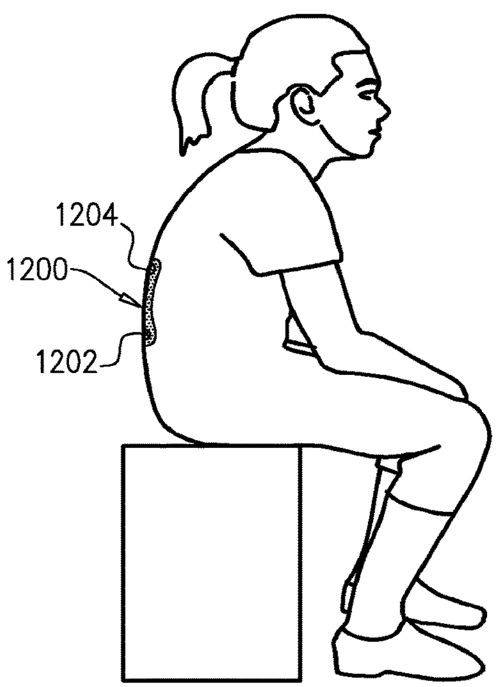
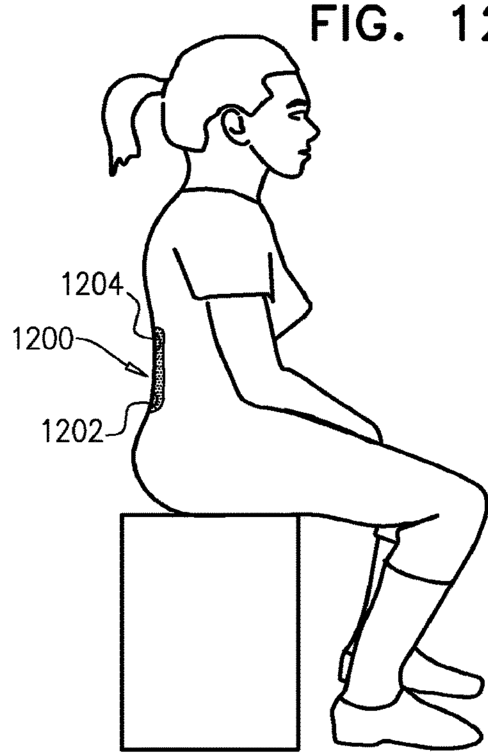


FIG. 12B



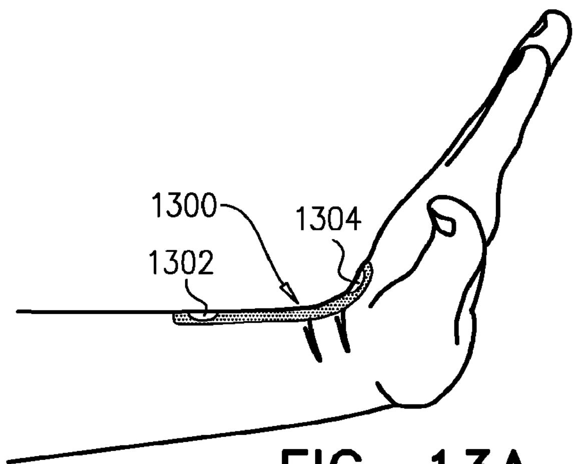


FIG. 13A

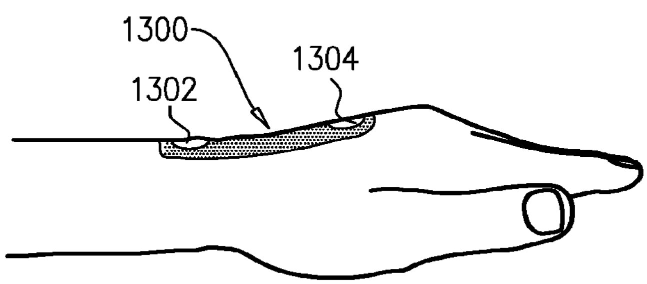


FIG. 13B

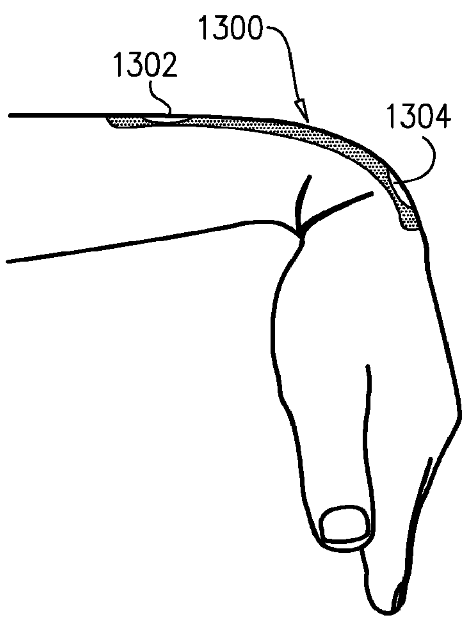


FIG. 13C

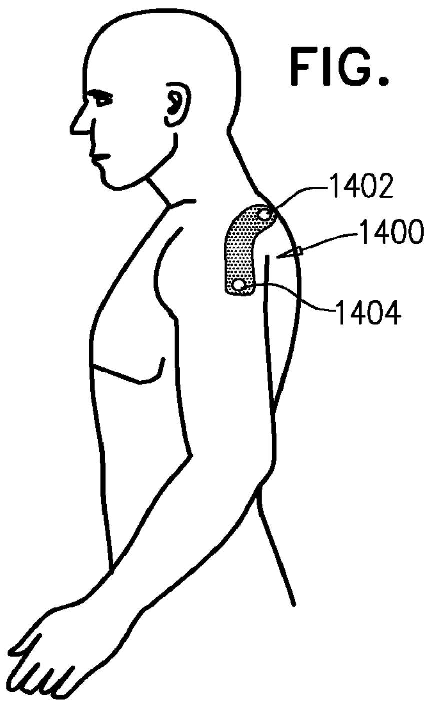


FIG. 14A

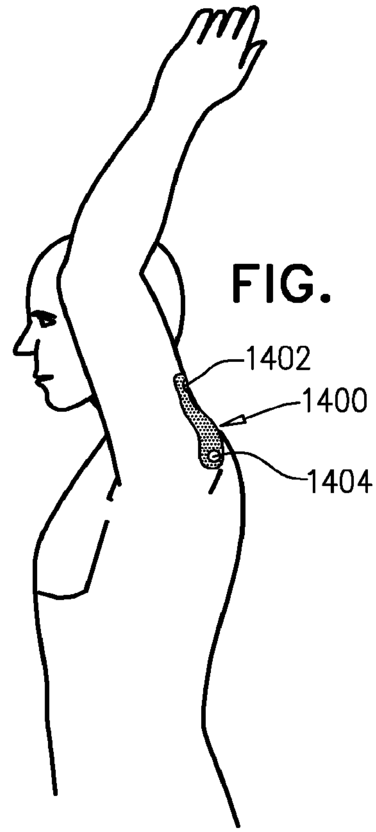


FIG. 14B

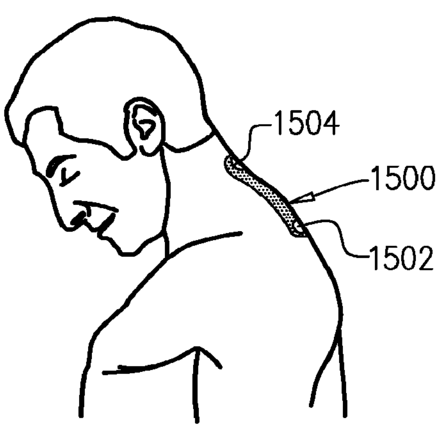


FIG. 15A

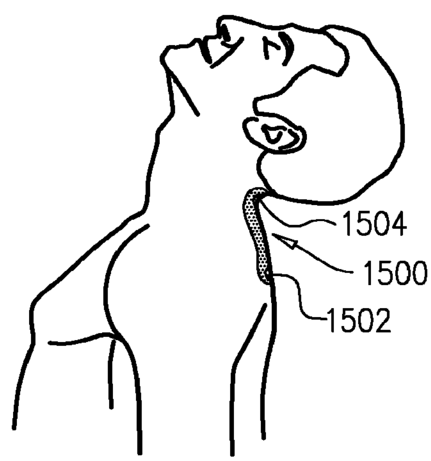


FIG. 15B

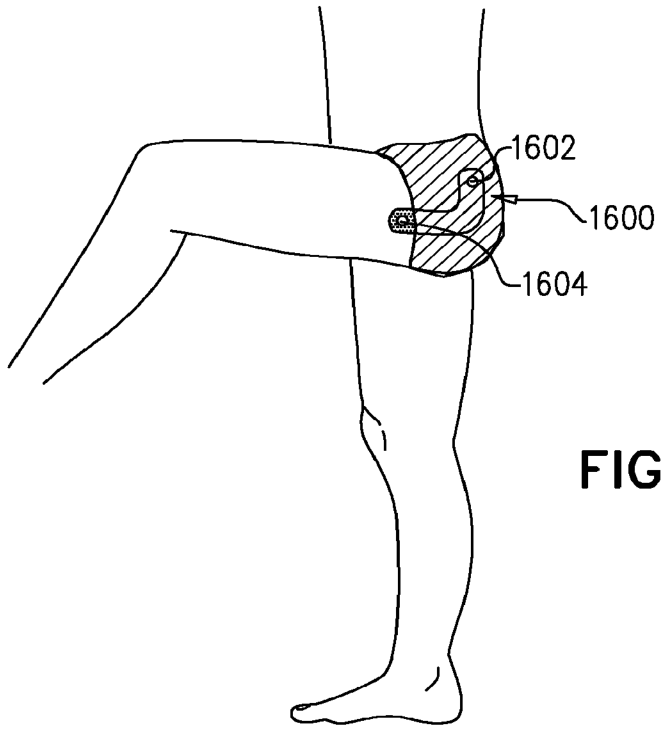


FIG. 16A

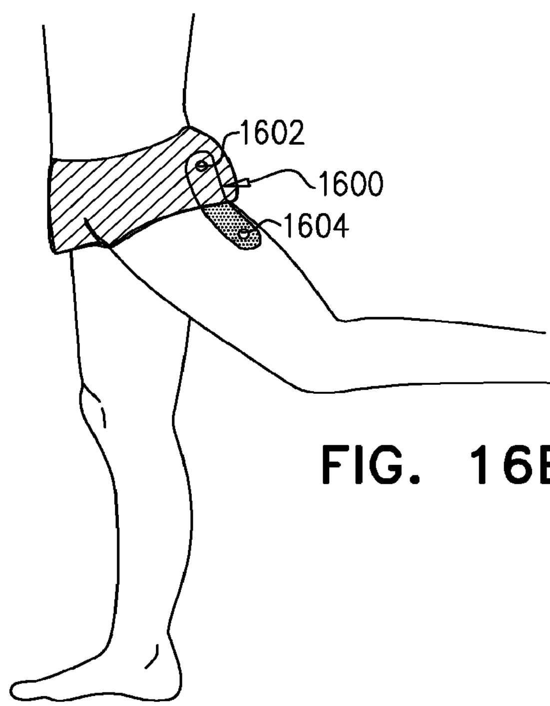


FIG. 16B

BODY MOVEMENT FEEDBACK SYSTEM AND METHOD

REFERENCE TO RELATED APPLICATIONS

[0001] Reference is hereby made to U.S. Provisional Patent Application Ser. No. 62/201,914, filed Aug. 6, 2015, entitled: BODY POSITION ASSESSMENT AND TRAINING DEVICE AND MANAGEMENT SYSTEM, the disclosure of which is hereby incorporated by reference and priority of which is hereby claimed pursuant to 37 CFR 1.78(a).

[0002] Reference is also hereby made to PCT Application No. PCT/IB2014/059041, filed Feb. 17, 2014, and entitled POSTURE DETECTION DEVICE, published Aug. 21, 2014 as PCT Published Patent Application WO 2014/125448 A1, the description of which is hereby incorporated by reference.

FIELD OF THE INVENTION

[0003] The present invention relates to body motion training systems and methodologies.

BACKGROUND OF THE INVENTION

[0004] There exist various systems and devices for body motion training.

SUMMARY OF THE INVENTION

[0005] The present invention seeks to provide improved systems and devices for body motion training.

[0006] There is thus provided in accordance with a preferred embodiment of the present invention a body movement feedback system including at least one position sensor operative to sense at least relative positions of mutually articulated body portions of a user in real time and providing sensor outputs, a mutually articulated body portion position processor, receiving the sensor outputs of the at least one position sensor and providing processor outputs representing relative movements of the mutually articulated body portions and a real time user feedback generator operative to generate predetermined feedback to the user in response to predetermined selected movements of the mutually articulated body portions.

[0007] In accordance with a preferred embodiment of the present invention the body movement feedback system also includes a user feedback selector adapted to receive feedback selection inputs from a person and operative to assign selectable user feedbacks to selectable movements of the mutually articulated body portions.

[0008] Preferably, the at least one position sensor includes at least two body portion orientation sensors. Alternatively, the at least one position sensor includes at least one body portion orientation sensor and at least one bend sensor sensing bending between at least two mutually articulated body portions.

[0009] In accordance with a preferred embodiment of the present invention each of the at least two body portion orientation sensors measures the orientation of at least two body portions about an articulation joint joining the at least two body portions. Alternatively, each of the at least one body portion orientation sensor and at least one bend sensor measures the orientation of at least two body portions about an articulation joint joining the at least two body portions.

[0010] Preferably, the predetermined feedback includes at least one of tactile feedback, auditory feedback and visual feedback.

[0011] In accordance with a preferred embodiment of the present invention the at least one position sensor includes at least one first sensor mounted onto a user's skin at a first location and at least a second sensor mounted to the user's skin on a second location, the first and second locations being mutually separated and being on opposite sides of a vertex of a joint.

[0012] Preferably, the real time user feedback generator includes a feedback transducer operative to provide a real time notification to a user when at least one predetermined orientation of a joint is reached.

[0013] In accordance with a preferred embodiment of the present invention the body movement feedback system also includes a stretchable enclosure at least partially enclosing the at least one position sensor. Additionally, the stretchable enclosure also at least partially encloses the microprocessor and the feedback transducer.

[0014] In accordance with a preferred embodiment of the present invention the at least one position sensor is mounted onto the user's skin using at least one re-attachable fastener. Alternatively or additionally, the at least one position sensor is mounted onto the user's skin using at least one band.

[0015] Preferably, the body movement feedback system also includes a portable controller communicating wirelessly with the microprocessor. Additionally, the portable controller communicates wirelessly with a database.

[0016] In accordance with a preferred embodiment of the present invention the body movement feedback system also includes a substrate including at least first and second relatively non-elastic portions and at least one relatively elastic portion disposed therebetween and wherein the at least first and at least second sensors are mounted on the non-elastic portions of the substrate.

[0017] Preferably, the stretchable enclosure includes a substrate including at least first and second relatively non-elastic portions and at least one relatively elastic portion disposed therebetween and wherein at least first and at least second sensors are mounted on the non-elastic portions of the substrate.

[0018] There is also provided in accordance with another preferred embodiment of the present invention a method for body movement feedback including the steps of sensing at least relative positions of mutually articulated body portions of a user in real time and providing sensor outputs, receiving the sensor outputs and providing processor outputs representing relative movements of the mutually articulated body portions and generating predetermined feedbacks to the user in response to predetermined movements of the mutually articulated body portions.

[0019] In accordance with a preferred embodiment of the present invention the method for body movement feedback also includes receiving feedback selection inputs from a person and assigning selectable user feedbacks to selectable movements of the mutually articulated body portions.

[0020] Preferably, the sensing includes sensing the orientation of at least two body portions. Alternatively, the sensing includes sensing the orientation of at least one body portion and sensing bending between at least two mutually articulated body portions.

[0021] In accordance with a preferred embodiment of the present invention the sensing the orientation of at least two body portions includes measuring mutual orientation of at least two body portions about an articulation joint joining the at least two body portions. Alternatively, the sensing the orientation of at least one body portion and sensing bending between at least two mutually articulated body portions includes measuring mutual orientation of at least two body portions about an articulation joint joining the at least two body portions.

[0022] Preferably, the predetermined feedback includes at least one of tactile feedback, auditory feedback and visual feedback.

[0023] There is further provided in accordance with yet another preferred embodiment of the present invention a body position training device for measuring a user's joint orientation including at least one first sensor mounted onto a user's skin at a first location, at least a second sensor mounted to the user's skin on a second location, the first and second locations being mutually separated and being on opposite sides of a vertex of a joint, a microprocessor receiving inputs from the first and second sensors for calculating an orientation of the joint and a feedback transducer operative to provide a real time notification to a user when a predetermined orientation of the joint is reached.

[0024] Preferably, the first and second locations are each separated from the vertex by a distance sufficient to ensure that the first and second locations remain on opposite sides of the vertex at all orientations of the joint.

[0025] In accordance with a preferred embodiment of the present invention the body position training device for measuring a user's joint orientation also includes a stretchable enclosure at least partially enclosing the first and second sensors. Additionally, the stretchable enclosure also at least partially encloses the microprocessor and the feedback transducer.

[0026] Preferably, the at least first and at least second sensors are mounted onto the user's skin using at least one sticker. Alternatively, the at least first and at least second sensors are mounted onto the user's skin using at least one band.

[0027] In accordance with a preferred embodiment of the present invention the body position training device for measuring a user's joint orientation also includes a portable controller communicating wirelessly with the microprocessor.

[0028] In accordance with a preferred embodiment of the present invention the body position training device for measuring a user's joint orientation also includes a substrate including at least first and second relatively non-elastic portions and at least one relatively elastic portion disposed therebetween and wherein the at least first and at least second sensors are mounted on the non-elastic portions of the substrate. Additionally or alternatively, the stretchable enclosure includes a substrate including at least first and second relatively non-elastic portions and at least one relatively elastic portion disposed therebetween and wherein the at least first and at least second sensors are mounted on the non-elastic portions of the substrate.

BRIEF DESCRIPTION OF PREFERRED EMBODIMENTS

[0029] The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

[0030] FIG. **1** is a simplified illustration of a body position training system including a body-mounted body position training device, a portable control device and a management interface workstation;

[0031] FIGS. **2**A and **2**B are simplified respective top view and bottom view perspective illustrations of a body position training device constructed and operative in accordance with a preferred embodiment of the present invention;

[0032] FIGS. **3**A and **3**B are simplified respective top view and bottom view perspective illustrations of a body position training device constructed and operative in accordance with another preferred embodiment of the present invention;

[0033] FIGS. **4**A and **4**B are simplified respective top view and bottom view perspective illustrations of a body position training device constructed and operative in accordance with yet another preferred embodiment of the present invention;

[0034] FIGS. **5**A and **5**B are simplified pictorial illustrations of two phases in the operation of the body position training system for training;

[0035] FIGS. **6**A and **6**B are simplified pictorial illustrations of two phases in the operation of the body position training system for training;

[0036] FIGS. **7**A and **7**B are simplified front and back body outline illustrations showing examples of body locations for possible mounting and operation of the body-mounted body position training device of FIGS. **1-6**B;

[0037] FIGS. **8**A and **8**B are simplified illustrations of two body positions which may be sensed by an elbow-mounted body position training device of FIGS. **1-5**B;

[0038] FIGS. **9**A and **9**B are simplified illustrations of two body positions which may be sensed by an ankle-mounted body position training device of FIGS. **1-5**B;

[0039] FIGS. **10**A and **10**B are simplified illustrations of two body positions which may be sensed by a knee-mounted body position training device of FIGS. **1-5**B;

[0040] FIGS. **11**A and **11**B are simplified illustrations of two body positions which may be sensed by an upper back-mounted body position training device of FIGS. **1-5**B;

[0041] FIGS. **12**A and **12**B are simplified illustrations of two body positions which may be sensed by a lower back-mounted body position training device of FIGS. **1-5**B;

[0042] FIGS. **13**A, **13**B and **13**C are simplified illustrations of three body positions which may be sensed by a wrist-mounted body position training device of FIGS. **1-5**B;

[0043] FIGS. **14**A and **14**B are simplified illustrations of two body positions which may be sensed by a shoulder-mounted body position training device of FIGS. **1-5**B;

[0044] FIGS. **15**A and **15**B are simplified illustrations of two body positions which may be sensed by a neck-mounted body position training device of FIGS. **1-5**B; and

[0045] FIGS. **16**A and **16**B are simplified illustrations of two body positions which may be sensed by a hip-mounted body position training device of FIGS. **1-5**B.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0046] Reference is now made to FIG. **1**, which is a simplified illustration of a body position training system including a body-mounted body position training device **100** that is preferably worn by the user, a portable control device **110** that is preferably controlled by the user and a management interface workstation **120** that is preferably controlled by a practitioner such as a physician, physical therapist or sports coach.

[0047] The body-mounted body position training device **100** is preferably controlled by portable control device **110**, which may be embodied in a generic smartphone, a smart-watch or any other suitable mobile communication device, which may or may not be specifically designed for use in the system.

[0048] The portable control device **110** preferably communicates wirelessly with the body-mounted body position training device **100** and wirelessly, typically via the Internet, with the management interface workstation **120**. The user preferably is the only person who can control the body position training device **100**. Alternatively or additionally, a practitioner may control the body position training device **100** using the management interface workstation **120** and the portable control device **110** or directly via the portable control device **110**.

[0049] The management interface workstation **120** preferably interfaces with one or more other healthcare provider networks **130**. A practitioner can access the management interface workstation **120** directly using suitable software and/or from a general healthcare platform **140**, typically via a healthcare provider network **130**. Various health management databases **150** are connected via networks **130**, which may be connected to one or more cloud servers **156**.

[0050] The management interface workstation **120** may provide selectable access to one or more of the following: a practitioner database **160**, a user database **162**, a training program database **164** and an exercise protocol database **166**. Via the management interface workstation **120**, a practitioner can send training programs from a training program database **164** and exercise protocols from database an exercise protocol data base **166** to be carried out by the user as well as other data and information to the portable control device **110**.

[0051] From the portable control device **110**, programmed commands and conditions related to the assigned training programs and exercise protocols can be sent to the body position training device **100**. According to these commands and conditions, the body position training device **100** collects data from the user and administers feedback to the user during training and exercise. For example, such data and feedback could be related to the accuracy of the user's performance of an assigned exercise.

[0052] Information sent to a user's portable control device **110**, such as exercise protocols, training programs and data collected by the body position training device **100**, is preferably stored in the user's profile in the user database **162**. Furthermore, the aforementioned user profile can preferably be accessed by the practitioner via the interface workstation **120**.

[0053] During use of the system, data collected by the body position training device **100** is sent wirelessly by the body position training device **100** to the portable control device **110**. From the portable control device **110**, information and data preferably is exported to the management interface workstation **120**. From the management interface workstation **120**, information can also be sent to healthcare provider networks **130** to be stored in health management databases **150**.

[0054] An example of how a practitioner, in this case a physiotherapist, may instruct a user, in this case a client, to use the body position training device **100** is as follows: The practitioner assigns an exercise protocol of elbow stretching and bending exercises and a training program of performing two sets of specific elbow exercises per day including 10 repetitions per set. The practitioner instructs the user to wear the body position training device **100** on his elbow while performing the exercises in order to ensure that the exercises are performed correctly.

[0055] Preferably, the body position training device **100** provides feedback to the user. The body position training device **100** preferably transmits data acquired during the exercises to the portable control device **110** for viewing by the user and, preferably via the portable control device **110** to the management interface workstation **120** for consideration by the practitioner and archiving in one or more databases, such as health management databases **150**.

[0056] Reference is now made additionally to FIGS. **2**A and **2**B, which illustrate, in greater detail, the embodiment of the body position training device **100** shown in FIG. **1**.

[0057] As seen in FIGS. **1-2**B, the body position training device **100** preferably includes an enclosure **200**, arranged along a longitudinal axis **202**, which is preferably bendable through at least 90 degrees about an axis perpendicular to the longitudinal axis **202** and stretchable by at least 10% and preferably by 25% along longitudinal axis **202**. A preferred material for enclosure **200** is Neoprene Foam manufactured by Marco International Company, Marco Product Inc from 78 Bunsen, Irvine, Calif. 92618. Preferably the length of the enclosure **200** is preferably between 6-14 cm and more preferably between 8-12 cm and the width of the enclosure **200** is preferably between 1-4 cm and more preferably between 2-3 cm, the thickness of the enclosure material is up to 1 mm. Stretchability may be enhanced by providing cut outs **206**, shown in dashed lines.

[0058] Disposed within enclosure **200** is a printed circuit board **210**, preferably of dimensions 25 mm×25 mm, on which are preferably mounted a microprocessor **212** as well as a tactile feedback generator **214**, a battery **216**, a wireless transceiver **218**, a visual feedback generator **220**, a memory **221** and an auditory feedback generator **222**, all coupled to microprocessor **212**. Optionally an orientation sensor **224** may also be mounted on printed circuit board **210** and coupled to the microprocessor **212**.

[0059] Also disposed within enclosure **200** adjacent ends thereof are a pair of orientation sensors, here designated by reference numerals **226** and **228**. Orientation sensors **226** and **228** are not mounted on printed circuit board **210** and are not rigidly coupled to printed circuit board **210**. Orientation sensors **226** and **228** are preferably each mounted on a printed circuit board, here respective designated by reference numerals **230** and **232**. Orientation sensors **226** and **228** are preferably electrically connected to microprocessor **212** via respective flexible conductors **234** and **236**. Orientation sensors **224**, **226** and **228** are preferably model numbers BHI **160** or BMI **160** manufactured by Bosch Sensor Tech from Gerhard-Kindler-StraBe 9 72770 Reutlingen/Kusterdingen, Germany.

[0060] Each of printed circuit boards **210**, **230** and **232** is preferably enclosed in respective relatively rigid protective capsules **240**, **242** and **244**, which preferably provide hermetic sealing and mechanical protection to the orientation sensors and other components mounted thereon.

[0061] Disposed on an underside outside surface of enclosure **200** underlying each of capsules **240**, **242** and **244** are fastener strips **250**, **252** and **254** respectively. Fastener strips **250**, **254** and **256** are preferably VELCRO® hook strips having an adhesive backing, which adheres to the underside outside surface of enclosure **200**. Fastener strips **250**, **252** and **254** are configured to be removably attachable to corresponding fastener strips **260**, **262** and **264**, preferably VELCRO® loop strips, which are adhesively attachable to the skin of a user. Fastener strips **260**, **262** and **264** are preferably disposable and are not reused. The adhesive backing is preferably, for example, are #2475 [formerly MSX-6936A] Single Coated Medical Silicone Adhesive Tape on Liner, commercially available from the **3**M Company of Saint Paul, Minn., United States.

[0062] Orientation sensors **224**, **226** and **228** preferably include an accelerometer, for measuring the angle relative to gravity, and/or a gyroscope, for measuring the orientation of the body position training device **100**.

[0063] It is appreciated that printed circuit board **210** may be obviated and that microprocessor **212**, as well as a tactile feedback generator **214**, battery **216**, wireless transceiver **218**, visual feedback generator **220**, memory **221** and auditory feedback generator **222** may be mounted on printed circuit board **230** or **232**.

[0064] Reference is now made additionally to FIGS. **3**A and **3**B, which illustrate an alternative embodiment of the body position training device **100** shown in FIG. **1**.

[0065] As seen in FIGS. **3**A & **3**B, the body position training device, here designated by reference numeral **300**, preferably includes an enclosure **301**, arranged along a longitudinal axis **302**, which is preferably bendable through at least 100 degrees about an axis perpendicular to the longitudinal axis **302** and stretchable by at least 10% and preferably by 25% along longitudinal axis **302**. A preferred material for enclosure **301** is Neoprene Foam manufactured by Marco International Company, Marco Product Inc from 78 Bunsen, Irvine, Calif. 92618. Preferably the length of the enclosure **301** is between 6-14 cm and more preferably between 8-12 cm, the width of the enclosure **200** is preferably between 1-4 cm and more preferably between 2-3 cm and the thickness of the enclosure material is up to 1 mm. Stretchability may be enhanced by providing cutouts as shown at **306** in FIGS. **3**A and **3**B.

[0066] Disposed within enclosure **301** is a printed circuit board **310**, preferably of dimensions 25 mm×25 mm, on which are preferably mounted a microprocessor **312** as well as a tactile feedback generator **314**, a battery **316**, a wireless transceiver **318**, a visual feedback generator **320**, a memory **321** and an auditory feedback generator **322**, all coupled to microprocessor **312**. Optionally an orientation sensor **324** may also be mounted on printed circuit board **310** and coupled to the microprocessor **312**.

[0067] Also disposed within enclosure **301**, adjacent an end thereof, is an orientation sensor, here designated by reference numerals **326**. Orientation sensor **326** is not mounted on printed circuit board **310** and is not rigidly coupled to printed circuit board **310**. Orientation sensor **326** is preferably mounted on a printed circuit board **330**. Orientation sensor **326** is preferably electrically connected to microprocessor **312** via a flexible conductor **334**. Orientation sensors **324** and **326** are preferably BHI **160** or BMI **160** manufactured by Bosch Sensor Tech from Gerhard-Kindler-Straße 9 72770 Reutlingen/Kusterdingen, Germany.

[0068] Additionally disposed within enclosure **301** is a bend sensor **336**, preferably Tactilus® Flex manufactured by Sensor Products Inc from 300 Madison Avenue Madison, N.J. 07940 USA, which is preferably fixedly mounted at one end thereof to printed circuit board **310**.

[0069] Each of printed circuit boards **310** and **330** is preferably enclosed in respective relatively rigid protective capsules **340** and **342**, which preferably provide hermetic sealing and mechanical protection to the orientation sensors and other components mounted thereon.

[0070] Disposed on an underside outside surface of enclosure **301** underlying each of capsules **340** and **342** and underlying an end of enclosure **301** opposite to the end at which capsule **350** is located are snap fastener elements **350**, **352** and **354** respectively. Snap fastener elements **350**, **352** and **354** are configured to be removably attachable to corresponding snap fastener elements **360**, **362** and **364**, which are fixedly mounted onto a flexible, stretchable mounting strip **366**, such as inelastic cotton manufactured by STRENGTHTAPE® from 6753 Engle Road Middleburg Heights, Ohio 44130 United States of America. Stretchable mounting strip **366** and the snap fastener elements **360**, **362** and **364** are preferably disposable and not reused. It is understood that other types of fasteners may be used, such as metal sheets, magnets, textile and buttons, which are adhesively attachable to the skin of a user. A suitable adhesive material is, for example, are #2475 [formerly MSX-6936A] Single Coated Medical Silicone Adhesive Tape on Liner, commercially available from the **3**M Company, of Saint Paul, Minn., United States.

[0071] Orientation sensors **324** and **326** may include an accelerometer, for measuring the angle relative to gravity, and/or a gyroscope, for measuring the orientation of the body position training device **300**.

[0072] Bend sensor **336** for measuring the degree of curvature of the body position training device **300** may include a force sensor such as FlexiForce A401 Sensor, manufactured by Tekscan, Inc. from, 307 West First Street South Boston, Mass. 02127-1309, USA, a flex sensor such as flex sensor manufactured by Spectra Symbol from 3101 W. 2100 S. Salt Lake City, Utah 84119 USA, used to measure the flexure of the body-mounted body position training device **100**; a stretch sensor such as Leap stretch sensor from Science and Technology Park, Diplomvej 381, 2800 Kgs. Lyngby, Denmark, used to measure the stretch of a component of the body-mounted body position training device **100** and a strain gauge such as Zhonghang Electronic Measuring Instruments Co., LTD from, No. 166, West Avenue, Chang'an District, Xi'an, Shaanxi, China, used to measure the strain on the body-mounted body position training device **100**.

[0073] It is appreciated that printed circuit board **310** may be obviated and microprocessor **312**, as well as a tactile feedback generator **314**, battery **316**, wireless transceiver **318**, visual feedback generator **320**, memory **321** and auditory feedback generator **322** may be mounted on printed circuit board **330**.

[0074] Reference is now made to FIGS. **4**A and **4**B, which are simplified respective top view and bottom view perspective illustrations of a body position training device constructed and operative in accordance with yet another preferred embodiment of the present invention.

[0075] As seen in FIGS. **4**A and **4**B, the body position training device **400** preferably includes an enclosure **401**, arranged along a longitudinal axis **402**, which is preferably bendable through at least 100 degrees about an axis perpendicular to the longitudinal axis **402** and stretchable by at least 10% and preferably by 25% along longitudinal axis **402**. A preferred material for enclosure **401** is Neoprene

Foam manufactured by Marco International Company, Marco Product Inc from 78 Bunsen, Irvine, Calif. 92618. Preferably the length of the enclosure **401** is preferably between 6-14 cm and more preferably between 8-12 cm, the width of the enclosure **401** is preferably between 1-4 cm and more preferably between 2-3 cm and the thickness of the enclosure material is up to 1 mm. Stretchability of the enclosure **401** may be enhanced by providing cut outs **406**, shown in dashed lines.

[0076] Disposed within enclosure **401** is a printed circuit board **410**, preferably of dimensions 25 mm×25 mm, on which are preferably mounted a microprocessor **412** as well as a tactile feedback generator **414**, a battery **416**, optionally a wireless transceiver **418**, a visual feedback generator **420** and an auditory feedback generator **422**, all coupled to microprocessor **412**. Optionally an orientation sensor **424** may also be mounted on printed circuit board **410** and coupled to the microprocessor **412**.

[0077] Also disposed within enclosure **401** adjacent ends thereof are a pair of orientation sensors, here designated by reference numerals **426** and **428**. Orientation sensors **426** and **428** are not mounted on printed circuit board **410** and are not rigidly coupled to printed circuit board **410**. Orientation sensors **426** and **428** are preferably each mounted on a printed circuit board, here respective designated by reference numerals **430** and **432**. Orientation sensors **426** and **428** are preferably electrically connected to microprocessor **412** via respective flexible conductors **434** and **436**.

[0078] Also disposed within enclosure **401** are additional intermediate orientation sensors, here designated by reference numerals **438** and **439**. Orientation sensors **438** and **439** are not mounted on printed circuit board **410** and are not rigidly coupled to printed circuit board **410**. Orientation sensors **438** and **439** are preferably each mounted on a printed circuit board, here respective designated by reference numerals **440** and **441**. Orientation sensors **438** and **439** are preferably electrically connected to microprocessor **412** via respective flexible conductors **434** and **436**.

[0079] Orientation sensors **424**, **426**, **428**, **438** and **439** are preferably either of model numbers BHI **160** or BMI **160** manufactured by Bosch Sensor Tech from Gerhard-Kindler-Straße 9 72770 Reutlingen/Kusterdingen, Germany.

[0080] Each of printed circuit hoards **410**, **430** and **432**, **440** and **441** is preferably enclosed in a respective relatively rigid protective capsule **443**, **442**, **444**, **446** and **448**, which preferably provide hermetic sealing and mechanical protection to the orientation sensors and other components mounted thereon.

[0081] Disposed on an underside outside surface of enclosure **401** underlying each of capsules **442**, **443** and **444** are fastener strips **450**, **452** and **454** respectively. Fastener strips **450**, **452** and **454** are preferably of a type usable for wrist or ankle mountable spring-like bracelets or equivalents.

[0082] Orientation sensors **424**, **426**, **428**, **438** and **439** preferably include an accelerometer, for measuring angular orientation relative to gravitational acceleration, and/or a gyroscope, for measuring the orientation of the body position training device **400**.

[0083] Also disposed within enclosure **401** are buttons **470**, **472** and **474** and display **480**.

[0084] Body position training device **400** preferably is switched on and off by a long press on button **472**. Buttons **470** and **474** are preferably employed to move a menu displayed on display **480** up and down. Button **472** may be used also for menu selection. In contrast to body position training device **100** and **300** shown in FIGS. **1**A-**3**B, body position training device **400** is preferably operated without a portable control device **110**.

[0085] It is appreciated that printed circuit board **410** may be obviated and microprocessor **412**, as well as a tactile feedback generator **414**, battery **416**, wireless transceiver **418**, visual feedback generator **420**, memory **421**, auditory feedback generator **422**, buttons **470**, **472** and **474** and display **480** may be mounted on printed circuit board **430**, **432**, **440** and/or **441**.

[0086] Reference is now made to FIGS. **5**A and **5**B, which are simplified pictorial illustrations of two phases in the operation of the body position training system for training. For simplicity, the description refers to body position training device **100** shown in FIG. **1**-**2**B. It is appreciated that the description which follows is also applicable to the operation of body position training device **300** shown in FIGS. **3**A and **3**B.

[0087] FIG. **5**A illustrates an initial phase in which training instructions are downloaded to the portable control device **110**. The download may be from a management interface workstation **120** on the basis of instructions entered by a practitioner. Alternatively, the download may be from a website or any other suitable source of training instructions.

[0088] The training instructions downloaded to the portable control device **110** preferably include instructions to the user, which are intended for display on the portable control device **110**, as shown as well as instructions to the body position training device, such as body-mounted body position training device **100**, which are preferably relayed to the body-mounted body position training device **100** via the portable control device **110**. The instructions to the body position training device preferably include at least one of:

[0089] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **100**, such as a 90 degree bend of the elbow.

[0090] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **100**, such as a bend of the elbow exceeding 90 degrees.

[0091] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **100**, such as full extension of the arm, 90 degree orientation at the elbow and maximum arm bend.

[0092] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **100**, such as completion of each of a plurality of arm bends through a predetermined angular range.

[0093] FIG. **5**B illustrates a subsequent phase in which an exercise, instructions regarding which were earlier downloaded to the portable control device **110** and to the body-mounted body position training device **100**, is being carried out. FIG. **5**B shows an example corresponding to example 4 above wherein feedback is generated in response to completion of a predetermined number of predetermined movements of the body-mounted body position training device **100**.

[0094] As seen in FIG. **5**B, the user initially extends his arm as instructed by the image displayed on the portable control device **110** and finally fully bends his elbow as further instructed by the image displayed on the portable control device **110**, thus completing the exercise downloaded as shown in FIG. **5**A. In accordance with a preferred embodiment of the present invention the user receives feedback in real time upon completion of the exercise. Additionally, preferably, a report confirming completion of the exercise is sent from the body-mounted body position training device **100** via the portable control device to the management interface workstation **120** and to the practitioner.

[0095] Reference is now made to FIGS. **6**A and **6**B, which are simplified pictorial illustrations of two phases in the operation of the body position training system shown in FIG. **4**A-**4**B for training.

[0096] FIG. **6**A illustrates an initial phase in which training instructions are stored within memory **421**. Optionally, training instructions may be downloaded via wireless transceiver **418** to the body position training device **400**. The download may be from a portable control device (not shown).

[0097] The training instructions are intended for display on the display **480** of the body position training device **400**, as shown in FIG. **6**A as well as instructions to the body position training device **400**. The instructions to the body position training device preferably include at least one of:

[0098] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **400**, such as upon straightening of the knee.

[0099] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **400**, such as at half the way between straightening of the knee and 90 degrees knee bend.

[0100] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **400**, such as at a 90 degree knee bend and at a full straightening of the knee.

[0101] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **400**, such as completion of each of a plurality of knee bends through a predetermined angular range.

[0102] FIG. **6**B illustrates a subsequent phase in which an exercise, instructions regarding which were earlier stored within memory **480** of body-mounted body position training device **400**, is being carried out. FIG. **5**B shows an example corresponding to example 1 above wherein feedback is generated in response to reaching 180 degrees of knee straightening.

[0103] As seen in FIG. **6**B, the user initially bends his knee at 90 degrees as instructed by the prompt displayed on the body position training device **400** and finally fully straightening his knee as further instructed by a prompt displayed on display **480** of the body position training device **400** thus completing a repetition of an exercise downloaded as shown in FIG. **6**A. In accordance with a preferred embodiment of the present invention the user receives feedback notification in real time upon straightening his knee at 180 degrees. Additionally and optionally, a report confirming completion of the exercise is sent from the body-mounted body position training device **400** to portable control device.

[0104] Reference is now made to FIGS. **7**A and **7**B, which are simplified front and back body outline illustrations showing examples of body joint locations for possible mounting and operation of the body-mounted body position training device of FIGS. **1**-**6**B.

[0105] As seen in FIGS. **8**A and **8**B, for example, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's elbow, as described hereinbelow with reference to FIGS. **8**A and **8**B.

[0106] Alternatively, as described hereinbelow with reference to FIGS. **9**A and **9**B, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's ankle.

[0107] As a further alternative, as described hereinbelow with reference to FIGS. **10**A and **10**B, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's knee.

[0108] As another alternative, as described hereinbelow with reference to FIGS. **11**A and **11**B, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's upper back.

[0109] As yet another alternative, as described hereinbelow with reference to FIGS. **12**A and **12**B, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's lower back.

[0110] As still another alternative, as described hereinbelow with reference to FIGS. **13**A, **13**B and **13**C, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's wrist.

[0111] Alternatively, as described hereinbelow with reference to FIGS. **14**A and **14**B, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's shoulder.

[0112] As a further alternative, as described hereinbelow with reference to FIGS. **15**A and **15**B, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's neck;

[0113] As a still further alternative, as described hereinbelow with reference to FIGS. **16**A and **16**B, a body mounting body position training device of any of the types described above with reference to FIGS. **1**-**6**B, may be mounted on a user's hip.

[0114] Reference is now made to FIGS. **8**A and **8**B, which are simplified illustrations of two body positions, which may be sensed by an elbow-mounted body position training device of FIGS. **1**-**6**B. It is noted that body position training device **800**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1**-**6**B, is positioned such that two end sensors **802** and **804** are attached to the skin at locations sufficiently separated from the vertex of the elbow such that during bending of the elbow, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0115] In this example, the training instructions to the body position training device **800** preferably include at least one of:

[0116] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **800**, such as a 30 degree bend of the elbow, as shown in FIG. **8**A.

[0117] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **800**, such as a bend of the elbow exceeding 90 degrees as seen in FIG. **8**B.

[0118] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **800**, such as those shown in FIGS. **8**A and **8**B.

[0119] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **800**, such as completion of each of a plurality arm bends through a predetermined angular range exemplified in FIGS. **8**A and **8**B.

[0120] Reference is now made to FIGS. **9**A and **9**B, which are simplified illustrations of two body positions which may be sensed by an ankle-mounted body position training device of FIGS. **1**-**6**B. It is noted that body position training device **900**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1**-**6**B, is positioned such that two end sensors **902** and **904** are attached to the skin at locations sufficiently separated from the vertex of the ankle such that during bending of the ankle, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0121] In this example, the training instructions to the body position training device **900** preferably include at least one of:

[0122] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **900**, such as a 120 degree uplifting of the ankle, as shown in FIG. **9**B.

[0123] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **900**, such as a uplifting of the ankle exceeding 90 degrees as seen in FIG. **9**A.

[0124] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **900**, such as those shown in FIGS. **9**A and **9**B.

[0125] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **900**, such as completion of each of a plurality ankle upliftings through a predetermined angular range exemplified in FIGS. **9**A and **9**B.

[0126] Reference is now made to FIGS. **10**A and **10**B, which are simplified illustrations of two body positions which may be sensed by a knee-mounted body position training device of FIGS. **1**-**6**B. It is noted that body position training device **1000**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1**-**6**B, is positioned such that two end sensors **1002** and **1004** are attached to the skin at locations sufficiently separated from the vertex of the elbow such that during bending of the knee, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0127] In this example, the training instructions to the body position training device **1000** preferably include at least one of:

[0128] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **1000**, such as a 180 degree bend of the knee, as shown in FIG. **10**A.

[0129] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **1000**, such as a bend of the knee exceeding 90 degrees as seen in FIG. **10**B.

[0130] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **1000**, such as those shown in FIGS. **10**A and **10**B;

[0131] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **1000**, such as completion of each of a plurality arm bends through a predetermined angular range exemplified in FIGS. **10**A and **10**B.

[0132] Reference is now made to FIGS. **11**A and **11**B, which are simplified illustrations of two body positions which may be sensed by an upper back-mounted body position training device of FIGS. **1**-**6**B. It is noted that body position training device **1100**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1**-**6**B, is positioned such that two end sensors **1102** and **1104** are attached to the skin at vertebra locations sufficiently separated from each other along the spine such that during bending of the upper back, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0133] In this example, the training instructions to the body position training device **1100** preferably include at least one of:

[0134] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **1100**, such as a 30 degree bend of the upper back, as shown in FIG. **11**A.

[0135] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **1100**, such as a bend of the upper back exceeding 15 degrees as seen in FIG. **11**B.

[0136] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **1100**, such as those shown in FIGS. **11**A and **11**B.

[0137] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **1100**, such as completion of each of a plurality upper back bends through a predetermined angular range exemplified in FIGS. **11**A and **11**B.

[0138] Reference is now made to FIGS. **12**A and **12**B, which are simplified illustrations of two body positions which may be sensed by a lower back-mounted body position training device of FIGS. **1-6**B. It is noted that body position training device **1200**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1-6**B, is positioned such that two end sensors **1202** and **1204** are attached to the skin at vertebra locations sufficiently separated from each other along the spine, for example corresponding to L3 and L5 vertebra locations, such that during bending of the lower back, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0139] In this example, the training instructions to the body position training device **1200** preferably include at least one of:

[0140] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **1200**, such as concave bend of the lower back, as shown in FIG. **12**A.

[0141] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **1200**, such as a bend of the lower back exceeding convex bend as seen in FIG. **12**B.

[0142] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **1200**, such as those shown in FIGS. **12**A and **12**B.

[0143] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **1200**, such as completion of each of a plurality arm bends through a predetermined angular range exemplified in FIGS. **12**A and **12**B.

[0144] Reference is now made to FIGS. **13**A **13**B and **13**C, which are simplified illustrations of two body positions which may be sensed by an wrist-mounted body position training device of FIGS. **1-6**B. It is noted that body position training device **1300**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1-6**B, is positioned such that two end sensors **1302** and **1304** are attached to the skin at locations sufficiently separated from the vertex of the wrist such that during bending of the wrist, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0145] In this example, the training instructions to the body position training device **1300** preferably include at least one of:

[0146] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **1300**, such as a 90 degree bend of the wrist, as shown in FIG. **13**A or **13**C.

[0147] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **1300**, such as a bend of the wrist exceeding 180 degrees as seen in FIG. **13**B.

[0148] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **1300**, such as those shown in FIGS. **13**A and **13**C.

[0149] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **1300**, such as completion of each of a plurality arm bends through a predetermined angular range exemplified in FIGS. **13**A and **13**C.

[0150] Reference is now made to FIGS. **14**A and **14**B, which are simplified illustrations of two body positions which may be sensed by a shoulder-mounted body position training device of FIGS. **1-6**B. It is noted that body position training device **1400**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1-6**B, is positioned such that two end sensors **1402** and **1404** are attached to the skin at locations sufficiently separated from the vertex of the shoulder such that during bending of the shoulder, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0151] In this example, the training instructions to the body position training device **1400** preferably include at least one of:

[0152] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **1400**, the shoulder heading up of, as shown in FIG. **14**B.

[0153] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **1400**, such the shoulder exceeding straight down movement as seen in FIG. **14**A.

[0154] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **1400**, such as those shown in FIGS. **14**A and **14**C.

[0155] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **1400**, such as completion of each of a plurality shoulder heading up and down, through a predetermined angular range exemplified in FIGS. **14**A and **14**B.

[0156] Reference is now made to FIGS. **15**A and **15**B, which are simplified illustrations of two body positions which may be sensed by a neck-mounted body position training device of FIGS. **1-6**B. It is noted that body position training device **1500**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1-6**B, is positioned such that two end sensors **1502** and **1504** are attached to the skin at vertebra locations sufficiently separated from each other along the spine, such that during bending of the neck, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0157] In this example, the training instructions to the body position training device **1500** preferably include at least one of:

[0158] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **1500**, such as looking downwardly corresponding to concave bend of the neck, as shown in FIG. **15**A.

[0159] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **1500**, such as a bend of the neck, looking upwardly, exceeding the extent of a predetermined convex bend as seen in FIG. **15**B.

[0160] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **1500**, such as those shown in FIGS. **15**A and **15**B.

[0161] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **1500**, such as completion of each of a plurality neck bends through a predetermined angular range exemplified in FIGS. **15**A and **15**B.

[0162] Reference is now made to FIGS. **16**A and **16**B, which are simplified illustrations of two body positions which may be sensed by a hip-mounted body position training device of FIGS. **1**-**6**B. It is noted that body position training device **1600**, which may be constructed in accordance with any of the embodiments described hereinabove with reference to FIGS. **1**-**6**B, is positioned such that two end sensors **1602** and **1604** are attached to the skin at locations sufficiently separated from the vertex of the hip such that during bending of the hip, the stretching of the skin does not displace the sensors such that they overlie the vertex.

[0163] In this example, the training instructions to the body position training device **1600** preferably include at least one of:

[0164] 1. Feedback generation instructions based on a predetermined operative orientation of the body-mounted body position training device **1600**, such as a 90 degree bend of the hip, as shown in FIG. **16**A.

[0165] 2. Feedback generation instructions based on exceedance of a predetermined operative orientation threshold of the body-mounted body position training device **1600**, such as a bend of the hip exceeding 120 degrees as seen in FIG. **16**B.

[0166] 3. Feedback generation instructions based on a reaching a plurality of predetermined operative orientations of the body-mounted body position training device **1600**, such as those shown in FIGS. **16**A and **16**B.

[0167] 4. Feedback generation instructions based on a completion of a predetermined number of predetermined movements of the body-mounted body position training device **1600**, such as completion of each of a plurality arm bends through a predetermined angular range exemplified in FIGS. **16**A and **16**B.

[0168] It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly claimed and includes both combinations and subcombinations of features described and shown hereinabove as well as modifications thereof which are not in the prior art.

1.-**17**. (canceled)

18. A method for body movement feedback comprising the steps of:

sensing at least relative positions of mutually articulated body portions of a user in real time and providing sensor outputs;

receiving said sensor outputs and providing processor outputs representing relative movements of said mutually articulated body portions; and

generating predetermined feedbacks to said user in response to predetermined movements of said mutually articulated body portions.

19. A method for body movement feedback according to claim **18** and also comprising receiving feedback selection inputs from a person and assigning selectable user feedbacks to selectable movements of said mutually articulated body portions.

20. A method for body movement feedback according to claim **18** and wherein said sensing comprises sensing the orientation of at least two body portions.

21. A method for body movement feedback according to claim **18** and wherein said sensing comprises sensing the orientation of at least one body portion and sensing bending between at least two mutually articulated body portions.

22. A method for body movement feedback according to claim **20** and wherein said sensing the orientation of at least two body portions comprises measuring mutual orientation of at least two body portions about an articulation joint joining said at least two body portions.

23. A method for body movement feedback according to claim **21** and wherein said sensing the orientation of at least one body portion and sensing bending between at least two mutually articulated body portions comprises measuring mutual orientation of at least two body portions about an articulation joint joining said at least two body portions.

24. A method for body movement feedback according to claim **18** and wherein said predetermined feedback comprises at least one of tactile feedback, auditory feedback and visual feedback.

25.-**33**. (canceled)

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