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(54) **ORTHOPEDIC BRACE HAVING TELESCOPIC LATERAL PANELS AND AN ADJUSTABLE PULLEY SUBSYSTEM**

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(57) **ABSTRACT**

An orthopedic brace features a belt brace and an adjustable spinal support extension. The belt brace includes a structural member. The adjustable spinal support extension is configured for insertion into the structural member. The adjustable spinal support extension includes a sleeve, a first strut member, and a second strut member adjustably coupled to the first strut member to alter a length of the spinal support extension. The first strut member and the second strut member are partially enclosed within the sleeve and a fastener of the structural member is attachable to a fastener on the sleeve when the adjustable spinal support extension is placed within the sleeve.

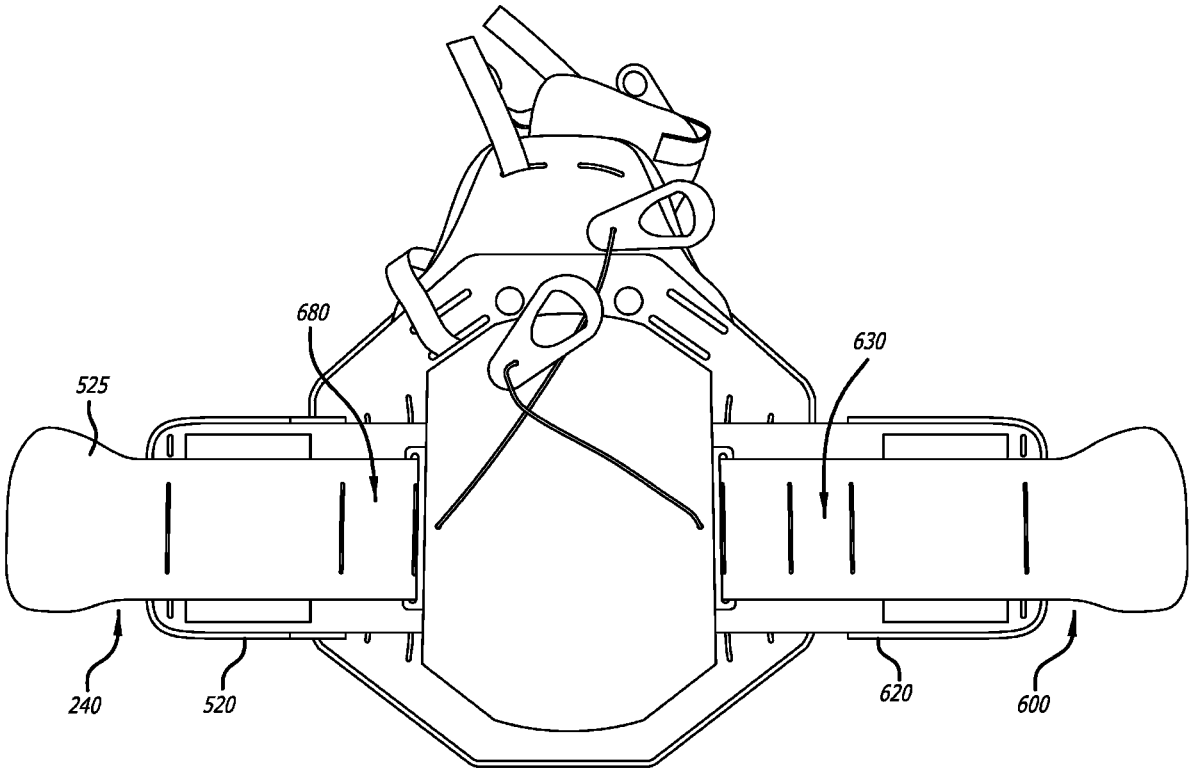
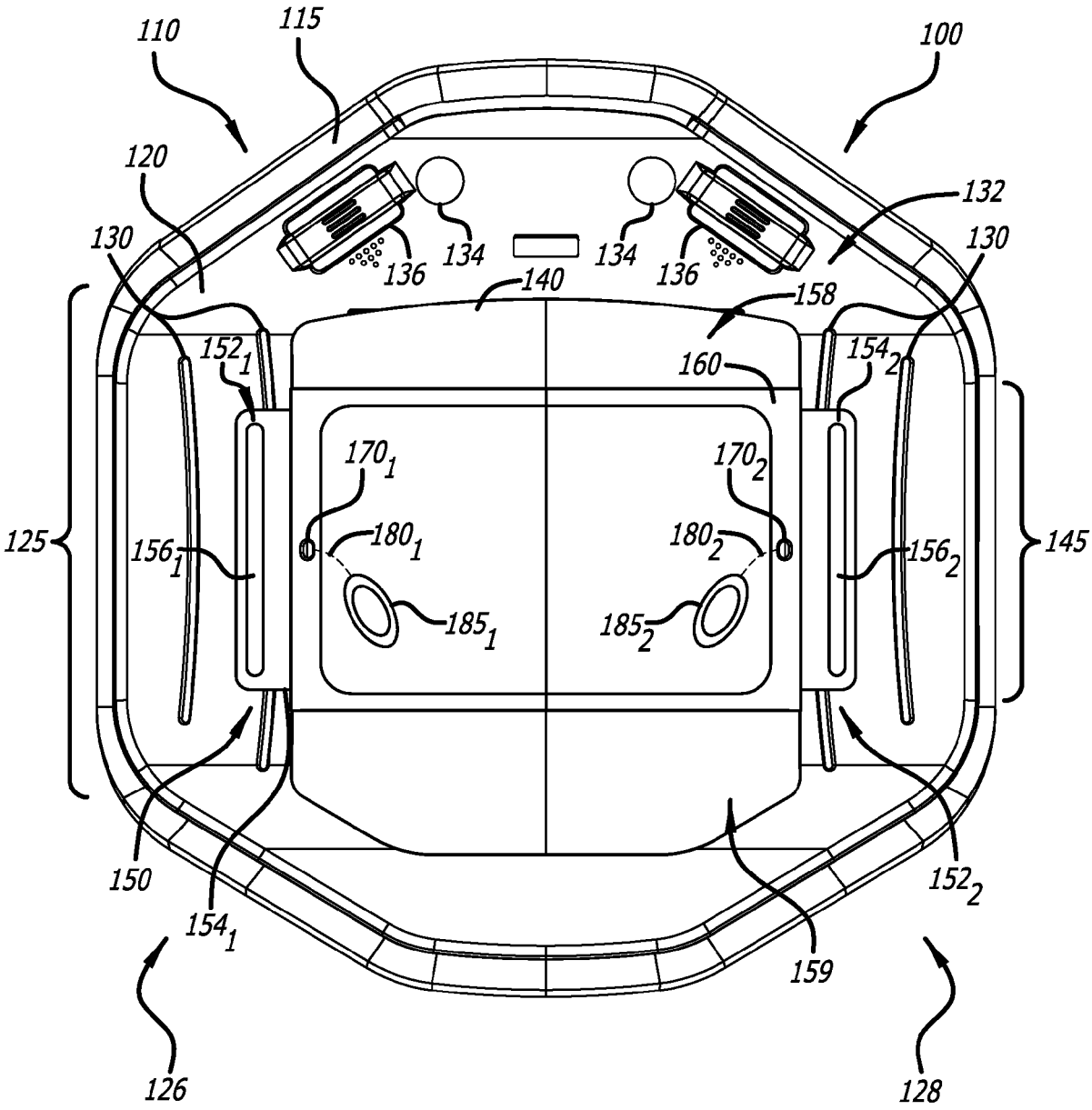


FIG. 1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180$_1$
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154$_1$
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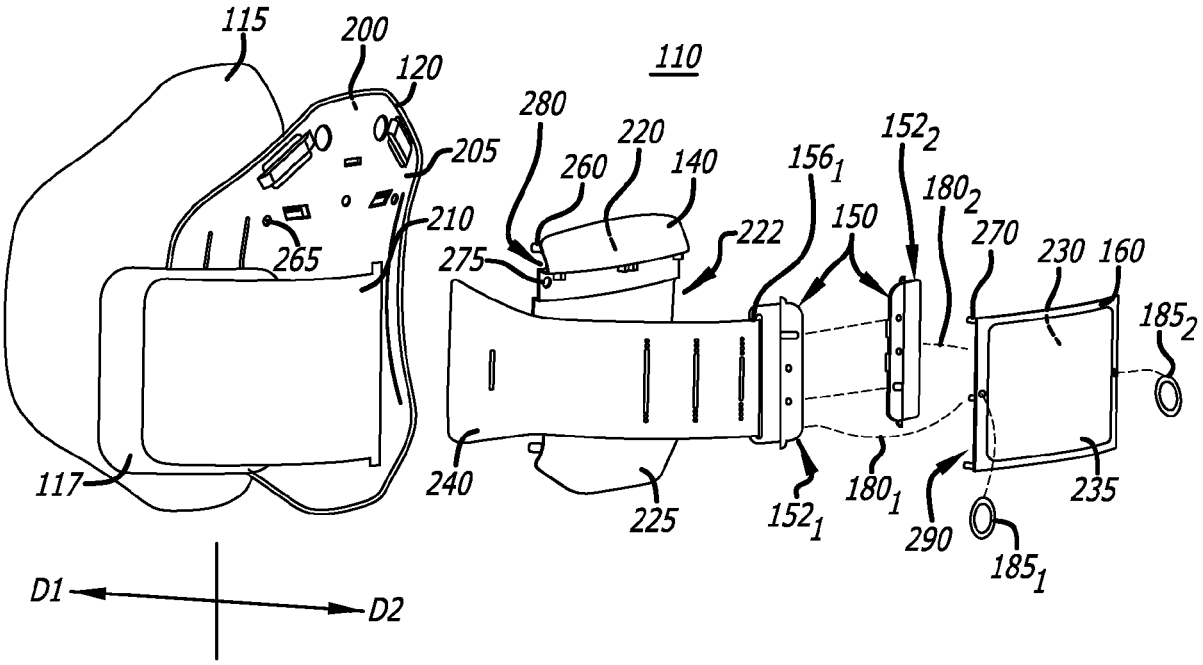
126
128

FIG. 2A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156$_1$
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205
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180$_2$
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117
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235
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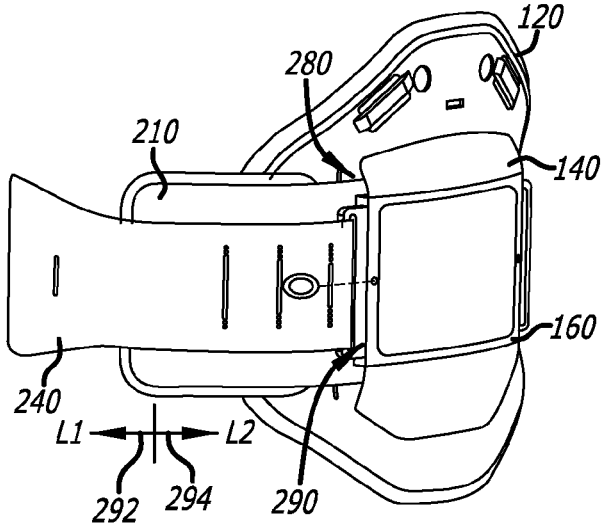
185$_1$
D1
D2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L2
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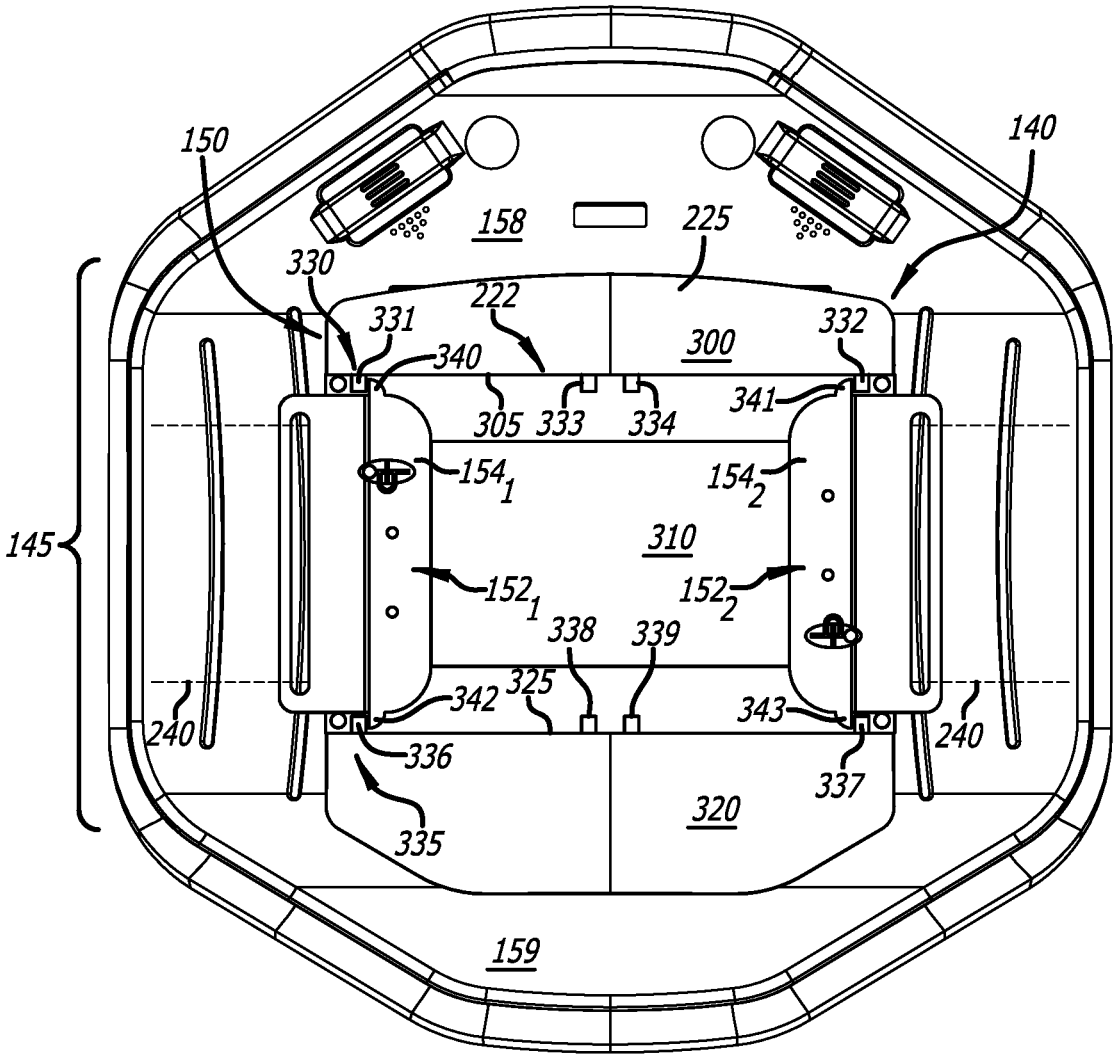
FIG. 2B

FIG. 3A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152₂
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325
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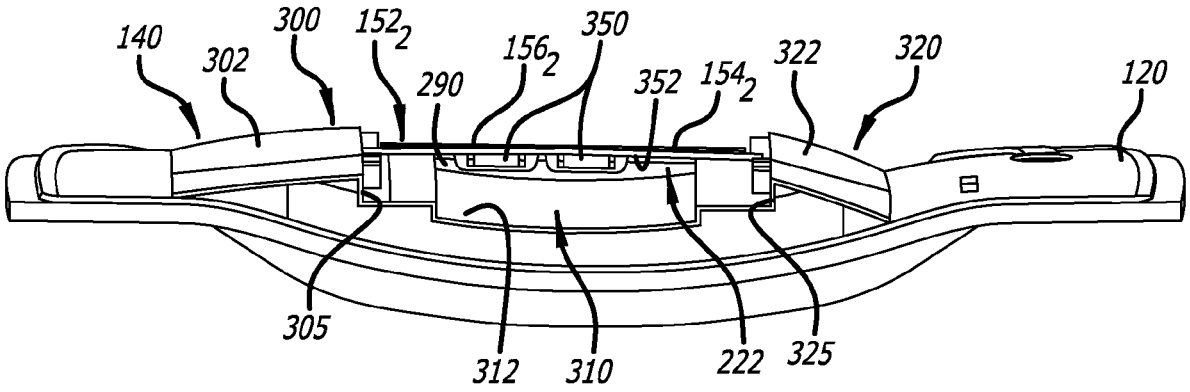
FIG. 3B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152_2
290
156_2
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154_2
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120
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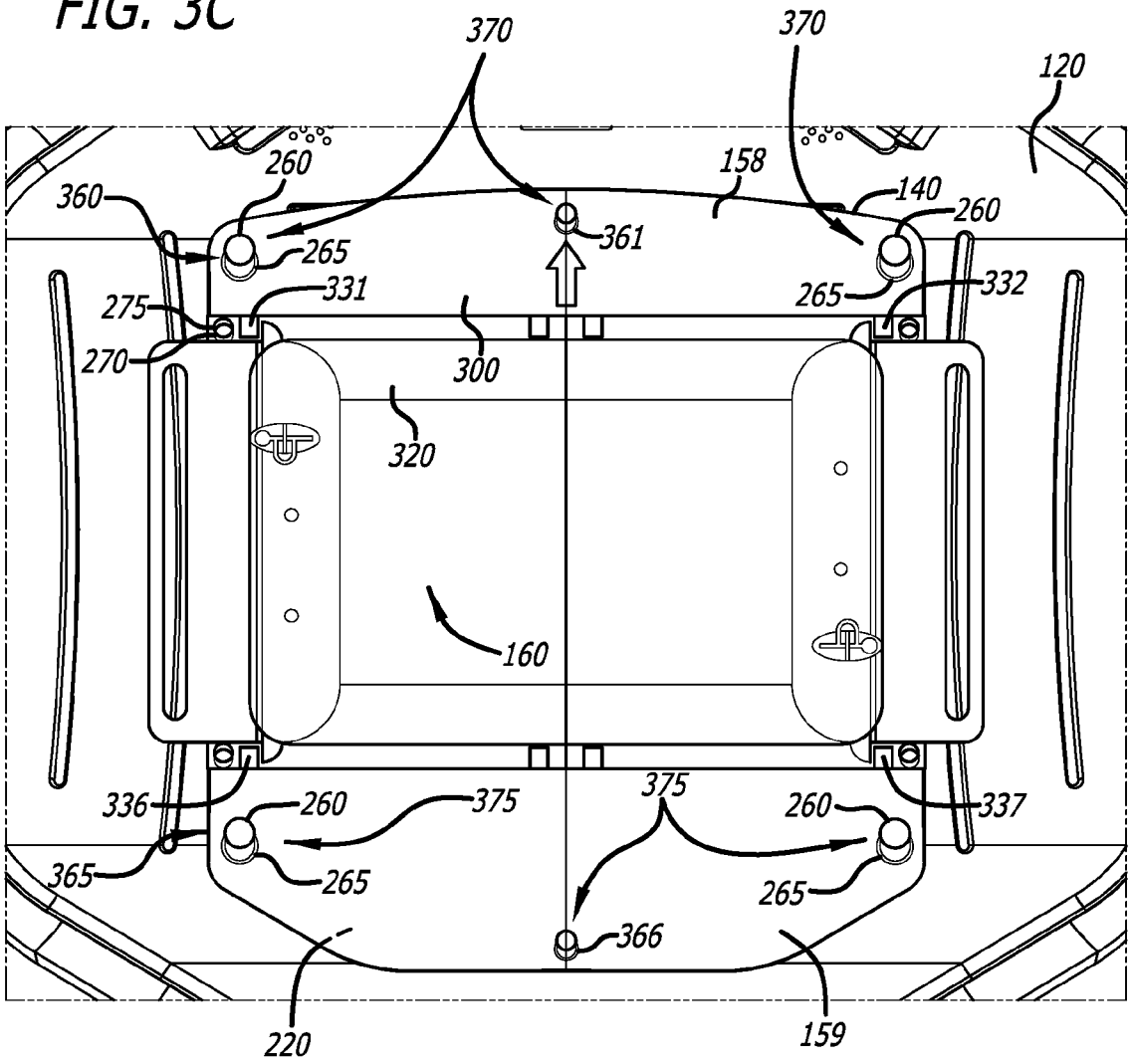
222
325

FIG. 3C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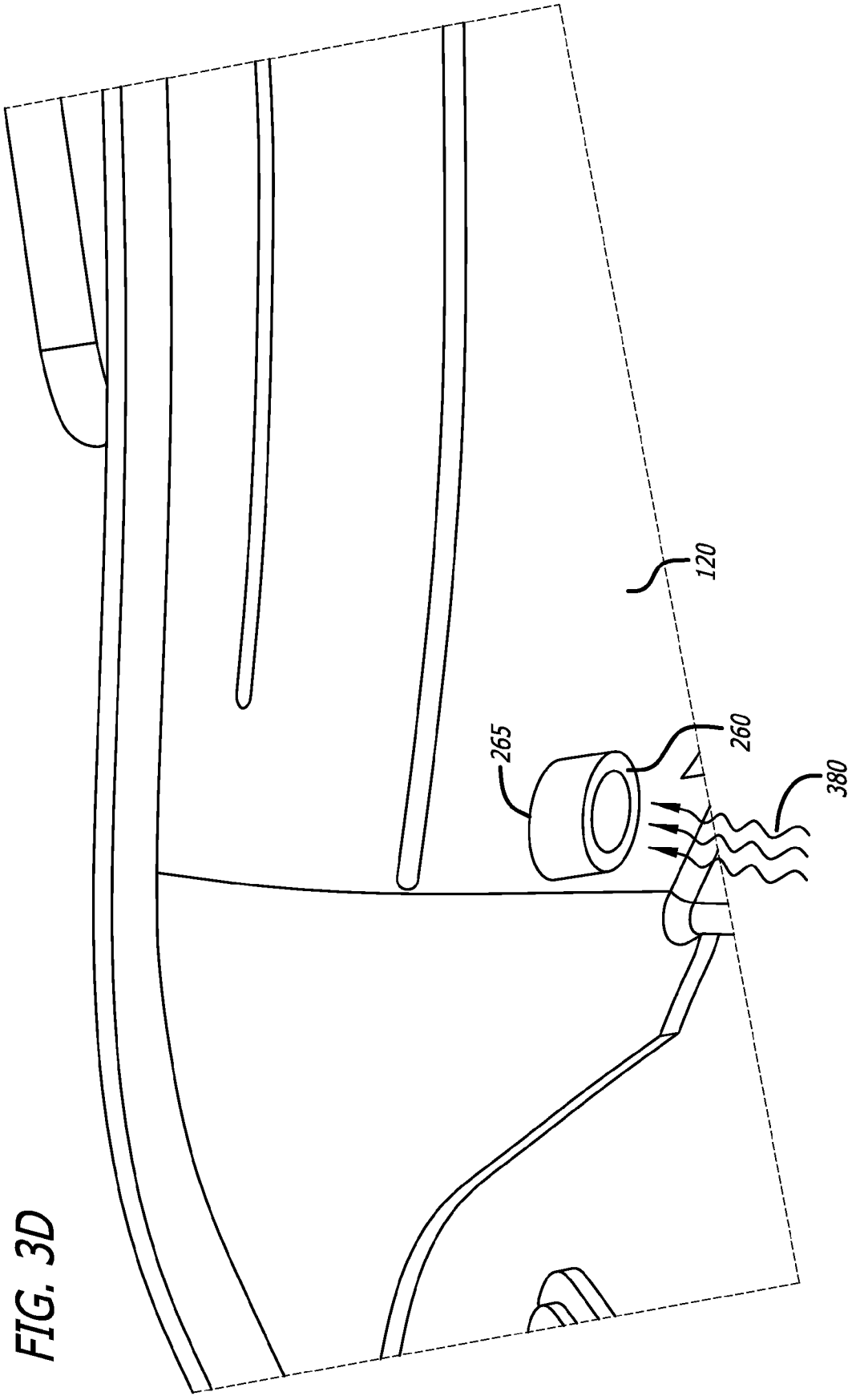
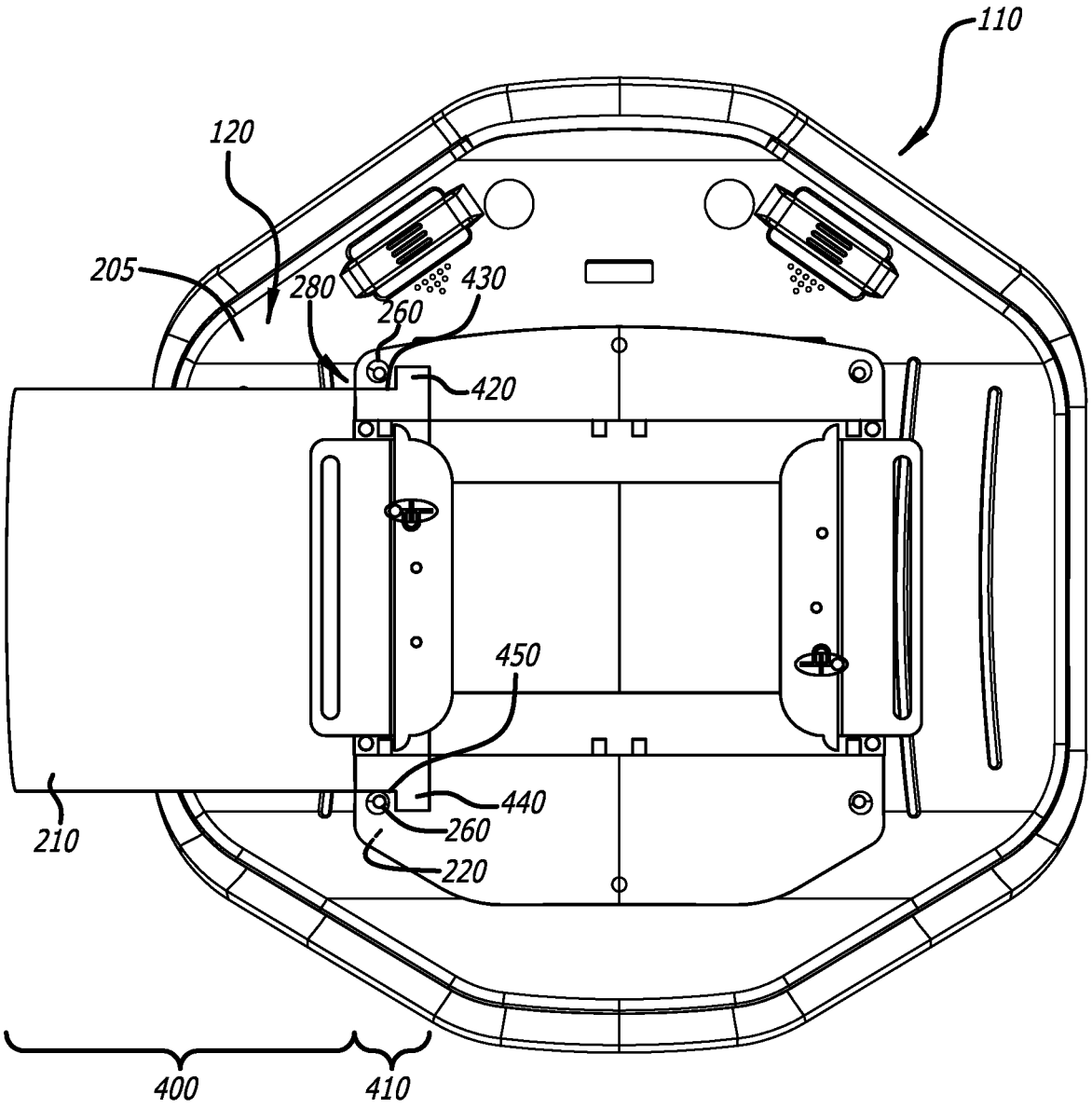


FIG. 3D

FIG. 4A



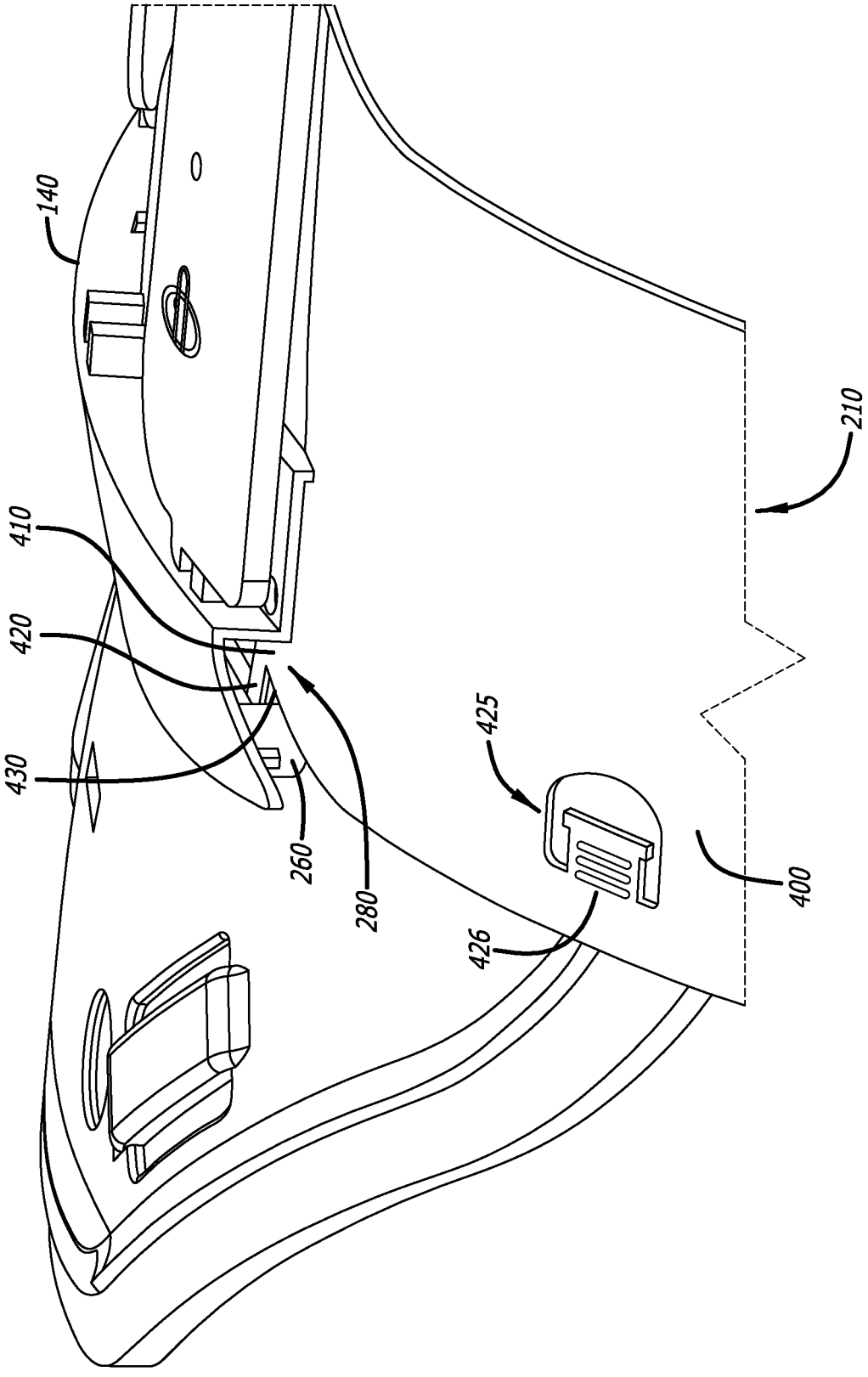


FIG. 4B

FIG. 4C

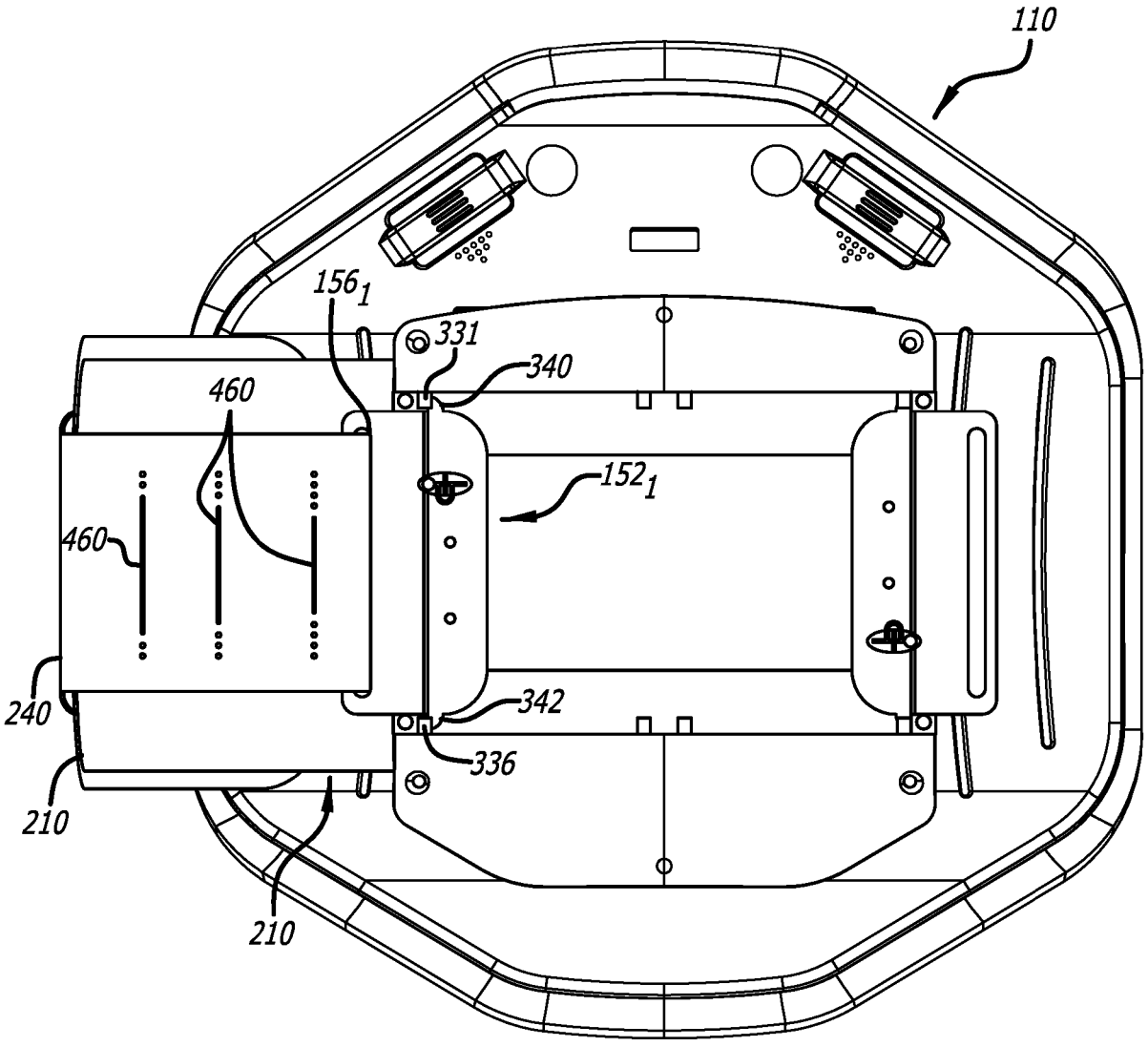
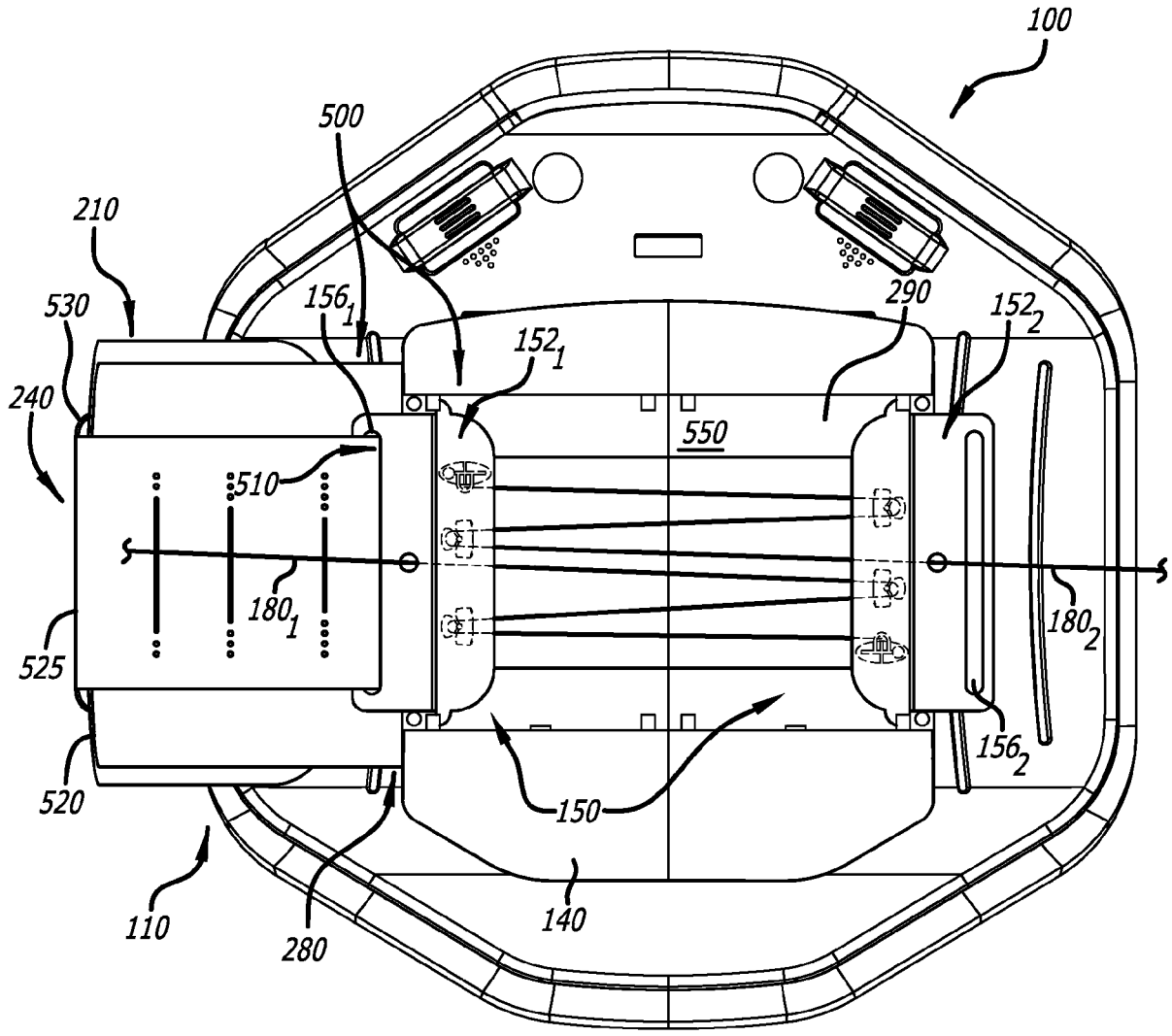


FIG. 5A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156$_1$
152$_1$
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140
180$_2$
156$_2$

FIG. 5B

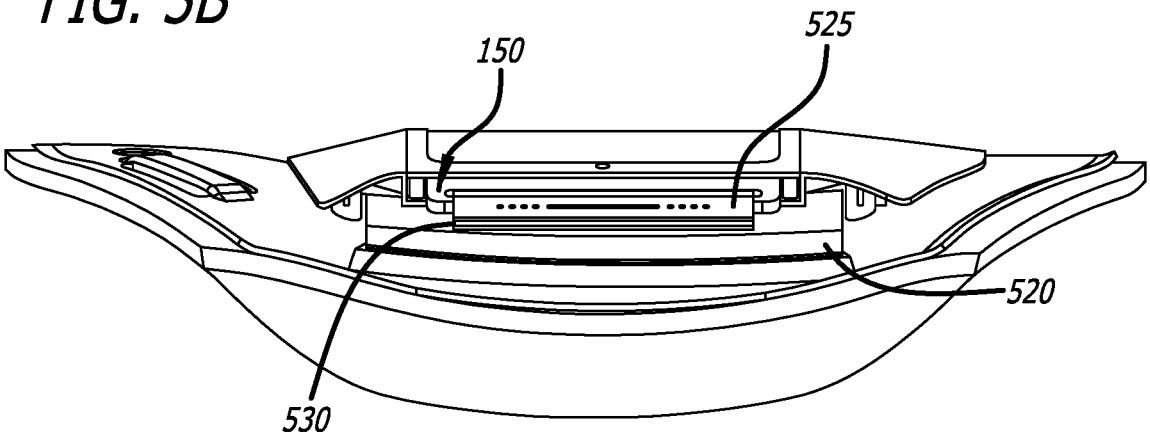
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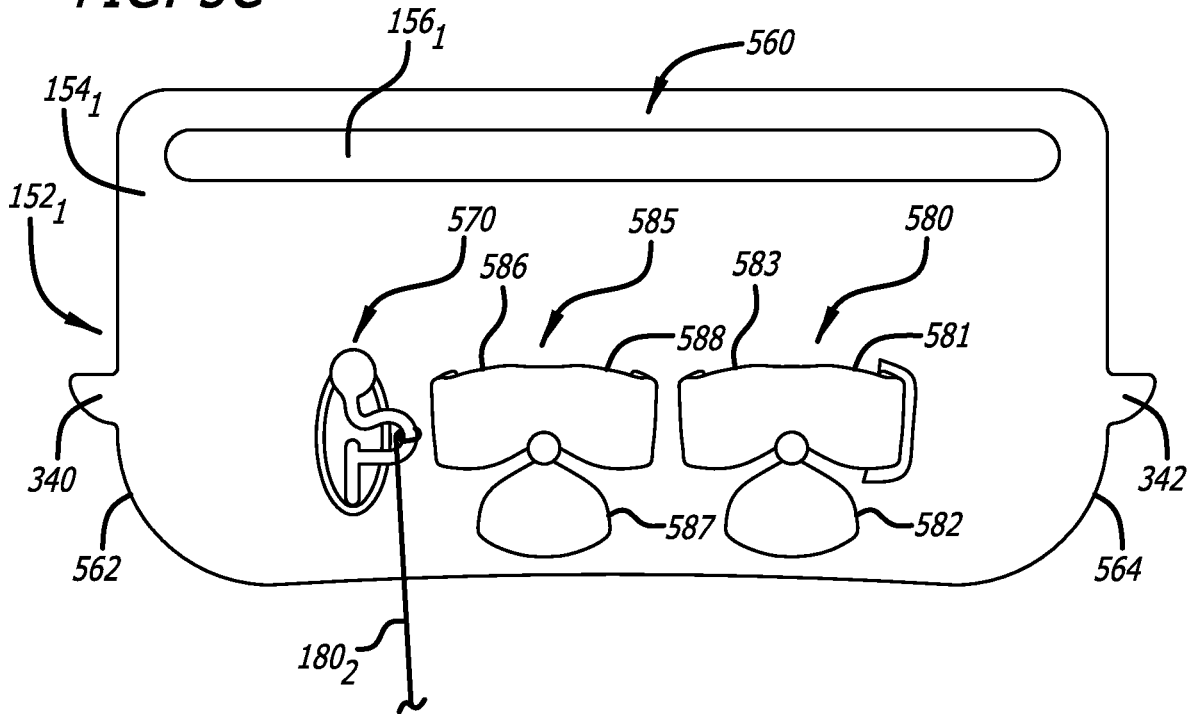
FIG. 5C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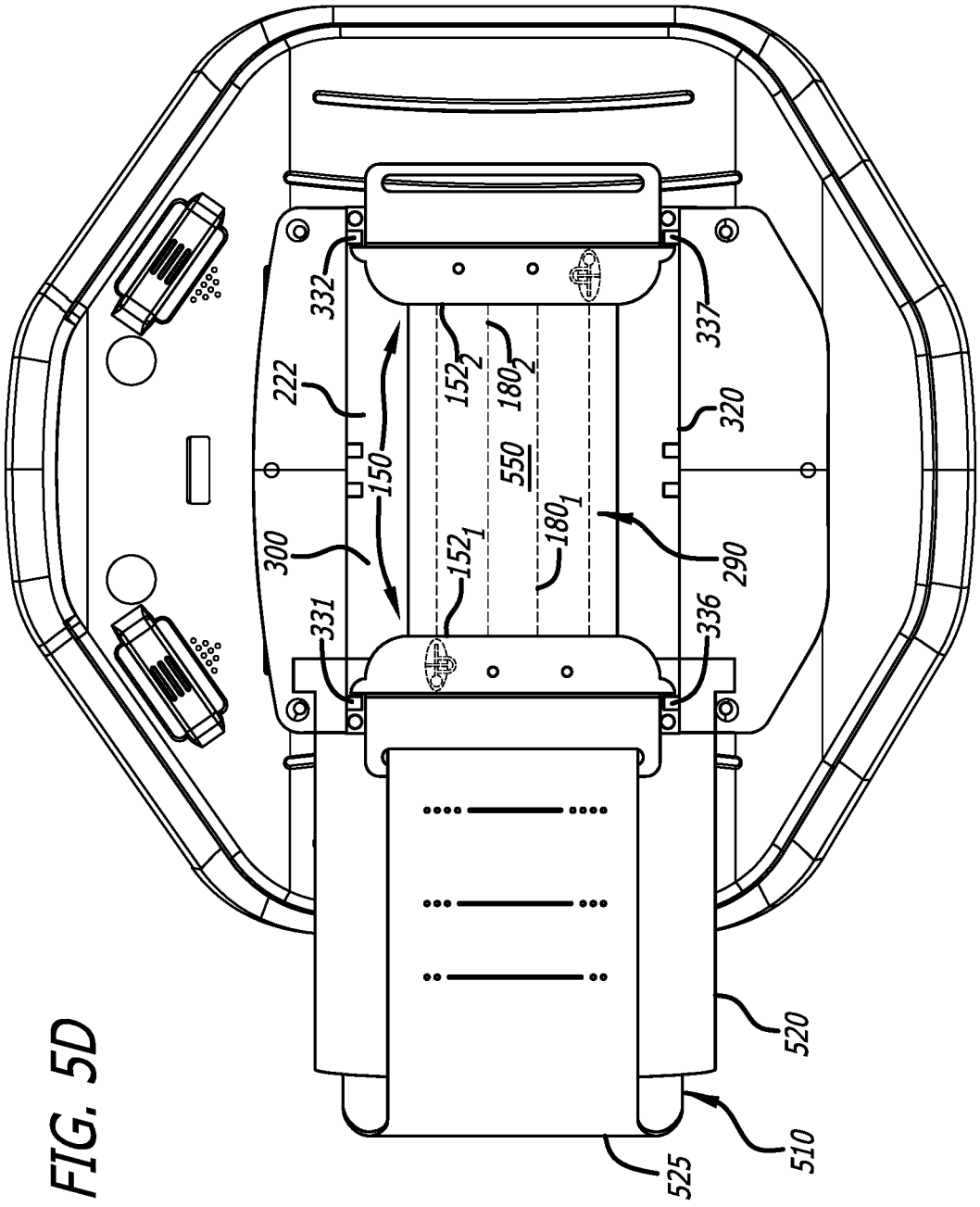
180_2


332
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180_2
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152_1
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FIG. 5D

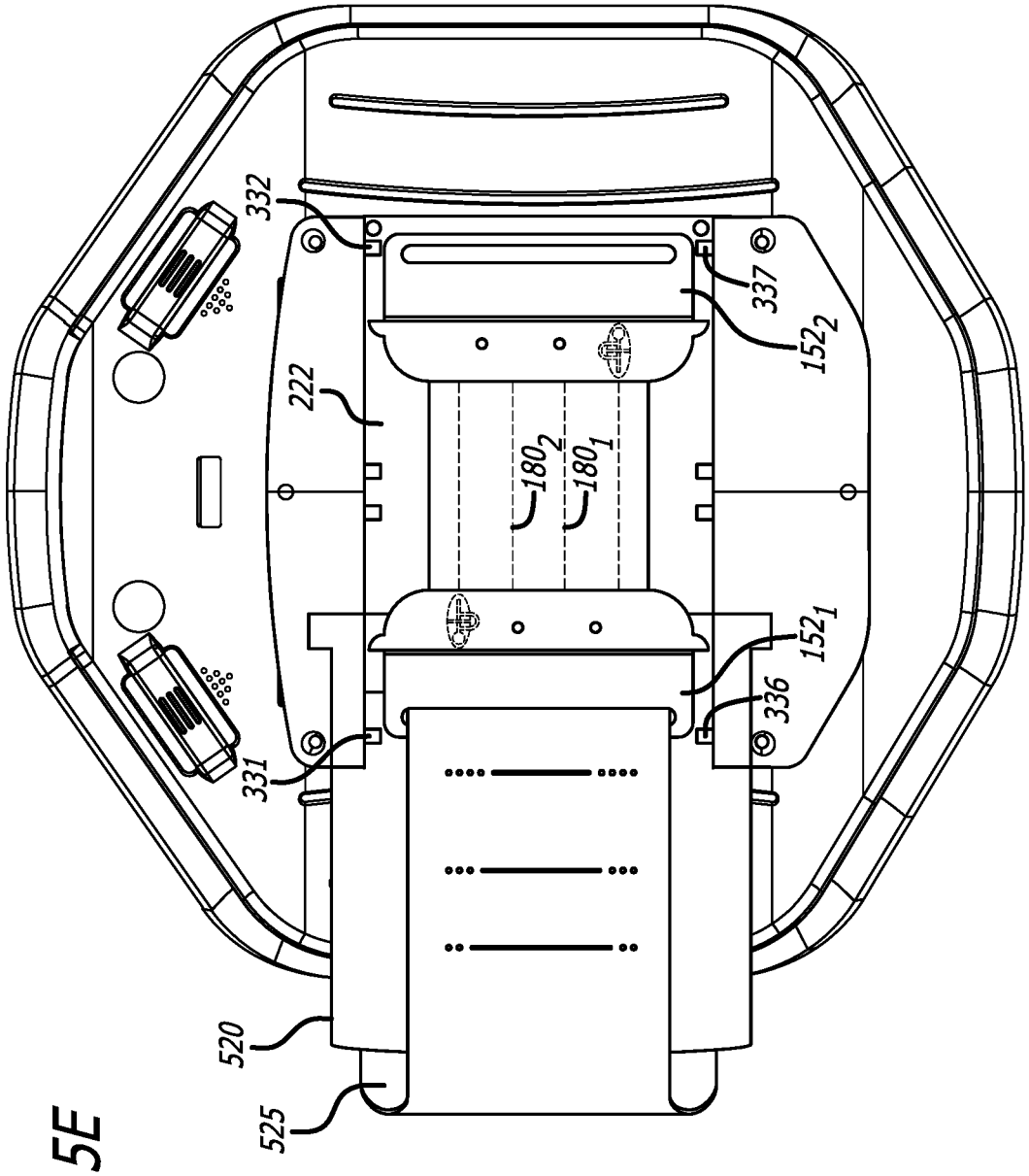

FIG. 5E

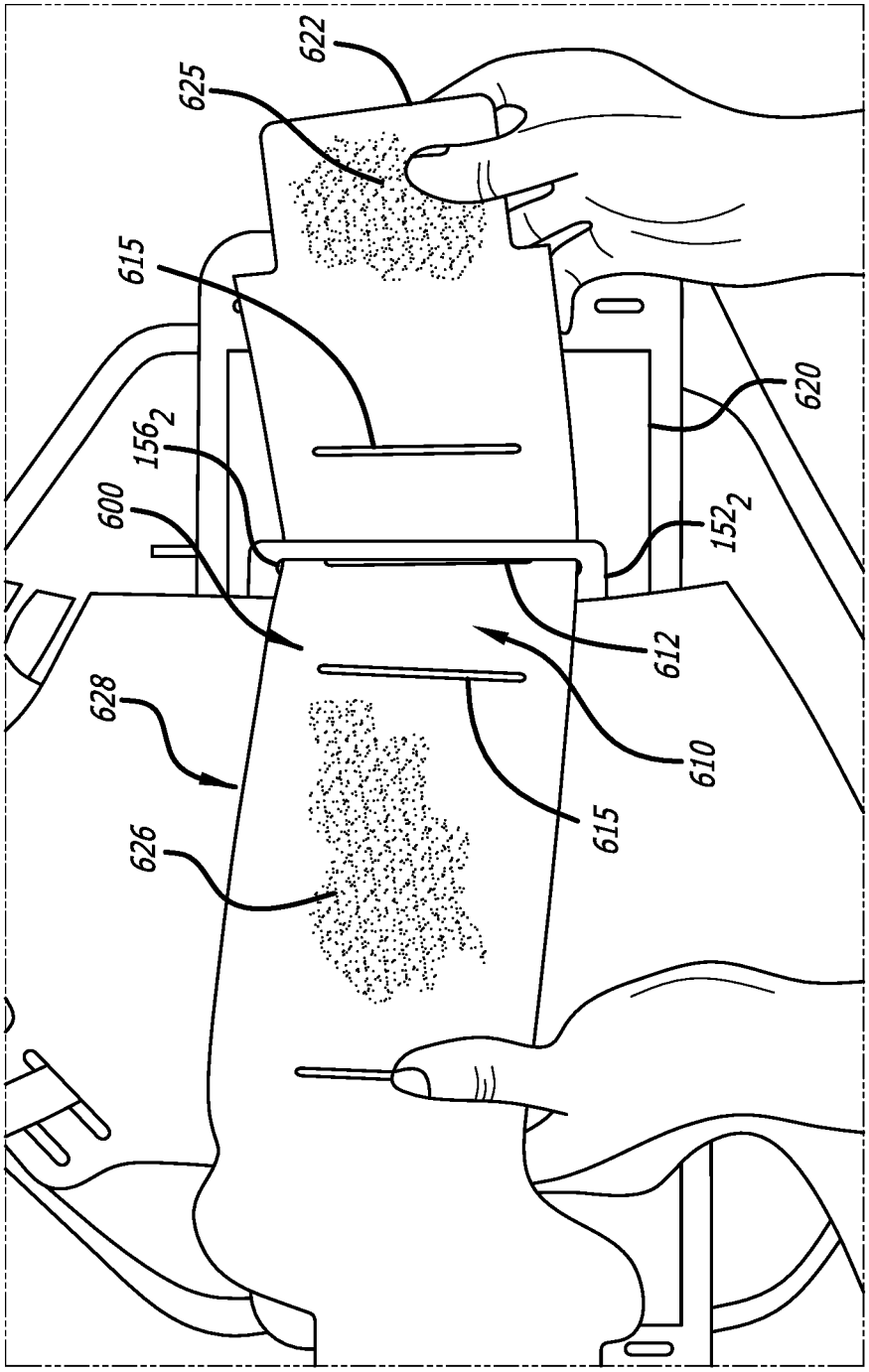

FIG. 6A

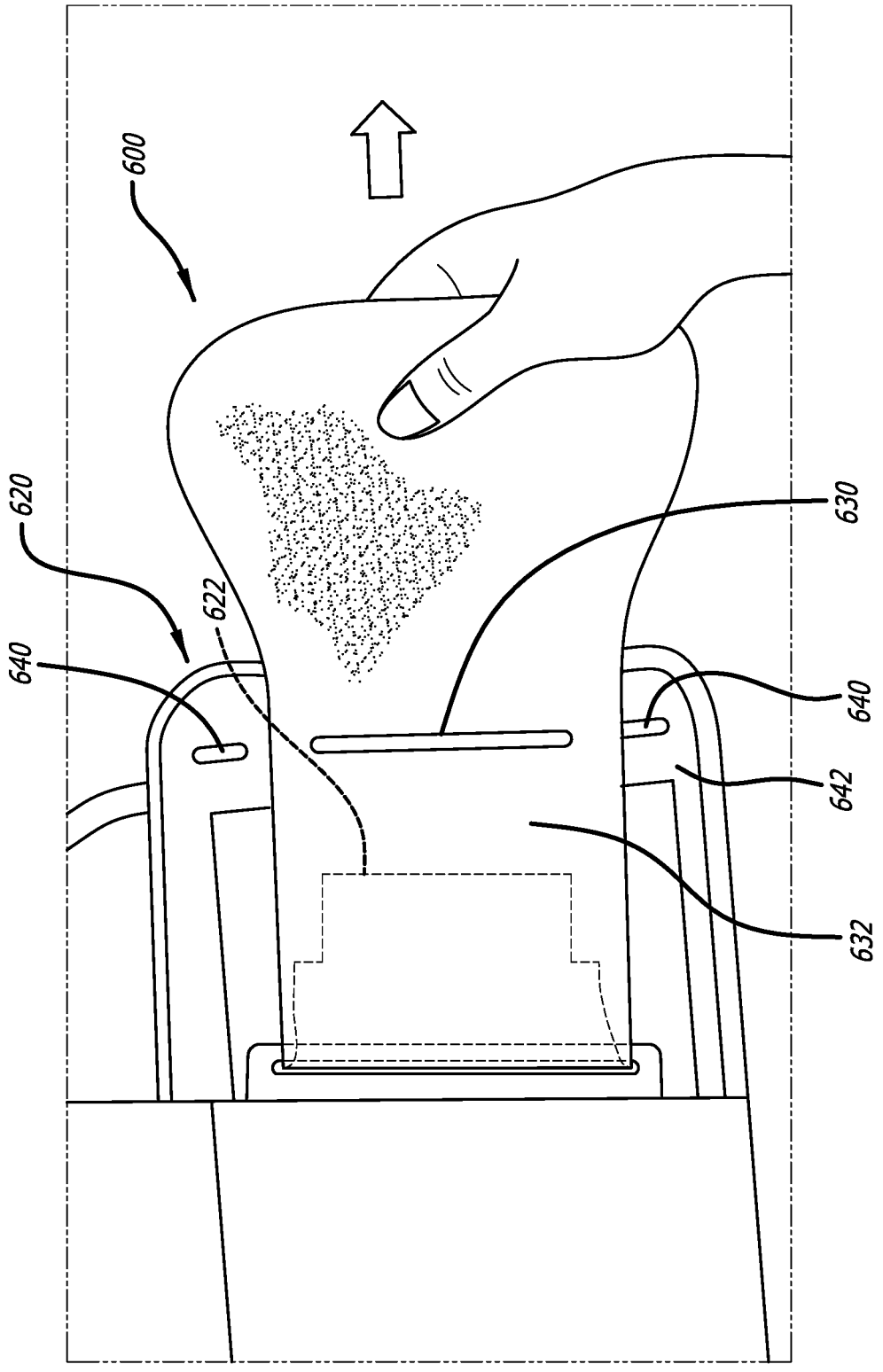

FIG. 6B

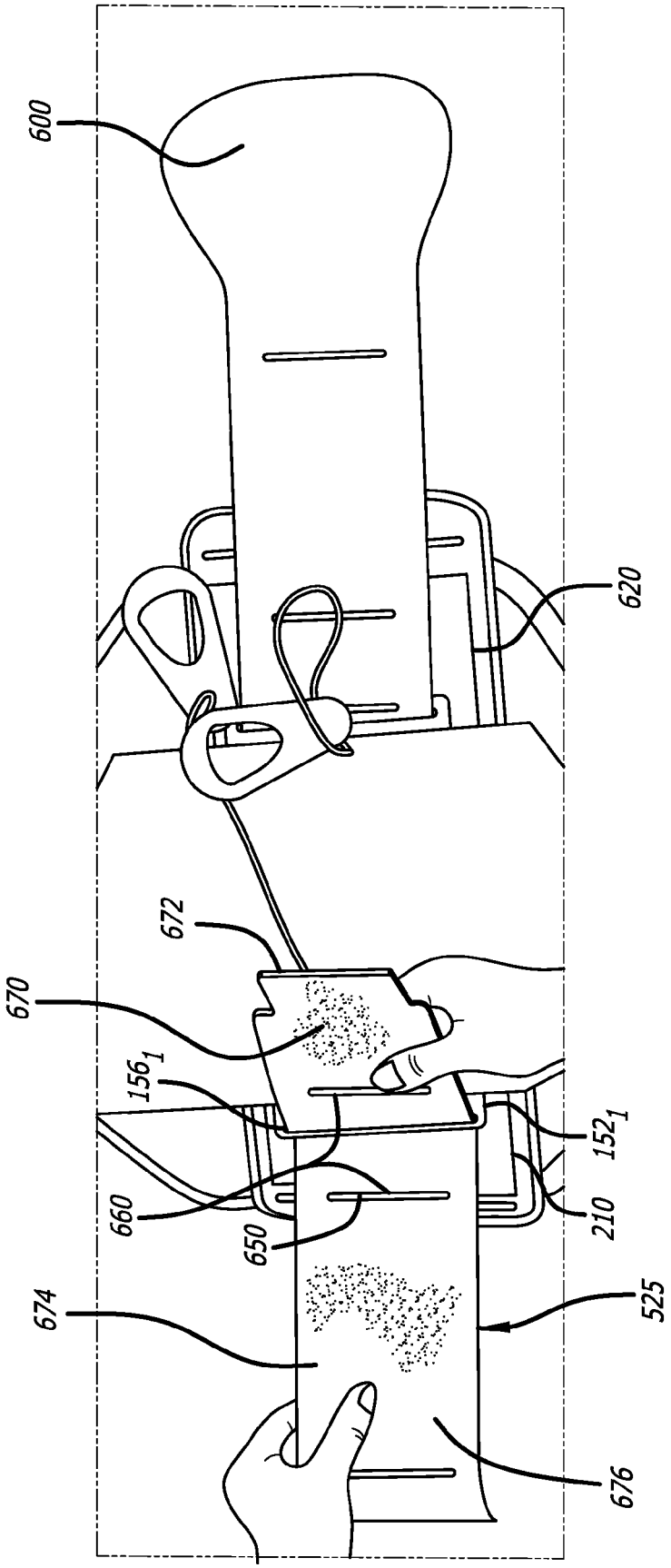

FIG. 6C

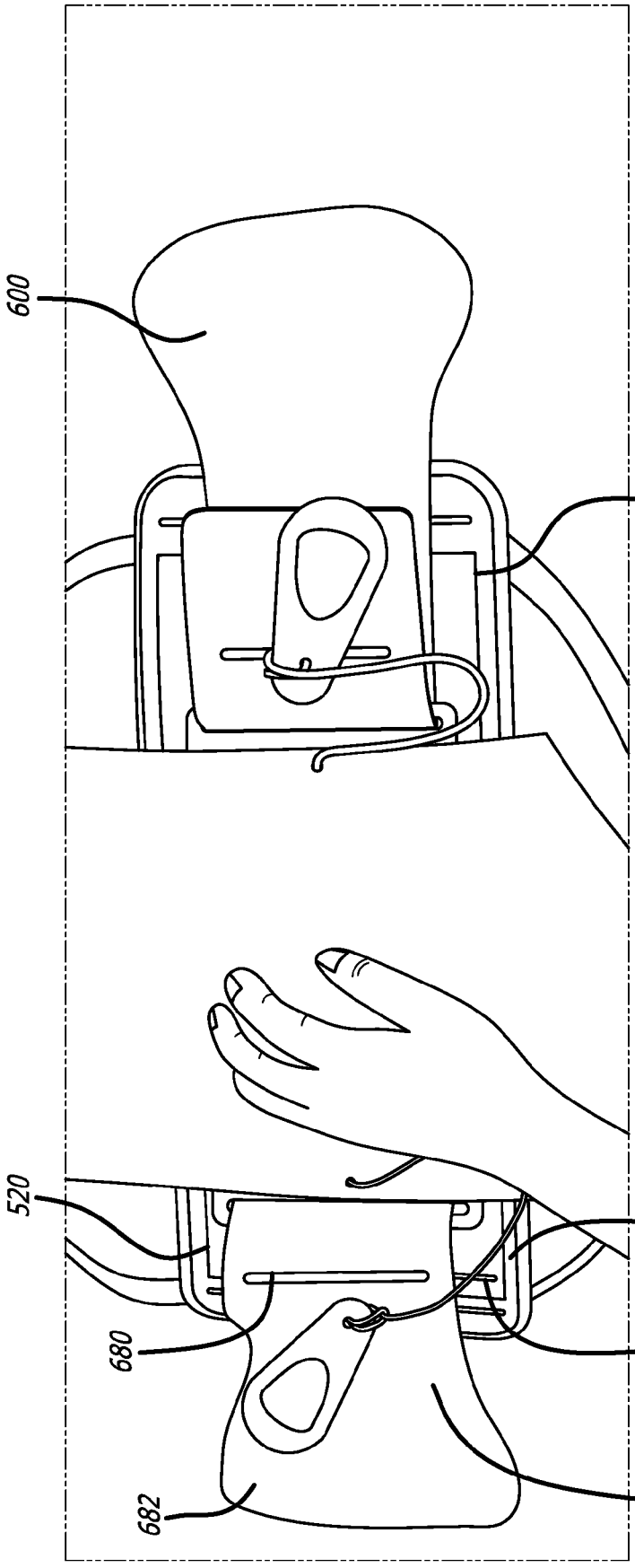

FIG. 6D

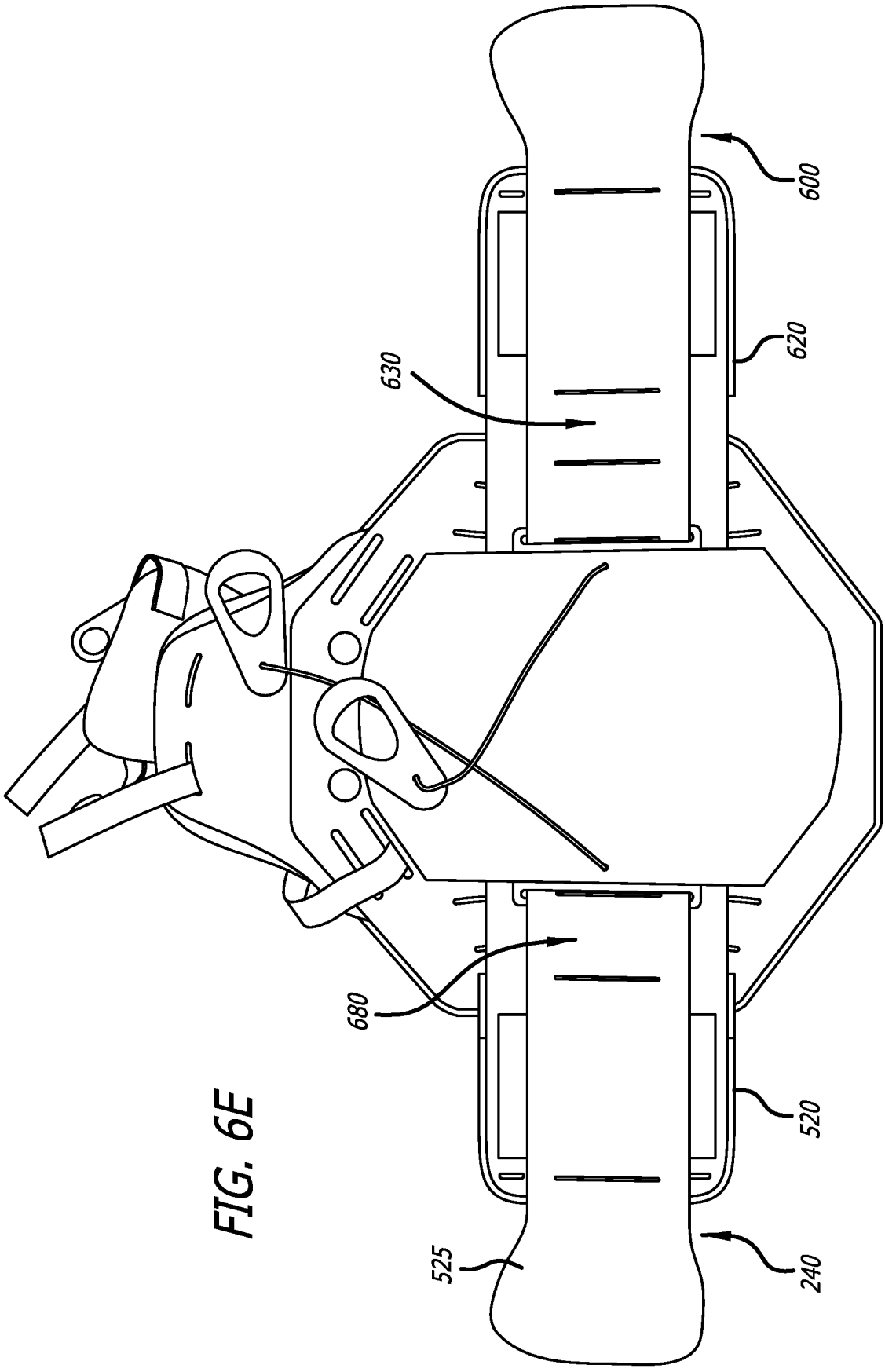

FIG. 6E

ORTHOPEDIC BRACE HAVING TELESCOPIC LATERAL PANELS AND AN ADJUSTABLE PULLEY SUBSYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority on U.S. Provisional Application No. 63/305,671 filed Feb. 1, 2022 and U.S. Provisional Application No. 63/305,678 filed Feb. 1, 2022, the entire contents of both of which are incorporated by reference herein.

FIELD

[0002] Embodiments of the disclosure relate to the field of medical devices. More specifically, one embodiment of the disclosure relates to an orthopedic brace and components thereof.

GENERAL BACKGROUND

[0003] The following description includes information that may be useful in understanding the described invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

[0004] Orthopedic braces (orthoses) usually need to be adjusted or customized in some manner to conform to the body part(s) being braced, and then properly positioned. A typical orthosis commonly has at least two portions, a rigid portion supporting a body part, and a flexible or semi-flexible portion securing the orthosis to the body. One type of orthopedic brace is referred to as a "thoracic-lumbar-sacral orthosis" or by the acronym "TLSO."

[0005] A TLSO is a brace that limits movement in a wearer's spine from the thoracic area (mid-back area) to the wearer's sacrum (lower-back area). At the same time, the TLSO allows a wearer's neck to move freely. This type of brace is normally used to provide support and stabilization of the spine after a back injury and/or surgery, and in some cases, may be utilized to address spinal pathologies.

[0006] One common problem associated with conventional TLSOs is the donning process is quite difficult, especially when the orthotist is trying to ensure that the TLSO properly fits to immobilize the patient as a proper fit of the orthosis normally provides the wearer with improved pain reduction and promotes healing. Conventional TLSOs rely on soft goods, namely a long belt extending from the posterior brace with a hook and loop fastener that is affixed to a complementary hook and loop fastener located on a top surface of the anterior brace, to secure the anterior brace to the posterior brace. Hence, the donning process may require the patient to be "log rolled" (moved face-down to face-up or vice versa) multiple times in order to adjust and fit the TLSO onto the patient. For example, the patient would be placed onto the posterior bracing system, then "log rolled" onto an anterior brace to allow the belt to be sized with excess belt strap being hidden. Thereafter, the patient may be "log rolled" one or more times to adjust the posterior bracing system or belt adjustment to better immobilize the patient. Avoidance of a complex (and in some cases painful) donning process would ensure more effective usage of TLSO-based orthopedic braces.

[0007] Furthermore, there are different braces for different conditions, including the usage of an orthopedic brace with a cervical collar, referred to as Cervical Thoracic Lumbar Sacral Orthosis (CTLSO). It would be advantageous to provide an orthopedic brace that features a uniform construction to enable transitioning from a TLSO to a CTLSO and vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Embodiments of the invention are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings, in which like references indicate similar elements and in which:

[0009] FIG. **1** is a perspective rear view of an exemplary embodiment of an orthopedic brace with a posterior bracing system.

[0010] FIG. **2**A is an exploded view of the exemplary embodiment of the posterior bracing system of FIG. **1**.

[0011] FIG. **2**B is an exemplary embodiment of the posterior bracing system of FIG. **1** with liner padding for donning.

[0012] FIG. **3**A is a top-down planar view of an exemplary embodiment of the pulley subsystem implemented with a guide channel formed within the posterior cover of FIG. **2**A.

[0013] FIG. **3**B is a side view of an exemplary embodiment of the posterior cover illustrating a second chamber formed, at least in part, by the guide channel.

[0014] FIG. **3**C is a cut-way view of an exemplary embodiment of support apertures implemented within the posterior panel of FIG. **2**A.

[0015] FIG. **3**D is a perspective view of an exemplary embodiment of a heat staking process, where a post and support aperture operate as a coupling point between the posterior panel and the posterior cover of FIG. **2**A.

[0016] FIG. **4**A is a top-down planar view of the brace adjustment system featuring telescopic panels and a belt deployed between the posterior panel and the posterior cover of FIG. **2**.

[0017] FIG. **4**B is a cut-away view of the brace adjustment system illustrating stops including a first stop type to preclude continued extension of the telescopic lateral panel from the first chamber formed between the posterior panel and the posterior cover.

[0018] FIG. **4**C is a top-down planar view of the posterior bracing system, featuring the telescopic lateral panel operating with the adjustable belt member.

[0019] FIG. **5**A is an exemplary embodiment of an orthosis fastening subsystem deployed within the orthopedic brace of FIG. **1**.

[0020] FIG. **5**B is a side view of an exemplary embodiment of posterior bracing system featuring the pulley subsystem of FIG. **5**A.

[0021] FIG. **5**C is a top-down planar view of an exemplary embodiment of the pulley base of FIG. **5**A.

[0022] FIG. **5**D is a top-down planar view of an exemplary embodiment of the pulley subsystem operating in a first state.

[0023] FIG. **5**E is a top-down planar view of an exemplary embodiment of the pulley subsystem operating in a second state in response to a tightening operation in which the telescopic lateral panel and the belt member partially return into the first and second chambers.

[0024] FIGS. **6**A-**6**B are exemplary embodiments of an internal sizing of the belt and subsequent sizing of the tele-

scopic lateral panel deployed within the posterior bracing system of FIG. **2**A.

[0025] FIGS. **6**C-**6**D are exemplary embodiments of an external sizing of the belt and subsequent sizing of the telescopic lateral panel deployed within the posterior bracing system of FIG. **2**A.

[0026] FIG. **6**E is an exemplary embodiment of the orthosis fastening system being adjusted to illustrate different lateral panel and belt member combinations with different size settings conducted in accordance with different belt sizing processes as illustrated in FIGS. **6**A-**6**D.

DETAILED DESCRIPTION

[0027] Embodiments of the present disclosure generally relate to an orthopedic brace including a posterior bracing system. According to one embodiment of the disclosure, the posterior bracing system features an orthosis fastening subsystem, which includes telescopic lateral panels that extend from opposite sides of the posterior bracing system and operate in concert with an adjustable belt to assist in donning of the orthopedic brace onto the patient. As described herein, the orthopedic brace may constitute any type of lumbar sacral orthosis (LSO), including a standard LSO (lower back brace belt) or other orthoses configured to provide greater patient immobilization, such as a thoracic LSO (TLSO), or a cervical TLSO (CTLSO) as described below.

[0028] When deployed as a TLSO or CTLSO or LSO, the posterior bracing system for the orthopedic brace may be configured in accordance with a layered component architecture including a posterior panel, a posterior cover, and a pulley cover. Each of these components may be formed with a rigid material, such as hardened plastic for example, to provide greater stiffness for immobilization of the patient. Herein, the posterior panel is shaped and sized to rest again the mid-to-lower portions of the patient's back to partially immobilize the spine of the patient. The posterior cover is sized to overlay a midsection area of the posterior panel, while the pulley cover is sized to overlay a midsection area of the posterior cover. This layered architecture creates distinct chambers for housing different components forming the orthosis fastening subsystem. For example, the posterior panel and posterior cover create a first chamber for housing and securing end portions of lateral (side) panels that can be slidably extended in a telescopic manner from side openings in the first chamber. Similarly, the posterior cover and the pulley cover create a second chamber for housing a pulley subsystem to which adjustable belt members are attached along with the telescopic lateral panels.

[0029] According to one embodiment of the disclosure, as an illustrative example, the posterior cover is positioned to partially overlay a rear surface of the posterior panel, such as a midsection of the posterior panel. As a result, the first chamber is created between the front (anterior facing) surface of the posterior cover and the rear (posterior facing) surface of the posterior panel. Additionally, the pulley cover is positioned to partially overlay a rear surface of the posterior cover, such as covering a recessed area formed as part of the posterior cover. As a result, a second chamber is created between the front (anterior) surface of the pulley cover and the rear (posterior) surface of the posterior cover.

[0030] Herein, a back of a patient may be positioned against a liner (padding) placed on a front (anterior) surface of the posterior panel. The front surface of the posterior panel is shaped with a contour that conforms with thoracic and lumbar regions of a patient's spine. A rear (posterior) surface of the posterior panel includes a first concave region that, in combination with the front surface of the posterior cover, creates the first chamber. The posterior cover includes posts that are coupled to the posterior panel, where such coupling may be realized by insertion of the posts into correspond support apertures and coupled thereto. According to one embodiment of the disclosure, the posts of the posterior cover may be formed of a solid material and inserted into corresponding apertures formed within the posterior panel. In response to the heat staking process, the posts are deformed to create a head portion that prevents removal of the post from being extracted from the aperture without removal of the head portion. The posts operate as (i) spacers to provide architectural stability by maintaining substantially constant side openings for adjustment of the telescopic lateral panels inward and outward from the first chamber and (ii) stops to preclude complete removal of the telescopic lateral panels from the first chamber.

[0031] The front surface of the pulley cover includes posts that are coupled to support apertures formed within the posterior cover. These posts may be applied in accordance with the heat staking process described above, or in the alternative, may be applied to be removable from these apertures (e.g., threaded, apertures with generally the same diameter as the posts for snug fitting, etc.) to allow an orthotist access to the pulley subsystem positioned under the pulley cover. These posts also operate as spacers, which provide architectural stability and allow movement of the pulley bases of the pulley subsystem unencumbered by forces being applied to the posterior cover and/or the pulley cover that would constrict a depth of the second chamber.

[0032] The pulley bases are interconnected by cords, where the tightening of the pulley cords (i.e., pulling on the handle at the end of the pulley cords) causes both pulley bases to transverse inwardly towards each other along a guide channel that is formed on a rear surface of the posterior cover to operate as part of the second chamber. During an inward traversal, the orthopedic belt is tightened. During such tightening, the pulley bases move inwardly towards each other, which causes the length of each belt member attached to a pulley bases along with lateral panel to which the belt member is attached, to reduce in size extending from the first and second chambers. Stated differently, during tightening, both the lateral panels and their corresponding belt members are drawn back into the first chamber and second chamber, respectively.

[0033] Conversely, by relaxing of the pulley cords (or loosening of the orthosis fastening subsystem), the pulley bases are moved outwardly towards pulley stops that are integrated as part of on the guide channel. Located on opposite sides of the pulley base, the flange members are positioned to engage with the stops when the belt and lateral panel extend from the first and second chambers to a prescribed length set during a belt adjustment process that may occur during the donning of the orthopedic brace.

I. Terminology

[0034] In the following description, certain terminology is used to describe aspects of the invention. For example, the term "member" may be construed as a structural component of an orthopedic brace. In certain situations, a member may

include a component covered by soft goods such as one or more textiles, one or more fabrics (woven fabrics and/or non-woven fabrics), leathers, and/or another covering material. These soft goods may feature "loop" type fasteners or other variants to which a "hook" type fastener may be attached or may feature a hook-type fastener for attachment to a loop-type fastener. In other situations, the member may be soft goods attached to another structural component of the orthopedic brace such as a textile or fabric sewn to form together such as a knit textile with pockets in which the structural component(s) can be positioned within the pocket(s).

[0035] The term "chamber" is a partially enclosed housing, namely a structure having partially enclosed perimeter except for one or more openings, such as at least two openings at opposite sides along the periphery for example. As a result, a partially enclosed chamber operates as a structure that is configured to secure, maintain and protect orthosis fastening subsystem components.

[0036] The term "attach" and other tenses of the term (attached, attaching, etc.) may be construed as physically connecting a first member to a second member. A "fastener" may be construed as any physical component that is used to attach different members together. An illustrative example of different types of fasteners and fastening techniques may include, but are not limited or restricted to snaps, buttons, clasps, buckles, adhesives, sewing, heat sealing (or melting), gluing, knitting, or other physical coupling techniques such as a hook and loop connection.

[0037] The terms "rigid" or "rigidity" with respect to a member or portion of a member may be construed as the member being configured to at least partially resist bending or deformation. According to this definition, different lengths of a given structure and composition can be rigid at a shorter length, and flexible at a longer length. As used herein, the term "rigid" with respect to a member or portion of a member may be construed as the member could be permanently deformed or broken if bent or twisted by at least 90°. Examples of a rigid member may include, but is not limited or restricted to the posterior panel or the extension panel, where the telescopic lateral panels are rigid, but are flexible to support placement into a concave-shape without breaking.

[0038] Finally, the terms "or" and "and/or" as used herein are to be interpreted as inclusive or meaning any one or any combination. As an example, "A, B or C" or "A, B and/or C" mean "any of the following: A; B; C; A and B; A and C; B and C; A, B and C." An exception to this definition will occur only when a combination of elements, functions, steps or acts are in some way inherently mutually exclusive.

[0039] As this invention is susceptible to embodiments of many different forms, it is intended that the present disclosure is to be considered as an example of the principles of the invention and not intended to limit the invention to the specific embodiments shown and described.

II. General Architecture

[0040] Referring to FIG. **1**, a perspective rear view of an exemplary embodiment of a posterior bracing system **110** deployed as part of an orthopedic brace **100** is shown. Herein, the posterior bracing system **110** features a posterior panel **120** that is oriented, when worn, to generally reside or is substantially in parallel with a frontal plane of the patient. As shown, a filler **115** (padding) may be inserted adjacent to an anterior surface of the posterior panel **120**. The posterior panel **120** provides support along a thoracic and lumbar regions of the patient's spine.

[0041] As further shown, the posterior bracing system **110** further features a plurality of structural members layered onto the posterior panel **120** to create a plurality of chambers therebetween. These structural members may include, but are not limited or restricted to a posterior cover **140** and a pulley cover **160**. The posterior cover **140** is coupled to a curved, midsection region **125** of the posterior panel **120**. This midsection region **125** is generally concave in shape to conform with the thoracic and lumbar regions of a patient's spine. One or more slotted openings **130** are positioned on each side (left **126**, right **128**) of the midsection region **125** to lessen lateral rigidity of the posterior panel **120** to allow for lateral and anterior movement of the sides of the posterior panel **120** when worn. As also shown, a top area **132** of the posterior panel **120** features locking slots **134** for retention of extension panels (not shown) and strap slots **136** for retention of an attachment strap (not shown).

[0042] The pulley cover **160** is coupled to the posterior cover **140**, namely at a midsection region **145** of the posterior cover **140**. This midsection region **145** of the posterior cover **140** features a recessed area (not shown), which is shaped to maintain a pulley subsystem **150** including a plurality of pulley bases $\mathbf{152}_1$-$\mathbf{152}_2$. Each of the pulley bases $\mathbf{152}_1$ or $\mathbf{152}_2$ includes (i) a base member $\mathbf{154}_1$ or $\mathbf{154}_2$ with a plurality of pulley members (not shown) positioned in a staggered orientation and interconnected with a designated pulley cord $\mathbf{180}_1$ or $\mathbf{180}_2$ with a handle $\mathbf{185}_1$ or $\mathbf{185}_2$, and (ii) a belt slot $\mathbf{156}_1$ or $\mathbf{156}_2$ positioned on an outer lateral edge of the pulley base member $\mathbf{154}_1$ or $\mathbf{154}_2$. Each pulley cord $\mathbf{180}_1$ or $\mathbf{180}_2$ is threaded through cord passage apertures $\mathbf{170}_1$ or $\mathbf{170}_2$ that reside within the same traversal plane. The pulley cover **160** is smaller in size (e.g., width and height) than the posterior cover **140** so as to overlay the recessed area of the posterior cover **140** so that the pulley cover **160** refrains from covering a top cover region **158** and a bottom cover region **159** of the posterior cover **140**.

[0043] Referring to FIG. **2**A, an exploded view of an exemplary embodiment of the posterior bracing system **110** of FIG. **1** is shown. Herein, the posterior bracing system **110** features the posterior panel **120**, the posterior cover **140** and the pulley cover **160** as shown in FIG. **1**. The liner **115** is positioned anterior to a front surface **200** of the posterior panel **120**. Furthermore, a plurality of lateral panels **210** are made of a rigid or semi-rigid material such as any type of hardened, flexible plastic (e.g., sheet of polyethylene, polycarbonate, etc.) and are positioned within a first chamber **280** (see also FIG. **2**B) formed between a rear surface **205** of the posterior panel **120** and a front surface **220** of the posterior cover **140** (and adjacent to another liner **117**). The pulley subsystem **150** is positioned within a second chamber **290** (see also FIG. **2**B), which is formed between a rear surface **225** of the posterior cover **140** and a front (anterior) surface **230** of the pulley cover **160**. Adjustable belt members **240** are attached to the belt slots $\mathbf{156}_1$-$\mathbf{156}_2$ formed within the pulley bases $\mathbf{152}_1$-$\mathbf{152}_2$.

[0044] More specifically, the front surface **220** of the posterior cover **140** includes a plurality of posts **260**, which are coupled to the posterior panel **120**, where such coupling may be realized by insertion of the posts **260** into correspond support apertures **265** within the posterior panel **120**

and permanently fused thereto (e.g., coupled together by a heat staking process). The posts **260** operate as (i) spacers to provide structural integrity by maintaining substantially constant width to side openings formed within the first chamber **280** (see FIG. **2**B) for adjustment of the telescopic lateral panels **210** inward and outward from the first chamber **280** and (ii) stops to preclude complete removal of the lateral panels **210** from the first chamber **280** by tab portions of the lateral panels **210** engaging with the posts **260** as shown in FIGS. **4**A-**4**B and described below.

[0045] Herein, according to one embodiment of the disclosure, the telescopic lateral panels **210** provide support by lessening circumferential pressure and helping with stabilizing the spinal system from bending sideways (coronal plane). The rigid, plastic lateral panels **210** may extend from sacrococcygeal junction area and terminate just inferior to the scapular spine. In combination with lateral panels associated with an anterior bracing system (not shown) that extend from symphysis pubis to the sternal notch, soft liner, the lateral panels **210** assist in restricting gross trunk motion in sagittal, coronal, and transverse planes as well as provides lateral strength.

[0046] Additionally, the pulley cover **160** features the front surface **230** that also includes a plurality of posts **270**. However, the posts **270** may be removably coupled to support apertures **275** formed within the posterior cover **140**. The posts **270** operate as spacers, which provide the structural integrity to resist substantial narrowing or closure of side openings formed within the second chamber **290** in response to forces exerted on the pulley cover **160** in an anterior direction D1 or forces exerted on the posterior cover **140** in a posterior direction D**2**. This allows the belt slots $\mathbf{156}_1$-$\mathbf{156}_2$ located on the pulley bases $\mathbf{152}_1$-$\mathbf{152}_2$ to be exposed from the second chamber **290** and unencumbered during usage.

[0047] Referring to both FIGS. **2**A-**2**B, the pulley bases $\mathbf{152}_1$-$\mathbf{152}_2$ are interconnected by the pulley cords $\mathbf{180}_1$-$\mathbf{180}_2$ extending from a back (posterior) surface **235** of the pulley cover **160**, where the tightening of one or both of the pulley cords $\mathbf{180}_1$-$\mathbf{180}_2$ (i.e., pulling on the handle $\mathbf{185}_1$ at the end of the pulley cord $\mathbf{180}_1$) causes both pulley bases $\mathbf{152}_1$-$\mathbf{152}_2$ to traverse inwardly towards each other along a guide channel **222** formed on the rear surface **225** of the posterior cover **140**. During traversal, one or more of the orthopedic belt members **240** is tightened. During such tightening, the pulley bases $\mathbf{152}_1$-$\mathbf{152}_2$ move inwardly towards each other, which cause the length of each of the lateral panels (e.g., lateral panel **210**) and its corresponding belt member **240**, respectively extending from the first and second chambers **280** and **290**, to be reduced as each belt member **240** is coupled to its corresponding lateral panel via hook and loop fastener, a loop connection attached to a surface of the belt member **240** and fed through a slot in the lateral panel **210** for attachment to a complementary fastener on the lateral panel. As a result, during adjustment, both the lateral panel **210** and its corresponding belt member **240** may be moved along a first lateral direction (L**1**) **292** away from the first and second chambers **280** and **290**. However, during tightening, the lateral panel **210** and its corresponding belt member **240** is drawn back into the first chamber **280** and second chamber **290** in accordance with a second lateral direction (L**2**) **294**, as described in more detail below.

[0048] Referring to FIG. **3**A, a top-down planar view of an exemplary embodiment of the pulley subsystem **150** implemented with the guide channel **222** formed within the posterior cover **140** is shown. Illustrating a rear surface **225** of the posterior cover **140**, the posterior cover **140** is structured with the midsection cover region **145** integrated with and interposed between the top cover region **158** and the bottom cover region **159**. The midsection cover region **145** features the guide channel **222** formed by a first guide member **300**, a second guide member **310**, and a third guide member **320**.

[0049] As further shown in FIG. **3**A, a first set (two or more) of pulley stops **330** are positioned along a side surface **305** of the first guide member **300** and a second set of pulley stops **335** are positioned along a side surface **325** of the third guide member **320**. The first and second sets of pulley stops **330** and **335** are positioned to prevent the pulley bases $\mathbf{152}_1$ and $\mathbf{152}_2$ from being accidentally slid and removed from the guide channel **222**. More specifically, each pulley base member $\mathbf{154}_1$ and $\mathbf{154}_2$ features a first flange **340** and **341**, which is positioned to engage with one of the first set of pulley stops **330** (e.g., pulley stops **331** and **332**) when each belt member **240** is set to a prescribed size and is fully extended from the second chamber **290**. Similarly, each pulley base member $\mathbf{154}_1$ and $\mathbf{154}_2$ features a second flange **342** and **343**, which is positioned to engage with one of the second set of pulley stops **335** (e.g., pulley stops **336** and **337**) when each belt member **240** is set to a prescribed size and is fully extended from the second chamber **290**. As an optional feature, besides pulley stops **331**-**332** and **336**-**337**, the first and second set of pulley stops **330** and **335** may include pulley stops **333**-**334** and **338**-**339** to prevent further inward movement of the pulley bases $\mathbf{152}_1$ and $\mathbf{152}_2$ beyond a prescribed location.

[0050] Referring now to FIG. **3**B, a side view of an exemplary embodiment of the posterior cover **140** is shown, which illustrates the second chamber **290** formed, at least in part, by the guide channel **222**. Herein, given that the posterior panel **120** is shaped to conform with the contours of the thoracic and lumbar back regions, a rear-facing surface **312** of the second guide member **310** is positioned below a rear-facing surface **302** of the first guide member **300** and a rear-facing surface **322** of the third guide member **320**. The rear-facing surface **302** of the first guide member **300** is generally orthogonal to the side surface **305** of the first guide member **300**, and the rear-facing surface **322** of the third guide member **320** is generally orthogonal to the side surface **325** of the third guide member **320**. This construction provide sufficient clearance for pulleys **350** mounted on a front-facing surface **352** of the pulley base member (e.g., pulley base member $\mathbf{154}_2$ of the pulley base $\mathbf{152}_2$), as the pulley base $\mathbf{152}_2$ slides along the first and third guide members **300** and **320** in response to forces applied to the belt slot $\mathbf{156}_2$ and/or forces applied via the pulleys **350**.

[0051] Referring to FIG. **3**C, a cut-way view of an exemplary embodiment of support apertures **265** implemented within the posterior panel **120** of FIG. **2**A is shown. Herein, as shown in FIGS. **3**B-**3**C, the plurality of support apertures **265** are positioned to correspond to the plurality of posts **260** extending from the front surface **220** of the posterior cover **140**. As shown, a first set of support apertures **360** are positioned to engage with a first set of posts **370** extending from a top cover region **158** of the posterior cover **140**. Additionally, a second set of support apertures **365** are positioned to

engage with a second set of posts **375** extending from a bottom cover region **159** of the posterior cover **140**. According to one embodiment, except for an optional central support aperture **361**, a remainder of the first set of support apertures **360** may be coplanar. Similarly, except for a central support aperture **366**, a remainder of the second set of support apertures **365** may be coplanar. Support apertures **275** for engagement with posts **270** associated with the pulley cover **160** (see FIG. **2**A) may be positioned along the first guide member **300** and the second guide member **320** in closer proximity to the pulley stops **331**-**332** and **336**-**337** than the support apertures **265**.

[0052] Referring to FIG. **3**D, a perspective view of an exemplary embodiment of a heat skating process is shown, where the post **260** and support aperture **265** operate as a coupling point between the posterior panel **120** and the posterior cover **140** as well as a reinforcement member. According to this embodiment of the disclosure, the post **260** of the posterior cover **140** may be inserted into a corresponding support aperture **265** formed within the posterior panel **120** and coupled together. For example, the post **260** and the support aperture **265** may be coupled together through a heat staking process **380**. In particular, after insertion of the post **260** within the support aperture **265**, a prescribed amount of heat is applied to the post **260**. This heat causes the material associated with the post **260** to slightly melt to form a head portion (dome) with a diameter greater that the aperture **265** so that, upon cooling, the post **260** cannot be removed from the support aperture **265** without disfigurement or elimination of the head portion.

[0053] Referring to FIG. **4**A, a top-down planar view of the posterior bracing system **110**, featuring the telescopic lateral panel **210** deployed between the first chamber **280** formed between the posterior panel **120** and the posterior cover **140**, is shown. According to one embodiment of the disclosure, the telescopic lateral panel **210** includes a main panel region **400** and a retention panel region **410**. As shown, the main panel region **400** corresponds to the portion of the lateral panel **210** that may be removed from the first chamber **280**, namely an enclosure formed between the rear surface **205** of the posterior panel **120** and the front surface **220** of the posterior cover **140**. The amount of the main panel region **400** removed from the first chamber **280** is dependent on a size (large (L), medium (M), small (S), or variations thereof such as XL, 2XL, XS, etc.) selected for the belt strap member **240** attached to the lateral panel **210** as illustrated in FIGS. **6**A-**6**E.

[0054] According to one embodiment of the disclosure, the main panel region **400** of the telescopic lateral panel **210** may include a buckle attachment aperture **425** that is sized to receive a buckle associated with a support strap (not shown) positioned under an axilla of the wearer. When the support strap is inserted therethrough, the buckle attachment aperture **425** features a buckle retention appendage **426**, which is flexible and applies a force against an inserted buckle to retain the buckle at least partially within the buckle attachment aperture **425**. As a result, the buckle attachment aperture **425** assists in retention of the buckle and its support strap to remain under and away from the axilla of the wearer. This avoids unwanted movement of the strap when the orthopedic brace **100** is worn.

[0055] As further shown in FIGS. **4**A-**4**B, the retention panel region **410** corresponds to a minimum portion of the lateral panel **210** that is configured to always remain within the first chamber **280**. According to this embodiment of the disclosure, the retention panel region **410** includes a first tab portion **420** extending from its edge **430**. The first tab portion **420** (and the lateral panel **210**) is positioned to engage with the post **260** of the posterior cover **140**, operating as a "stop" for the lateral panel **210**, when the lateral panel **210** has been extended to a size in which the main panel region **400** is fully removed from the first chamber **280**. The first tab portion **420** prevents the lateral panel **210** from being accidentally removed from the first chamber **280** upon engaging with the post **260**. Besides the first tab portion **420**, as shown in FIG. **4**A, a second tab portion **440** may be positioned to extend from an edge **450** of the retention panel region **410** and engage with another post **260** of the posterior cover **140** when the main panel region **400** is fully removed from the first chamber **280**.

[0056] Referring now to FIG. **4**C, a top-down planar view of the posterior bracing system **110**, featuring the telescopic lateral panel **210** operating with the adjustable belt member **240**, is shown. Herein, the belt member **240** is attached to the pulley base $\mathbf{152}_1$ via the belt slot $\mathbf{156}_1$. The belt member **240** may be sized based on indicia **460** placed on the belt member **240** being aligned with a portion of the pulley base $\mathbf{152}_1$, such as a belt slot $\mathbf{156}_1$. Herein, however, the belt member **240** has been sized to a maximum length as denoted by the first and second flanges **340** and **342** are engaging pulley stops **331** and **336**. The lateral panel **210** and belt member **240** are coupled together and moved laterally and anteriorly for coupling with an anterior bracing system (not shown).

[0057] Referring now to FIG. **5**A, an exemplary embodiment of an orthosis fastening subsystem **500** deployed within the orthopedic brace **100** is shown. Implemented as components of the posterior bracing system **110**, the orthosis fastening subsystem **500** features the pulley subsystem **150**, the telescopic lateral panels **210** (e.g., a first lateral panel **520** as shown), and the belt members **240** (e.g., a first belt member **525** as shown), which operate together for sizing and attachment of the orthopedic brace **100** to a patient. The first telescopic lateral panel **520** slidably extends from the first chamber **280** formed under the posterior cover **140** in a direction opposite to a direction of extension of a second telescopic lateral panel (not shown). Additionally, a first end **510** of the first belt member **525** is anchored to the belt slot $\mathbf{156}_1$ of the first pulley base $\mathbf{152}_1$ while a first end of the second belt member (not shown) would be anchored to the belt slot $\mathbf{156}_2$ of the second pulley base $\mathbf{152}_2$.

[0058] As further shown in FIGS. **5**A-**5**B, the pulley subsystem **150** includes the first pulley base $\mathbf{152}_1$ and the second pulley base $\mathbf{152}_2$ coupled together through the pulley cords $\mathbf{180}_1$ and $\mathbf{180}_2$. Although not shown, the pulleys mounted under the pulley bases $\mathbf{152}_1$-$\mathbf{152}_2$ apply tension and cause inward movement (toward a central area **550** of the second chamber **290**) of (i) the first belt member **525** when the pulley cord $\mathbf{180}_2$ is pulled away in an anterior and/or lateral direction and (ii) the second belt member (not shown) when the pulley cord $\mathbf{180}_1$ is pulled away in an anterior and/or lateral direction. Additionally, given that a portion of the first belt member **525**, proximate to the a second end **530** of the first belt member **525**, is attached to the first lateral panel **520** as shown in FIG. **5**B, such as through complementary loop and hook fasteners for example, inward movement of the first belt member **525** causes complementary interior movement of the first lateral panel

520 and vice versa. The same adjustment scheme would be applicable to the second lateral panel (not shown). This enables easier donning of the orthopedic brace without log-rolling the patient for customized re-fitting of the posterior lateral panels.

[0059] Referring to FIG. 5C, a top-down planar view of an exemplary embodiment of a pulley base (e.g., pulley base 152_1) of FIG. 5A is shown. Herein, the pulley base 152_1 includes the base member 154_1 featuring (i) the belt slot 156_1 positioned proximate to a first outer lateral edge 560 of the base member 154_1, (ii) the first flange 340 positioned on a second outer lateral edge 562 of the base member 154_1, and (iii) the second flange 342 positioned on a third outer lateral edge 564 of the base member 154_1. Herein, both the second and third outer lateral edges 562 and 564 are generally orthogonal to first outer lateral edge 560. The second and third outer lateral edges 562 and 564 are positioned on opposite sides of the base member 154_1.

[0060] Mounted on the base member 154_1, a first pulley cord attachment member 570 is configured to securely attach an end 182 of the second pulley cord 180_2 to the pulley base 152_1. The second pulley cord 180_2 is provided from the first pulley cord attachment member 570 to the second pulley base 152_2 as shown in FIG. 5A. Further mounted on the base member 154_1, a first pulley 580 is configured to receive the second pulley cord 180_2 from a pulley mounted on the second pulley base 152_2, where the second pulley cord 180_2 is threaded through an input port 581, wound around a first pulley wheel 582, and threaded through an output port 583 towards cord passage apertures 170_2. A second pulley 585 is configured to receive the first pulley cord 180_1 from the second pulley base 152_2, where the first pulley cord 180_1 is threaded through an input port 586, wound around a second pulley wheel 587, and threaded through an output port 588 for return to another pulley of the second pulley base 152_2.

[0061] As shown in FIG. 5D, after setting of the sizing of the belt members 240 and attachment to the lateral panels 210, the pulley bases 152_1-152_2 of the pulley subsystem 150 are positioned in a first state. In the first state, the pulley bases 152_1-152_2 may be located closer to the pulley stops 331-332 and 336-337 than the central area 550 of the second chamber 290. In response to tightening of pulley cord(s) 180_1 and/or 180_2, as shown in FIG. 5E, the pulley bases 152_1-152_2 traverse along the guide channel 222, in particular the first and third guide members 300 and 320, towards the central area 550 of the second chamber 290. The pulley bases 152_1-152_2 are non-stationary as these pulley bases 152_1 and 152_2 push their corresponding lateral panel/belt member combinations outwardly from the first and second chambers during initial sizing as well as pull their corresponding lateral panel/belt member combinations into the first and second chambers 280 and 290 during tightening. For example, the pulley base 152_1 is configured to push its corresponding lateral panel/belt member combinations 520/525 outwardly from the first and second chambers during initial sizing as well as pull the corresponding lateral panel/belt member combinations 520/525 into the first and second chambers 280 and 290 during tightening

[0062] Referring now to FIGS. 6A-6B, exemplary embodiments of an internal sizing of a second belt member 600 (e.g., opposite to belt member 525 of FIG. 5A) is shown, with subsequent sizing of the telescopic lateral panel 620 (e.g., opposite to lateral panel 520 of FIG. 5A). Herein, the second belt member 540 includes a first set of indicia 610 that identifies different belt sizes (large, medium, small, etc.) when oriented with a selected portion of the pulley base 152_2. For example, as an illustrated embodiment, the indicia 610 may include a plurality of indicia elements 615 each corresponding to a different belt size so that the second belt member 600 is sized accordingly. More specifically, a selected indicia element 612 may be oriented with a selected portion of the pulley base 152_2 (e.g., within the belt slot 156_2 of the pulley base 152_2), and thereafter, a first fastener 625 (e.g., loop and hook fastener) at a first end 622 of the second belt member 600 is coupled to a second fastener 626 (e.g., complementary loop and hook fastener) located along an interior surface 628 of the second belt member 600 so as to wrap the second belt member 600 around the belt slot 156_2 and the point of connection facing inward. As a result, the second belt member 600 is placed in a size corresponding to the selected indicia element 612.

[0063] After the second belt member 600 has been sized, as shown in FIG. 6B, indicia 630 located on its exterior surface 632 is aligned with indicia 640 located on a rear-facing surface 642 of the telescopic lateral panel 620 so that the telescopic lateral panel 620 is set to an identical size. Hence, the second belt member 600 restricts side extension of the telescopic lateral panel 620 to comfort with the sizing of the second belt member 600. It is contemplated that an exteriorly sized belt 600 may be semi-permanently attached to the lateral panel 620 so that we can reduce sizing needs by the orthotist. As a result, the orthotist or clinician would not need to align the belt to the indicia 640 on the lateral panel 620.

[0064] Referring to FIGS. 6C-6D, exemplary embodiments of an external sizing of a belt member (e.g., the first belt member 525 of FIG. 5A) is shown, with subsequent sizing of the telescopic lateral panel 520. Herein, the first belt member 525 includes a first set of indicia 650 that identifies different belt sizes (large, medium, small, etc.) when oriented with a selected portion of the pulley base 152_1. For example, as an illustrated embodiment and similar to the internal sizing of a belt member shown in FIGS. 6A-6B, the indicia 650 may include a plurality of indicia elements 660 each corresponding to a different belt size so that the first belt member 530 is sized accordingly. More specifically, a selected indicia element may be oriented with a selected portion of the pulley base 152_2 (e.g., within the belt slot 156_1 of the pulley base 152_1), and thereafter, a first fastener 670 (e.g., loop and hook fastener) at a first end 672 of the first belt member 525 is coupled to a second fastener 674 (e.g., complementary loop and hook fastener) located along an outer surface 676 of the first belt member 525 so as to wrap the first belt member 525 around the belt slot 156_1 and the point of connection facing outward. As a result, the first belt member 525 is placed in a size corresponding to the selected indicia element.

[0065] After the first belt member 525 has been sized, as shown in FIG. 6D, indicia 680 located on its exterior surface 682 is aligned with indicia 684 located on a rear-facing surface 686 of the telescopic lateral panel 520 so that the telescopic lateral panel 520 is set to an identical size. Hence, the first belt member 525 restricts side extension of the telescopic lateral panel 520 to comfort with the sizing of the first belt member 525.

[0066] As a result, as shown in FIG. 6E as an illustrative example, the first belt member 525 has been sized in accor-

dance with an external sizing process into a "medium" sizing. The second belt member **600** has been sized in accordance with an internal sizing process into a "large" sizing. The indicia **680** on the first belt member **525** is aligned with slots (or indicia) on the first telescopic lateral panel **520**. The indicia **630** on the second belt member **600** is aligned with slots (or indicia) on the second telescopic lateral panel **620**. As a result, both lateral panels **520** and **620** are sized consistent with their corresponding belt members **525** and **600**, and thus, the second telescopic lateral panel **620** (sized to large) extends further outside the first chamber than the first telescopic lateral panel **520** (sized to medium).

[0067] In the foregoing description, the invention is described with reference to specific exemplary embodiments thereof. For example, the telescopic lateral panels and adjustable belt member combination, operating with a pulley subsystem, may be deployed within an LSO orthopedic brace with an architecture different than the orthopedic brace described above. Hence, it will be evident that certain components may be deployed within different types of orthopedic braces and various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. A posterior bracing system deployed as part of an orthopedic brace, comprising:

a posterior panel;

a posterior cover coupled to the posterior panel, the posterior cover being configured to create a first chamber partially formed by an anterior facing surface of the posterior cover and a posterior facing surface of the posterior panel; and

a pulley cover coupled to the posterior cover to create a second chamber partially formed by an anterior facing surface of the pulley cover and a posterior facing surface of the posterior cover,

wherein the first chamber is configured to house a plurality of telescopic panels each arranged to extend laterally outward of the first chamber and the second chamber is configured to house a pulley subsystem including a plurality of pulley bases.

2. The posterior bracing system of claim **1**, wherein the posterior facing surface of the posterior cover comprises a guide channel formed on the posterior facing surface of the posterior cover, the guide channel enabling lateral movement of (i) a first pulley base of the plurality of pulley bases between a first opening within the second chamber and a central area of the second chamber and (ii) a second pulley base of the plurality of pulley bases between a second opening within the second chamber and the central area of the second chamber.

3. The posterior bracing system of claim **2**, wherein the first opening of the second chamber being positioned on an opposite side of the second chamber as the second opening.

4. The posterior bracing system of claim **2**, wherein a first belt member is attached to the first pulley base and a second belt member is attached to the second pulley base.

5. The posterior bracing system of claim **4**, wherein the first belt member associated with the first pulley base is attached to a first telescopic panel of the plurality of telescopic panels so that the first belt member moves concurrently with the first telescopic panel.

6. The posterior bracing system of claim **4**, wherein the first belt member is extended from the second chamber when the first telescopic panel is extended from the first chamber and the first belt member retreats within the second chamber when the first telescopic panel retreats within from the first chamber.

7. The posterior bracing system of claim **2**, wherein the first pulley base of the plurality of pulley bases includes a first flange extending toward a first edge of the guide channel, the first edge of the guide channel including at least a first stop that, upon the first flange coming into contact with the first stop, prevents further lateral movement of the first pulley base towards the first opening.

8. The posterior bracing system of claim **7**, wherein the first pulley base of the plurality of pulley bases further a second flange extending towards a second edge of the guide channel, the second edge of the guide channel including at least a second stop positioned in alignment with the first stop so that, upon the first flange coming into contact with the first stop and the second flange coming into contact with the second stop, further lateral movement of the first pulley base towards the first opening is prevented.

9. The posterior bracing system of claim **1**, wherein each of the plurality of telescopic panels includes a main panel region and a retention panel region, the main panel region of a first telescopic panel corresponding to a first portion of the first telescopic panel removable from the first chamber and the retention panel region correspond to a second portion of the first telescopic panel remaining within the first chamber.

10. The posterior bracing system of claim **9**, wherein the retention panel region of the first telescopic panel includes a first tab portion and a second tab portion that contact posts of the posterior cover operating as stops to prevent complete removal of the first telescopic panel from the first chamber.

11. The posterior bracing system of claim **1**, wherein the plurality of pulley bases includes a first pulley base including a first belt slot to which a first belt member is attached and a second pulley base including a second belt slot to which a second belt member is attached, each of the first belt member and the second belt member includes indicia for internal or external sizing of the first belt member and the second belt member.

12. The posterior bracing system of claim **11**, wherein the first belt member associated with the first pulley base is attached to the first telescopic panel, the first telescopic panel including indicia for aligning with the indicia for sizing the first belt member to set a degree of extension and retraction of the first telescopic panel from the first chamber.

13. The posterior bracing system of claim **9**, wherein the pulley cover includes a first aperture to receive a first pulley cord to control movement of the first pulley base by causing retraction of the first belt member into the second chamber and retraction of a first telescopic panel of the plurality of telescopic panels into the first chamber, where the first aperture retains that the first pulley cord remains centered on the first belt member.

14. The posterior bracing system of claim **1**, wherein each of the plurality of telescopic panels includes a buckle attachment aperture for retention of a buckle of a support strap.

15. An orthopedic brace, comprising:

a posterior panel;

a posterior cover positioned over a portion of a posterior surface of the posterior panel and coupled to the posterior panel, the posterior cover being configured to create a first chamber partially formed between an anterior facing

surface of the posterior cover and the posterior facing surface of the posterior panel,

wherein the first chamber is configured to house a plurality of rigid telescopic panels each arranged to partially extend laterally outward of the first chamber and bend in a concave manner towards a front of the orthopedic brace to provide lateral support for the wearer of the orthopedic brace.

16. The orthopedic brace of claim **15** further comprising:

a pulley cover positioned over a posterior surface of the posterior cover and coupled to the posterior cover to create a second chamber partially formed by an anterior facing surface of the pulley cover and a posterior facing surface of the posterior cover,

wherein the second chamber is configured to house a pulley subsystem including a plurality of pulley bases.

17. The orthopedic brace of claim **16**, wherein the posterior surface of the posterior cover comprises a guide channel formed on the posterior facing surface of the posterior cover, the guide channel enabling lateral movement of (i) a first pulley base of the plurality of pulley bases between a first opening within the second chamber and a central area of the second chamber and (ii) a second pulley base of the plurality of pulley bases between a second opening within the second chamber and the central area of the second chamber.

18. The orthopedic brace of claim **17**, wherein the first opening of the second chamber being positioned on an opposite side of the second chamber as the second opening.

19. The orthopedic brace of claim **17**, wherein a first belt member is attached to the first pulley base and a second belt member is attached to the second pulley base.

20. The orthopedic brace of claim **19**, wherein the first belt member associated with the first pulley base is attached to a first telescopic panel of the plurality of telescopic panels so that the first belt member moves concurrently with the first telescopic panel.

21. The orthopedic brace of claim **19**, wherein the first belt member is extended from the second chamber when the first telescopic panel is extended from the first chamber and the first belt member retreats within the second chamber when the first telescopic panel retreats within from the first chamber.

22. The orthopedic brace of claim **16**, wherein the first pulley base of the plurality of pulley bases includes a first flange extending toward a first edge of the guide channel, the first edge of the guide channel including at least a first stop that, upon the first flange coming into contact with the first stop, prevents further lateral movement of the first pulley base towards the first opening.

23. The orthopedic brace of claim **22**, wherein the first pulley base of the plurality of pulley bases further a second flange extending towards a second edge of the guide channel, the second edge of the guide channel including at least a second stop positioned in alignment with the first stop so that, upon the first flange coming into contact with the first stop and the second flange coming into contact with the second stop, further lateral movement of the first pulley base towards the first opening is prevented.

24. The orthopedic brace of claim **16**, wherein each of the plurality of telescopic panels includes a main panel region and a retention panel region, the main panel region of a first telescopic panel corresponding to a first portion of the first telescopic panel removable from the first chamber and the retention panel region correspond to a second portion of the first telescopic panel configured to be retained within the first chamber.

25. The orthopedic brace of claim **24**, wherein the retention panel region of the first telescopic panel includes a first tab portion and a second tab portion that contact posts of the posterior cover operating as stops to prevent complete removal of the first telescopic panel from the first chamber.

26. The orthopedic brace of claim **16**, wherein the plurality of pulley bases includes a first pulley base including a first belt slot to which a first belt member is attached and a second pulley base including a second belt slot to which a second belt member is attached, each of the first belt member and the second belt member includes indicia for internal or external sizing of the first belt member and the second belt member.

27. The orthopedic brace claim **26**, wherein the first belt member associated with the first pulley base is attached to the first telescopic panel, the first telescopic panel including indicia for aligning with the indicia for sizing the first belt member to set a degree of extension and retraction of the first telescopic panel from the first chamber.

28. The orthopedic brace of claim **24**, wherein the pulley cover includes a first aperture to receive a first pulley cord to control movement of the first pulley base by causing retraction of the first belt member into the second chamber and retraction of a first telescopic panel of the plurality of telescopic panels into the first chamber, where the first aperture retains that the first pulley cord remains centered on the first belt member.

29. A posterior bracing system deployed as part of an orthopedic brace, comprising:

a posterior panel;

a posterior cover coupled to the posterior panel and including an anterior facing surface and a posterior facing surface including a guide channel, the posterior cover being configured to create a first chamber partially formed by an anterior facing surface of the posterior cover and a posterior facing surface of the posterior panel, wherein the first chamber is configured to house a plurality of rigid, telescopic panels each arranged to extend laterally outward of the first chamber; and

a pulley cover coupled to the posterior cover to create a second chamber partially formed by an anterior facing surface of the pulley cover and the guide channel of the posterior cover, wherein the second chamber is configured to house a pulley subsystem and provide lateral movement of a plurality of pulley bases including (i) a first pulley base positioned within the guide channel between a first opening within the second chamber and a central area of the second chamber and (ii) a second pulley base positioned within the guide channel between a second opening within the second chamber and the central area of the second chamber.

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