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(54) **Title**: ARCH SPRING FOOTWEAR SYSTEM FOR PROVIDING ENERGY-RETURN DURING HUMAN GAIT

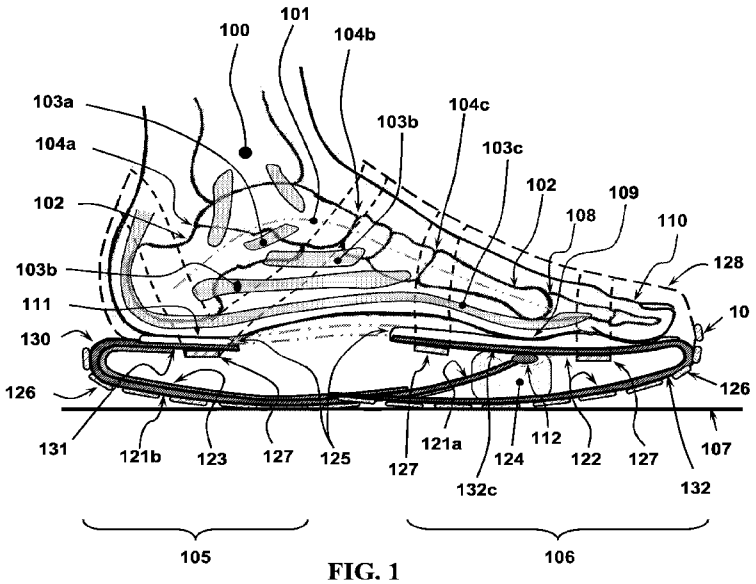

FIG. 1

(57) **Abstract**: A footwear system utilizing a configuration of components or sub-assembles is provided to promote energy-return features during human gait. The footwear system configuration utilizes structural arches and cantilever beams formed and/or fabricated with structural materials allowing for storage and release of kinetic energy produced during gait motions. The energy transfer is enhanced by a forward propulsion component during gait while providing cushioning via elastic deformation of the various semi-rigid components comprising the system.

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ARCH SPRING FOOTWEAR SYSTEM FOR PROVIDING ENERGY-RETURN DURING HUMAN GAIT

PRIORITY

This Application claims priority to and the benefit of US Provisional Patent Application No. 61/952,059, filed March 12, 2014, and U.S. Provisional Patent Application No. 62/100,813, filed January 7, 2015; both of which are incorporated fully herein by reference.

FIELD

The embodiments herein relate generally to footwear. More specifically, embodiments of the invention are directed to an arch spring suspension system as a footwear system made part of an article of a footwear shoe, or external to the shoe structure, or combination thereof, thereby enhancing the performance of human locomotion.

BACKGROUND

Human gait has evolved since walking with our bare feet. The use of protective materials over the feet provided protection and cushion for the feet and the body above. The protective materials are commonly referred to as shoes. Many improvements have been made in shoe designs, enhancing dampening features from ground impacts with the feet and body during heel strike and other phase of gait. Specific tasks, such as in different sports or occupations have specific design features to aid the feet during its specific task. The task of aiding motion has been addressed in shoe designs to aid traction and lower the shoe's overall weight with lighter materials or configurations.

The design feature of energy-return during gait has been attempted as well. Others have incorporated designs for taking kinetic energy from heel strike and returning it during toe off. However, in practice there are issues in controlling the energy release, requiring complicated mechanisms, or including parts to the shoes that are impractical to build or manufacture. There are issues with these shoe designs being dysfunctional due to premature energy release or failure to aid the forward motion of gait itself. Rather, the attempted remedies and designs have provided vertical motion which is not desirable during propulsion. Therefore, footwear systems having improved energy-return to assist the forward motion of gait would be beneficial.

SUMMARY

The present invention provides a simplified mechanism for capturing and returning energy for the purpose of aiding the propulsion of human gait, while cushioning ground reaction impacts. The invention redirects kinetic energy during human locomotion to aid the user during forward motion, while cushioning the feet and body above from ground contacts. The invention can be employed or included with a myriad of shoes articles, including running shoes, walking shoes, hiking shoes, boots, and any other form of footwear.

The mechanism and construct of the inventive system utilizes elastic deformation as a means for storing and returning kinetic energy while providing cushioning. The geometrical shape of the system captures kinetic energy during heel strike through a system of arch springs, while the mass of the body is transferred to the foot and supported by the ground. The forward momentum of the body mass will store the kinetic energy as elastic energy within the arch springs during mid-stance. As the mass of the body is released during toe-off, the elastic energy will be released in a forward vector as the arch springs rotate with the anatomical motions within the foot's ankle during gait. The coupled placement of the arch

spring system with key anatomical features provides a controlled system for providing energy-return to assist forward motion, while cushioning the ground impact during gait, as well as providing beneficial cushion to the foot during stance.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 depicts an anatomical ankle sagittal view illustrating structural features with placement of footwear system components against the inferior aspect of the foot, in accordance with embodiments of the present invention.

FIGS. 2a-2c are stylized stick models illustrating phases of human gait, in accordance with embodiments of the present invention.

FIGS. 3a-3b depict perspective views of a footwear system without a shoe body or sole tread material present, in accordance with embodiments of the present invention.

FIG. 4a depicts a perspective view of a footwear system having a compound generally S-shaped component of a unitary heel and toe saddle structure, in accordance with embodiments of the present invention.

FIG. 4b depicts a wedge type shoe utilizing the heel component as a footwear system with padding replacing a toe saddle component, shown without shoe body or sole components, in accordance with embodiments of the present invention.

FIGS. 5a-5b depict another configuration of a footwear system with a lower profile toe component, shown without shoe body or sole components, in accordance with embodiments of the present invention.

FIGS. 6a-6b depict an externally attached configuration of a footwear system, in accordance with embodiments of the present invention.

FIGS. 7a-7c depict a high heel type shoe employing a footwear system, in accordance with embodiments of the present invention.

The accompanying drawings, which are incorporated herein and form part of the specification, illustrate various embodiments of the present disclosure and, together with the description, further explain the principles of the disclosure and to enable a person skilled in the pertinent art to make and use the embodiments disclosed herein. In the drawings, like reference numbers indicate identical or functionally similar elements. The drawings are not drawn to scale, may be exaggerated to illustrate various aspects of the present disclosure, and should not be construed as limiting the design features.

DETAILED DESCRIPTION

Referring generally to FIG. 1, various anatomical structures of the foot are shown in conjunction with structural aspects of the footwear system 10 in accordance with embodiments of the present invention. The anatomical features within the foot 100 already provide some energy-return during human locomotion by the structural motions within the ankle during gait. The ankle includes a natural arch 101 formed by the configuration of bones 102 and ligament structures 103 to provide mobility and stability. The arch 101 acts as a shock absorber and adapts to changes in terrain with mobility between the bone's joints 104 (e.g., the Subtalar joint 104a, the Transverse Tarsal joint 104b, and the Tarsometatarsal joint 104c). Flexion in the arch's bones are effected by the Plantar Calcaneonavicular 103a, the Plantar Calcaneocuboid 103b, and the Plantar Fascia 103c ligaments that function as springs to maintain the arch 101.

In stability, the arch 101 distributes the body mass (weight) 201 across the hind foot 105 and fore foot 106. During gait, the distribution of body mass 201 is translated from the hind foot 105 towards the fore foot 106 as the arch 101 lifts the hind foot 105 off the ground 107. The Metatarsophalangeal joint 108 (commonly referred as the "ball of the foot" 109)

connects the toes 110 anteriorly from the arch 101, acting as stabilizers during push off of the foot 100 from the ground 107.

Referring generally to FIGS. 1-2, the footwear system components will interact with the anatomical features within the foot 100 to provide a stable transfer of forces during gait and articulated motions within the foot 100. The footwear system 10 becomes an extension to the natural anatomical features 100, as opposed to hindering their functions. In general, the footwear system 10 mirrors the convex anatomical arch 101 in the foot, providing a concave structure across the heel 111 on the hind foot 105, and to the ball of the foot 109 in the fore foot 106. A double arch support (121, 101) mimics, while also enhancing, the shock absorption feature across the natural arch 101 of the foot. A saddle toe arch component 122 is saddled across the ball of the foot 109, providing stabilization attachment 112 against the heel component 121 and articulation within the footwear system during push off of the foot 100 from the ground 107.

Various embodiments of the footwear systems are illustrated in the Figures (*e.g.*, FIGS. 1, 3a-3b, 4a-4b, and 5a-5b) and further described herein. In summary, the heel arch 121 and the saddle toe arch 122 components are the primary components providing the energy-return feature for the footwear systems via the components' elastic stiffness and geometrical shape and construct. The elastic stiffness of the footwear components and geometrical arch shapes can be altered between articles of shoe type, to tailor the energy-return aspect between shoe sizes and different style types. In addition, secondary arch springs 123 components, or various combinations or sub-components (*e.g.*, bushings 124 and support padding 125), to the primary footwear system components described herein may generally be used with any of the articles of shoe to provide adjustments to the energy-return feature. As a result, the additional force aiding gait can be tailored for the specific user and target footwear application.

Attachment components such as straps 127, for example, shown holding the footwear system 10 to the shoe body 128 should not be over-constraining, so as to not hinder functions to the footwear systems. The constrain components 127 should allow for functional ranges of anatomical articulation during normal gait, allowing the footwear system components to provide energy-return while enhancing anatomical motions of the foot 100 during gait for the given style of shoe article. This is similar to bridge supports on a bridge - allowing for joint expansion and contraction, where at least one end allows for some freedom of motion. The footwear system components will require some freedom of motion to provide the desired and/or optimal elastic-energy return. This is further addressed in the description of individual footwear components.

The sole tread component(s) 126 interface the footwear system 10 with contact to the ground 107. Further, the sole components can also be part of the attachment component for holding the footwear system 10 to the shoe body 128. In certain embodiments, the sole can be used to encapsulate and protect the footwear system 10 from external exposer, elements, or wear.

With reference to FIGS. 2a-2c, human gait models are illustrated for normal walking (FIG. 2a), and with us of the footwear system 10 (FIG. 2b - showing just the foot region 100). This exemplary model is focused on the stance phase of gait while one of the legs is in the act of contacting the ground. The swing phase of gait, with the foot not in contact with the ground 107, is not shown. The model includes only the lower limbs 202 and pelvic region 203 with the upper section of the body 204 removed for clarity - although it does play a role with human gait. The limbs 202 are represented by stick figure lines, and various body joints 205 are represented by solid circles. Initial contact during gait is commonly referred to as heel strike 206, and is associated by the hind foot 105 making contact with the ground 107, and this case through the footwear system supporting the foot 100 and body mass 201.

During heel strike 206, elastic deformation 210 in one or more of the footwear component's materials is providing energy capture 207 while cushioning the impact of heel strike, as the body mass 201 is transferring the body support to the ground 107. The energy capture 207 is storing some of the energy from the body mass 201 as potential energy in the form of elastic deformation 210 within the footwear system components. While continuing from heel strike 206 to the mid-stance 208 phase of gait, the transition of the body mass 201 is transitioning forward 209 while both the hind foot 105 and the fore foot 106 are in contact with the ground 107. The captured kinetic energy 207 during heel strike 206 is stored as potential energy within the elastic deformed materials 210 within the footwear components during mid-stance 208 phase of gait. As a result of the arch structural shape used within the footwear system components, the potential energy is also transitioning forward 209 within the component's arch structures, following the transition observed by ground reaction forces measured by force plate measuring gait forces; staging the energy potential change in force vector directions as the body is transitioning forward 209, as mid-stance 208 moves towards toe-off 211 phase of gait where the body mass 201 will be released 212. The stored elastic energy within the footwear component's elastically deformed material 210 will be released at 212 in sync with toe-off 211, providing additional forward propulsion force as the body mass 210 is released 212 and aiding gait.

The structural material used to make the primary footwear component providing energy-return features by elastic deformation will require flexion property suites for the functional mass of the user as well as any additional, carried items. For example, the functional body mass of the user can comprises a range of 0 pounds to 500 pounds. In various embodiments, the functional weight of the same user comprises a range of 100 pounds to 300 pounds. Additional secondary components 123, 124, 125 and 126 can be incorporated into the article of shoe as interchangeable components allowing the user or manufacturer to adjust

the functions within the footwear system. Alternatively for the given article of shoe, the primary footwear system components 121 and 122 can be incorporated as interchangeable or modular components, or the system 10 could be pre-adjusted, thereby allowing for a wide range of fully optimized options and embodiments - depending on the type of shoe article and use case.

Referring generally to FIGS. 3a-4b, the structural material used for primary footwear components 121 and 122, and other secondary components 123, for providing the energy-return feature to the shoe, will include a semi-rigid or like shape memory material well suited for multiple storages and releases of energy by elastic deformation, without incurring fatigue. For example, a structural engineered composite or polymer material, such as vinylester, can be employed that includes flexure modulus (bending modulus) providing a ratio of stress to strain allowing flexural deformation or tendency for the material to bend and store elastic energy. In other embodiments, the primary components can comprise an injected plastic material. In other embodiments, the components can comprise a metallic spring material or some combination of different materials or composites as described above or otherwise understood by those of ordinary skill in the art. However, primary footwear system components can be comprised of any material or material composite suitable for providing elastic deformation that provides effective energy-return to the size, type, and use of the shoe article being produced.

In addition to the primary elements 121 and 122, and possible secondary footwear components 123, providing the energy-return feature, additional sub-components 124 and 125 can be used to protect the energy-return components from extending beyond the respective material's elastic range extending the deformation into overload status or protect from direct component-to-component contact that is not desired. The additional sub-

components can comprise an elastomeric bushing 124 or pad 125, limiting the non-desirable state in the energy-return components.

The footwear system's heel component 121 is a structural component supporting the hind foot 105, extending towards the balls of the foot 109. The heel component 121 is the primary component for the footwear system, providing energy-return by utilization of an arch shape structure including a curved shank with upper bends on both the anterior 121a and inferior 121b aspects of the component. The angulation, curvature radius, width, and thickness of the structural arch all influence the functional energy-return from this component. The anterior end of the heel's arch structure 112 is interfaced with the toe saddle arch component 122, providing support against or proximate the ball of the foot region. Ideally, the anterior portion can be concentrically placed with the anatomical structures in the forefoot support 106 to provide balance across the foot. The heel's anterior interface is shown with an elastomeric bushing or member 124, holding the interface to the toe saddle 122 component in contact while allowing articulation motion between the components.

In other embodiments, this anterior interface could be mechanically hinged, a slotted bushing tab, or structurally a continuation of a combined single hybrid component for the two components (e.g., FIG. 4a). FIG. 4a shows an exemplary embodiment having a generally S-shaped component including both the heel and the toe saddle components as a single structure. The heel component's anterior attachment should allow for the angular motion seen in this ball of the foot joint 109, (*e.g.*, 40° to upwards of 80°). Posterior to the heel component's structural arch 121b is a radially curved structure 130 that extends upward and around anteriorly to a platform extension 131, to support the hind foot 105 at the heel 111. As such, a gap or flex space is created between the platform extension 131 and the top surface of the structural arch 121b. Again, in other embodiments, the posterior aspect of the

heel component could terminate similar as described for the anterior end, or contain a downward radial curvature allowing for a traditional shoe heel (not shown).

With the depicted configurations, the extended platform 131 provides a cantilever support to the heel 111 and additional elastic deformation for the energy-return feature. The greater the extension, such as extending the posterior curvature 130 further posterior from the heel 109, the greater the increase in the energy-return. Although interior lengthening of the extension 131 could potentially provide contact with the interior aspect of the component 121b, that is not desired in certain embodiments. However, in such a configuration, an elastomeric bushing 124 (not shown) can be provided between components 131 and 121b, protecting against such contact. It should be noted that the reduced radial curvature 130, providing attachment of the posterior extension 131 to the arch structure 121, also plays a role in supporting the energy-return feature in the component; the radial size of the curvature, and cross-sectional shape (width and thickness) all can influence strain within the energy-return. It can be critical that the curvature and cross-sectional shape does not hinder the support of strain limiting the energy-return. Furthermore, the attachment constraint of the heel component extension 131 to the hind foot's 105 heel 111 is critical with maintaining energy-return.

A strap 127 component or similar structure for attaching the extension to the shoe body 128 can be used for holding the heel's extension 131 and arch structure 121 to the hind foot portion 105, as shown in FIG. 4b. The strap 127 component, or a like attachment structure or device, can extend upwards to the ankle region on the shoe body 128, allowing the user to adjust the comfort level while securing the foot to the footwear system 10. A bushing material or padding 125 may be used against adjacent contacting surfaces to reduce friction, allowing for enhanced elastic deformation. A loose connection could lead to heel slap from the heel extension 131 component coming up and hitting the heel 111 during gait,

and a tight or bonded connection can provide a restriction feeling of being over constrained and reducing the energy-return function. Again, in other embodiments, the posterior attachment 131 can be altered to fit the article style of shoe by either its length or structural construct. Overall, the footwear system's heel components 121, 130 and 131 should allow for anatomical flexion of the ankle, (*e.g.*, downward plantar flexion 0-50°, upwards dorsiflexion 0-20°, as well as avoid restricting abduction or inversion and eversion motions about the ankle), by either freedom within the attachments or elastic deformation within the structural components of the attachments, or a combination thereof.

The heel component 121 can consist of a single mono-element transitioning about the width of the foot, or consist of a pair of components working in tandem, or some other multiple element configuration across the width of the foot. In either the single/mono or multiple element configurations, the thickness and width of the heel component 121 can be altered as well, as various changes in the width and thickness alter the elastic stiffness support between the interior medial and exterior lateral aspect of the foot. Further, other structural aspects of the heel component 121 can be altered to change the elastic stiffness response laterally across the foot. In addition, one or more secondary arch components 121 can be provided on the interior aspect of the heel component(s) for increasing elastic stiffness (e.g., FIG. 3b).

Depending on the article of shoe type, the heel component 121 can be made such that it can be detachable to allow for refinements of elastic stiffness or size/height adjustments across different sizes within a specific shoe size for the user; or it can be integral as a non-removable component for other embodiments within a given shoe type.

The footwear system's toe saddle arch 122 component is shown across the ball of the foot (*e.g.*, FIGS. 3a-4a) with an anterior extension that curves under, providing a secondary flexion arch 132 structure support directly below the ball of the foot 109. The anterior

extension 132 can be divided into two arches providing a medial 132a and lateral 132b arch support next to the anterior aspect of the heel 121a component, intended to increase stability for the footwear system 10 and provide cushioning during enhanced gait motion in which the hind foot 105 does not make ground 107 contact - such as during running. The toe saddle arch component 122 is an extension from the anterior end of the heel arch 121a, distributing the push off force from the heel component 121 across the ball of the foot 109 and insuring that the fore foot 106 is concentrically supported. The toe saddle 132c in this component is formed to match the anatomical curvatures across the inferior aspects on the fore foot 106. The stability aspect allows for flexion of the toes 110 with supporting gait, and allows for higher planter flexion angles (30-50°) during higher speeds. As stated herein, the toe saddle 122 could contain a hinge or like feature for direct attachment to the heel component 121, or utilize a bushing support 124 for maintaining contact with the heel 121 component during gait. Again, as described within the heel component 121, the structural arches 132a and 132b within the toe saddle arch 122 component are effected by structural geometric variations. In other embodiments, similar variations in geometrical features in the toe saddle arch 122 can be made to alter the energy-return feature for the footwear system 10 as described for the heel component 121.

Depending on the article of shoe type, the footwear system 10 can further include a toe saddle arch 122 component incorporated together directly within the heel component 121, *e.g.*, when a lower anterior profile is desired, as shown in Fig. 4b. This combined component can still bend below the ball of the foot 109, using a built in living hinge design having an elastic strain release to allow for some flexion. Alternatively, the component can solely depend on elastic flexibility within the cross-section of the structural shape for stability. In addition, an anterior slot 133 through the toe region could be incorporated to provide inversion/eversion flexibility. Furthermore, an elastomeric or like pad 125 can be included

with this combined component across the anterior aspect below the ball of the foot 109 to provide cushioning for the toe region 110.

Depending on the type of article or shoe type, the footwear system 10 can utilize a weld plate 125 or transitional structure padding across the superior aspect of the footwear system 10 to provide structural attachment and cushioning within the shoe body 128. The plate 125 can also include semi-rigid materials to allow for anatomical articulation of the shoe body 128 while not interfering with the footwear system function of providing energy-return. Alternatively, the footwear system 10 could be directly used for mounting the shoe body 128 against the foot (*e.g.*, FIG. 4b), providing and addressing proper constraint issues described herein. Furthermore, isolated mounting structures 125 on both the heel component 121 and toe saddle 122 component can be incorporated by providing cushioning between the shoe body 128 and footwear system 10. Additionally, the attachment of the footwear system 10 could utilize straps 127, clamps, ties, or various known bonding methods between the footwear components 121, 122, 125 and the shoe body 128.

Depending on the type of article or shoe type, the footwear system 10 can include an encapsulating sole 126 structure up to the shoe body 128, as shown in FIG. 4b. This can provide interfacing materials for direct ground traction, or alternatively the sole structure 126 can be placed on just the inferior aspect of the footwear system 10 along exposed or partially exposed configurations between these two examples. With an encapsulating sole 126, care must be made to not hinder or restrict the movements of the footwear system 10. The encapsulation material can replace internal bushing 124 structures described herein, or partly replace sub-components of the footwear system - such as secondary stiffeners 123 around the primary arch structures 121 and 122. The inferior sole 126 configuration can bridge across the heel 121 component and toe saddle 122 component, as well as be separated to allow free motion between the two components.

Referring generally to FIGS. 5a-5b, a low profile configuration of the toe component 122 is depicted without spring arch extensions. Such components 122 can include a standard heel component 121with a shortened length terminating at the balls of the feet 109. This low profile toe component 122 is advantageous as it can expand the transfer forces from the heel component against the forefoot over a larger surface area than the contact region directly by the heel component. The low profile component 122 can be freely provided (*e.g.*, held just by the constraint of the shoe body) under the balls of the feet, or integrated or otherwise provided with the system. The cross-sectional profile area of this low profile toe component 122 can include slight curvatures in both anterior-posterior and medial-lateral directions, conforming to the geometrical structures of the forefoot. In addition, the low profile component 122 can include a plurality of distinct or segmented members 122a (with or without gaps provided therebetween) to generally or approximately match the profile of the user's toes. Various flexible, rigid, semi-rigid, elastomeric, or like materials can be used to form all or part of the low profile component 122. The low profile component 122 can be generally flat, concaved, or take on a variety of other shapes, sizes, and configurations to facilitate the functionality described and depicted herein.

Depending on the type of article or shoe type, or required use by the user, the footwear system 10 can be utilized by providing it external to the shoe, as depicted in FIGS. 6a-6b. The external footwear system 10 can utilize the same aspects as detailed herein for the internal footwear system, except it will not be restricted in size and geometrical shape to fit below the anatomical foot 100, 105 and 106, within the body of the footwear. The external footwear system 10 can extend to the internal medial or lateral aspects, allowing for greater energy-return with structurally larger components. In addition, external sub-component attachments, straps, clasps, and the like can be employed to facilitate attachment of the external components of the footwear system 10 to the body of footwear 128.

The external footwear system 10 can include a heel support platform 140 and a toe support portion 142, adapted to restrain and support respective heel and toe portions of a corresponding shoe, boot, or like footwear 128. Like internal framework embodiments of the present invention, the external footwear system 10 can include a heel component 121 and a toe arch component 122. Further, the component 121 includes a structural arch 121b having a curved or bending structure 130 extending up and around to the support platform 132c. The toe arch component 122 can bend down under the toe support portion 132c and back under the component 122 at curve or bend structure 132. In addition, sole tread components 126 interface the footwear system 10 with contact to the ground 107. One or more connection features 148 can be included to provide attachment of the supports 140 and 142 to the components 121 and 122, respectively. In certain embodiments, the features 148 can include fasteners capable of variable adjustment – to tighten, pivot, or otherwise adjust or secure the supports 140 and 142.

FIGS. 7a-7c show embodiments of the footwear system 10 employed with a high heel type footwear 128. Again, the heel component 121 and the toe arch component 122 are included to provide the energy-return feature for the footwear system 10 via the components' elastic stiffness and geometrical shape and construct, as detailed herein. The toe saddle 132c assists in distributing the push off force from the heel component 121 across the ball of the foot 109, insuring that the fore foot 106 is concentrically supported. Various embodiments of the component 122 can include the flexion arch structure support 132 (FIGS. 7a-7b), while others can include a generally flat or low profile support 122 (FIG. 7c). As depicted in certain embodiments, the heel component 121 can include an extension portion extending vertically and including one or more curved portions 150 (e.g., concave and/or convex). In those embodiments including more than a single curved portion, a generally undulating support structure is provided (FIGS. 7a-7b). The heel component 121 and its undulating

support extension can provide energy-return. The number of curves, as well as the radius, width, and thickness of the structure all influence the functional energy-return from this component 121. Subcomponents, such as structure or pad 125, can be included to protect the energy-return components from extending beyond the respective material's elastic range. The extended platform 131 is included to provide support to the heel 111 and additional elastic deformation for the energy-return feature. Again, sole tread components 126 interface the footwear system 10 with contact to the ground 107. As shown in FIGS. 7b and 7c, an ankle strap 152 or like element can be included to facilitate securement to the wearer's ankle.

Several characteristics and advantages have been set forth in the preceding description, including various alternatives, together with details of the structure and function of the devices, components, and/or systems. The disclosure is intended as illustrative only and as such is not intended to be exhaustive or limiting. It will be evident to those skilled in the art that various modifications may be made, especially in matters of structure, materials, elements, components, shapes, sizes, and arrangements of parts including combinations within the principles described herein, to the full extent indicated by the broad, general meaning of the terms in which the appended claims are expressed. To the extent that these various modifications depart from the spirit and scope of the appended claims, they are intended to be encompassed therein. All references, publications, and patents referred to herein, including the figures and drawings included therewith, are incorporated by reference in their entirety.

CLAIMS

What is claimed is:

1. A footwear system provided with a footwear article for returning energy to aid in the propulsion of human gait, comprising:

a heel component including a cantilevered extension and an arcuate structure extending to the cantilevered extension to facilitate energy-return; and

a toe arch component including a saddle structure to distribute energy return from the heel component.

2. The system of claim 1, wherein at least the heel component and the toe arch component are constructed of a composite material.

3. The system of claim 2, wherein the composite material allowing flexural deformation to bend and store elastic energy.

4. The system of claim 1, wherein at least the heel component and the toe arch component are constructed of an injected plastic material.

5. The system of claim 1, wherein at least the heel component and the toe arch component are constructed of a metallic spring material.

6. The system of claim 1, wherein the footwear article is a shoe body.

7. The system of claim 6, further including an interfacing attachment portion securing the shoe body with the heel component and the toe arch component and allowing for non-restrictive flexion of the footwear system.

8. The system of claim 7, wherein the interfacing attachment portion includes a device selected from the group consisting of: one or more straps, one or more adjustable ties, and one or more clamps.

9. The system of claim 1, wherein the toe arch component includes an arcuate arch structure.

10. The system of claim 9, wherein the arcuate arch structure includes a plurality of extension segments.

11. The system of claim 10, wherein the plurality of extension segments includes a first arch segment to provide medial arch support and a second arch segment to provide lateral arch support.

12. The system of claim 11, wherein a gap is define between the first arch segment and the second arch segment.

13. The system of claim 9, wherein the arcuate arch structure curves under the toe arch component.

14. The system of claim 1, wherein the cantilevered extension and the arcuate structure combine to define a generally C-shaped construct.

15. The system of claim 1, wherein at least the heel component and the toe arch component are provided internally within the footwear article.

16. The system of claim 1, wherein at least the heel component and the toe arch component are provided external to the footwear article.

17. A footwear system provided with a footwear article for returning energy to aid in the propulsion of human gait, comprising:

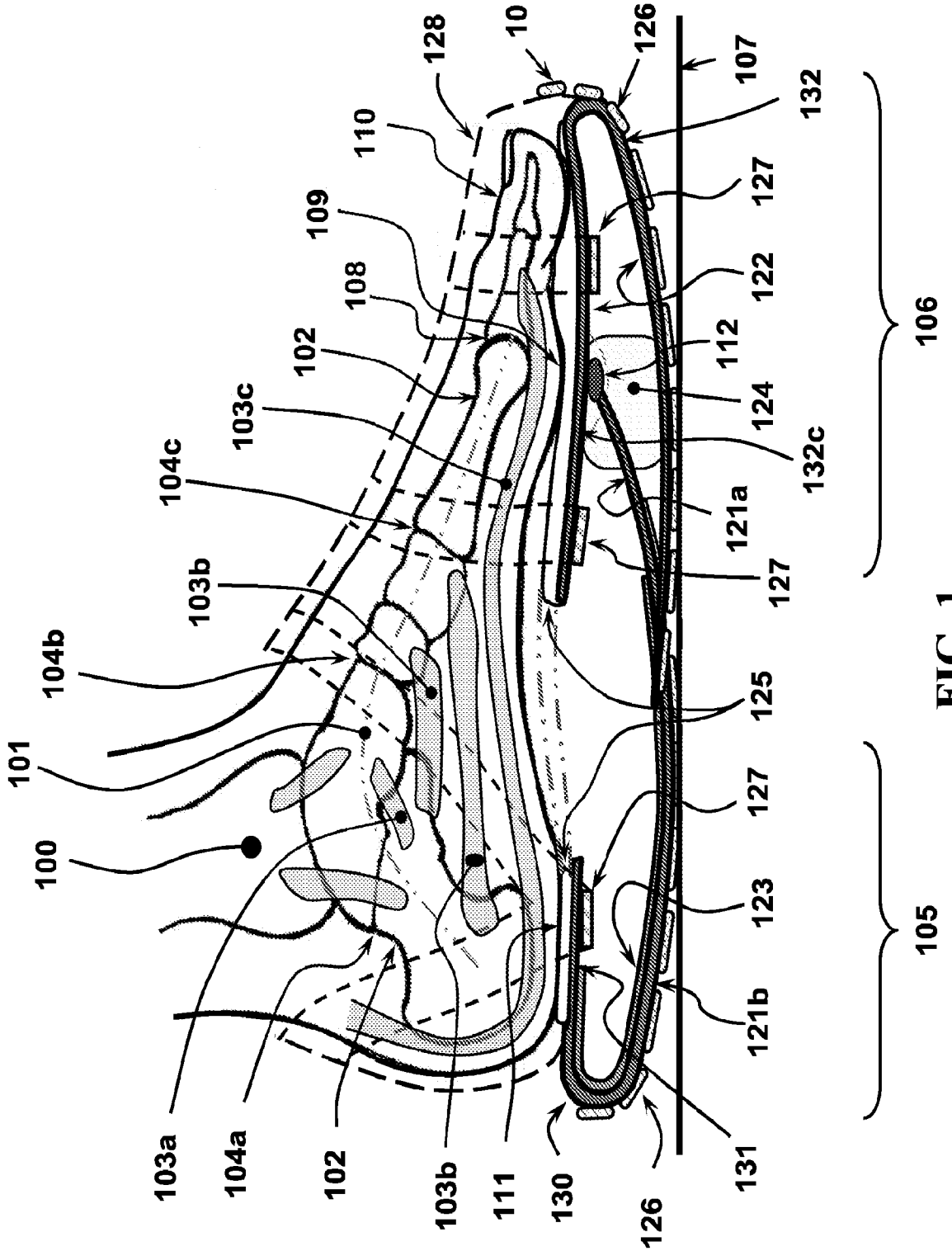
a heel component including a cantilevered extension and an arcuate structure extending to the cantilevered extension to facilitate energy-return; and

a toe arch component including a saddle structure and an arcuate arch structure, with the toe arch component in operable communication with the heel component.

18. The system of claim 17, wherein the heel component and the toe arch component are constructed of a material selected from the group consisting of: a composite, a plastic material, and a metallic spring material.

19. The system of claim 17, further including an interfacing attachment portion including a device selected from the group consisting of: one or more straps, one or more adjustable ties, and one or more clamps.

20. The system of claim 17, wherein the cantilevered extension and the arcuate structure combine to define a generally C-shaped construct.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127
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122
108
112
102
124
103c
132c
104c
121a
103b
127
106
104b
125
101
127
100
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105
121b
103a
104a
102
103b
111
130
126
131

FIG. 1

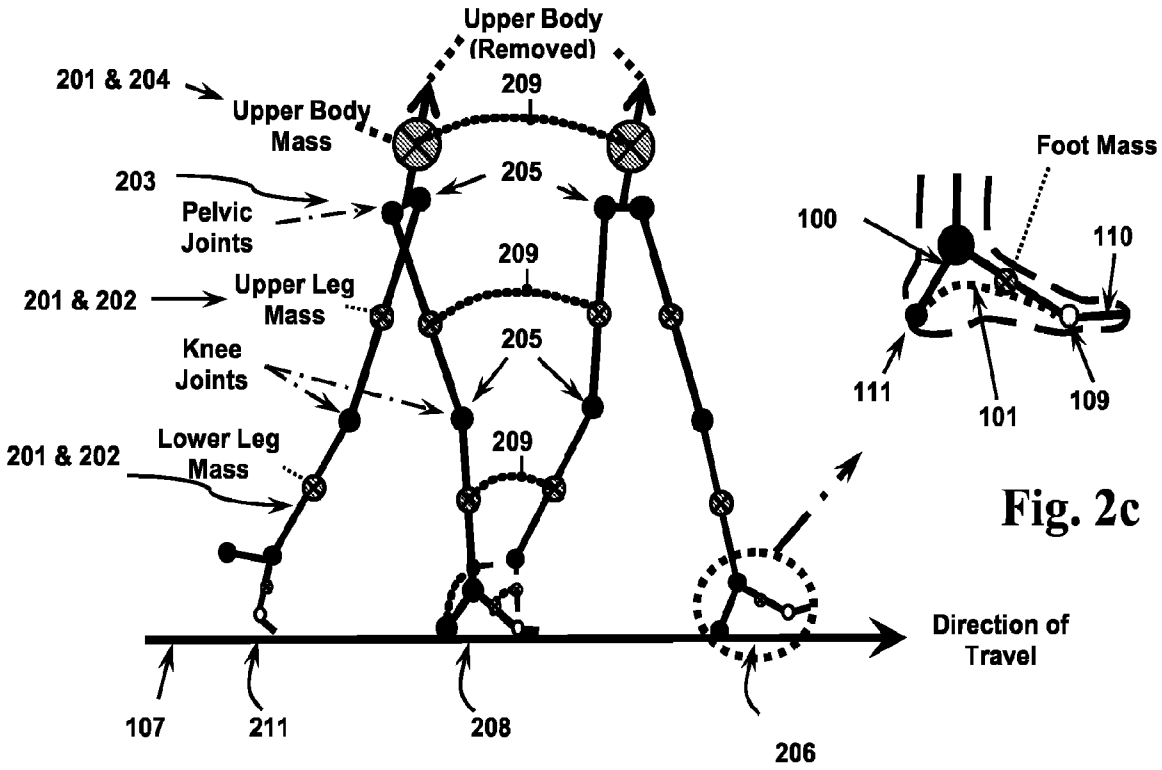


Fig. 2c

FIG. 2a

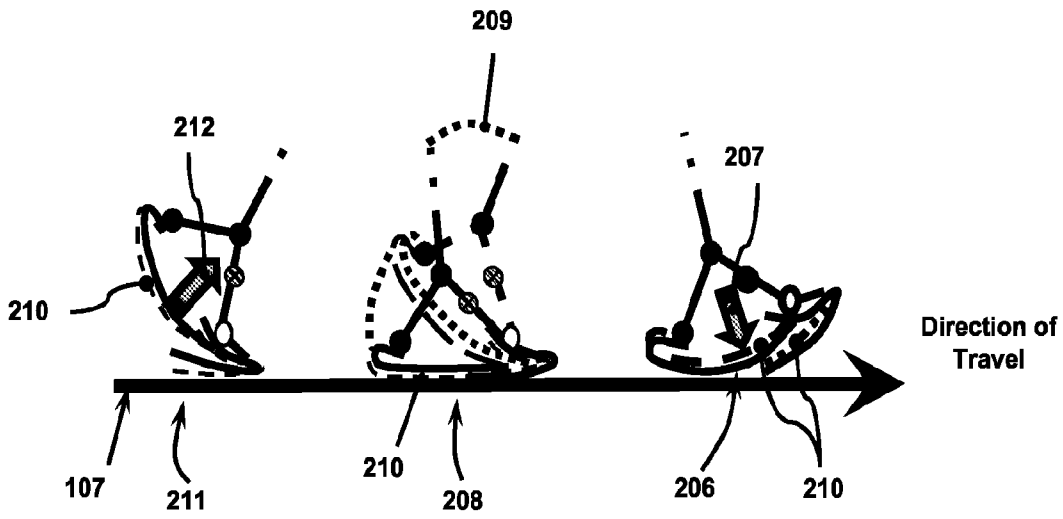
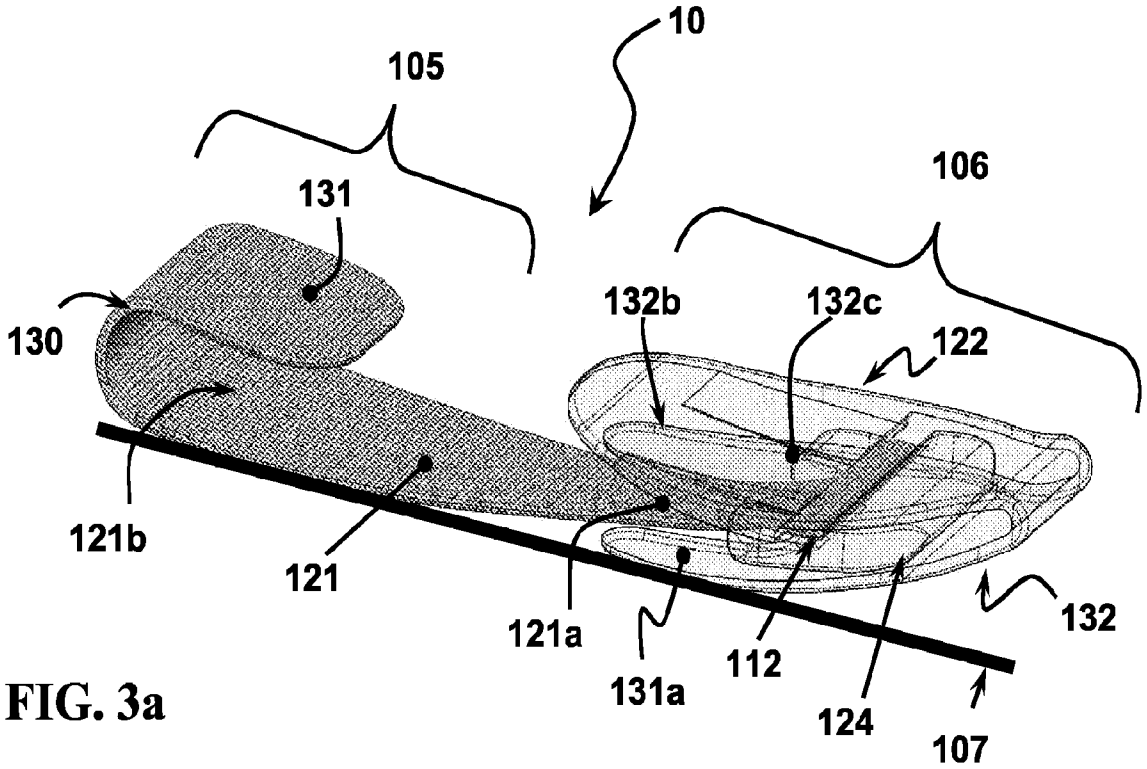


FIG. 2b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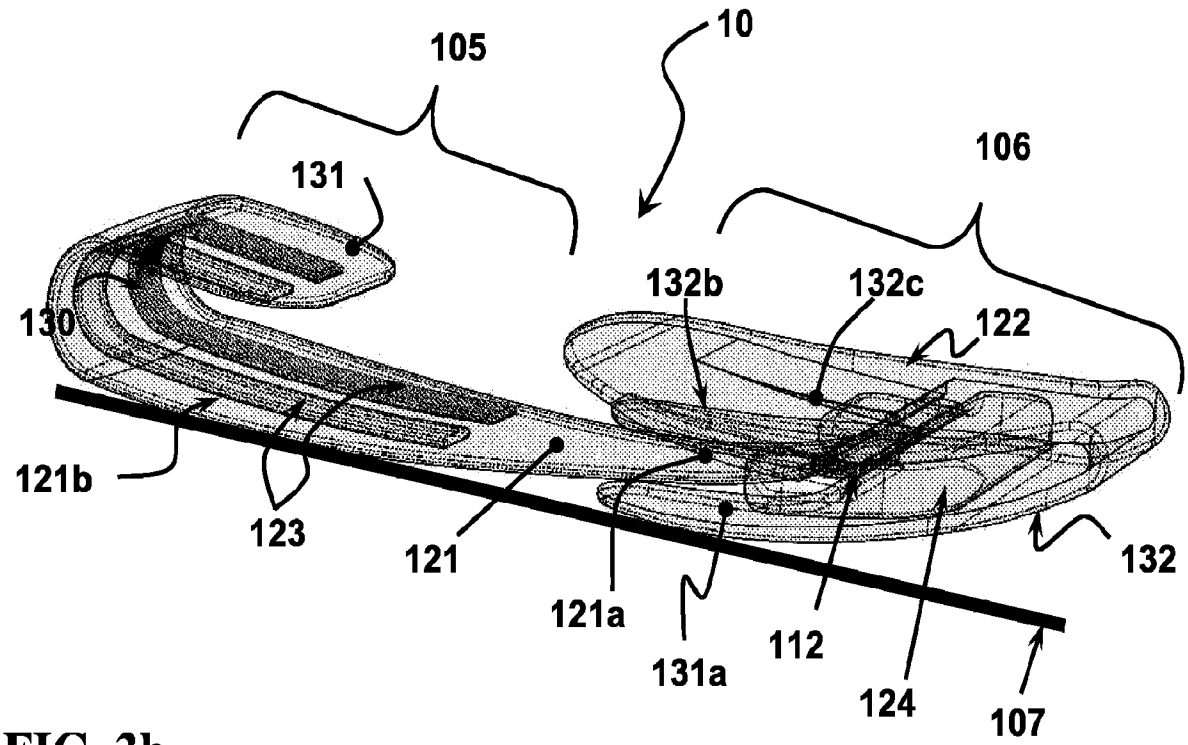
132b
132c
122
121b
121
121a
131a
112
124
107
132

FIG. 3a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121b
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121a
131a
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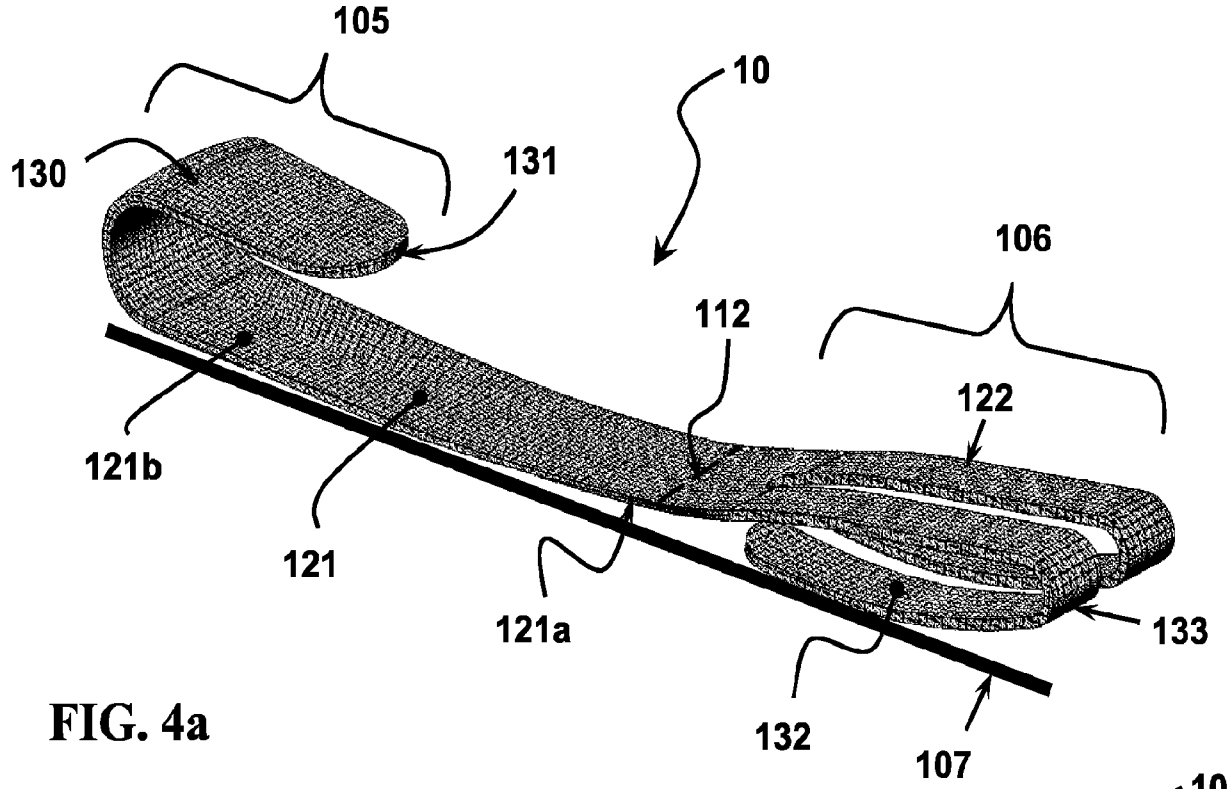
107
132

FIG. 3b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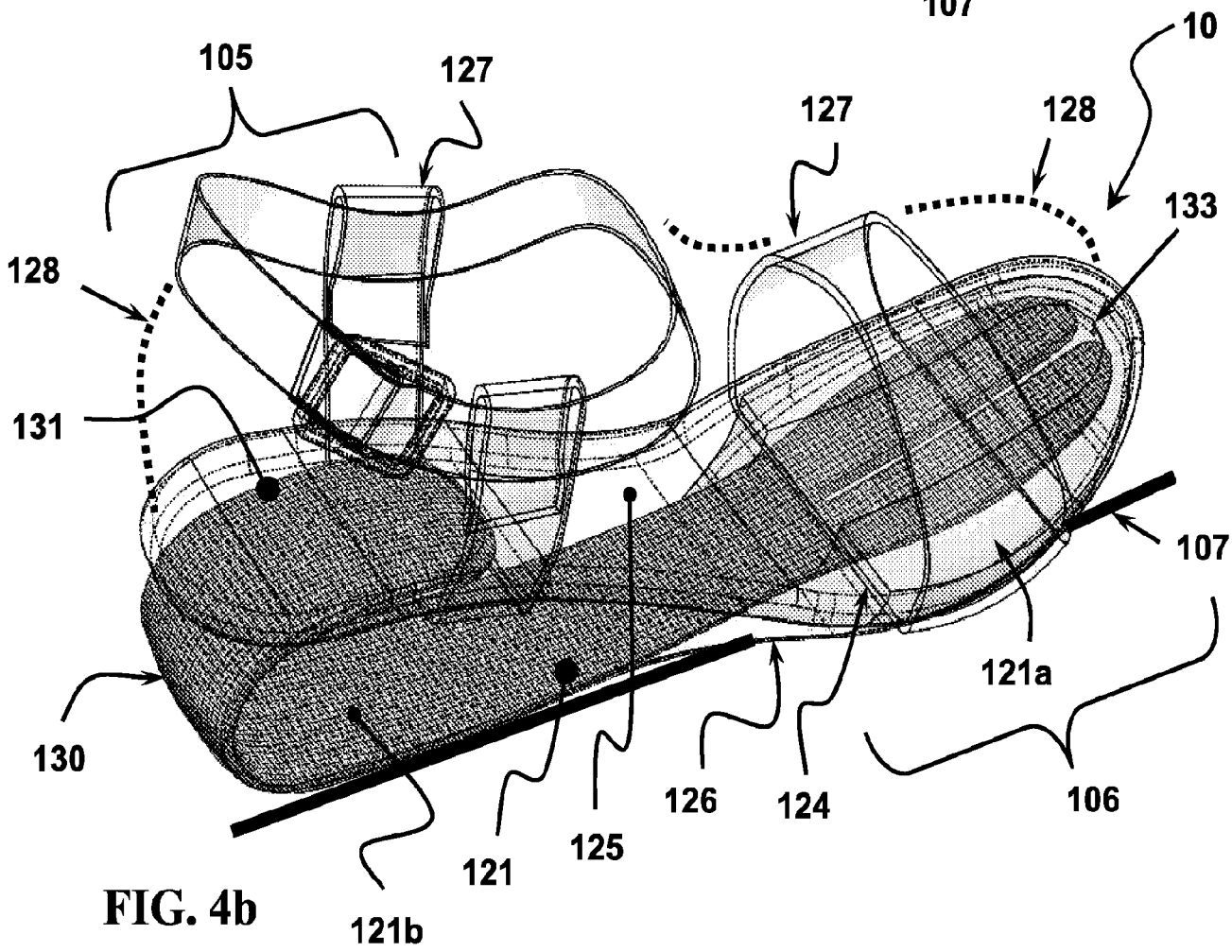
121b
121
121a
133
132
107

FIG. 4a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107
121a
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124
106
121
125
121b

FIG. 4b

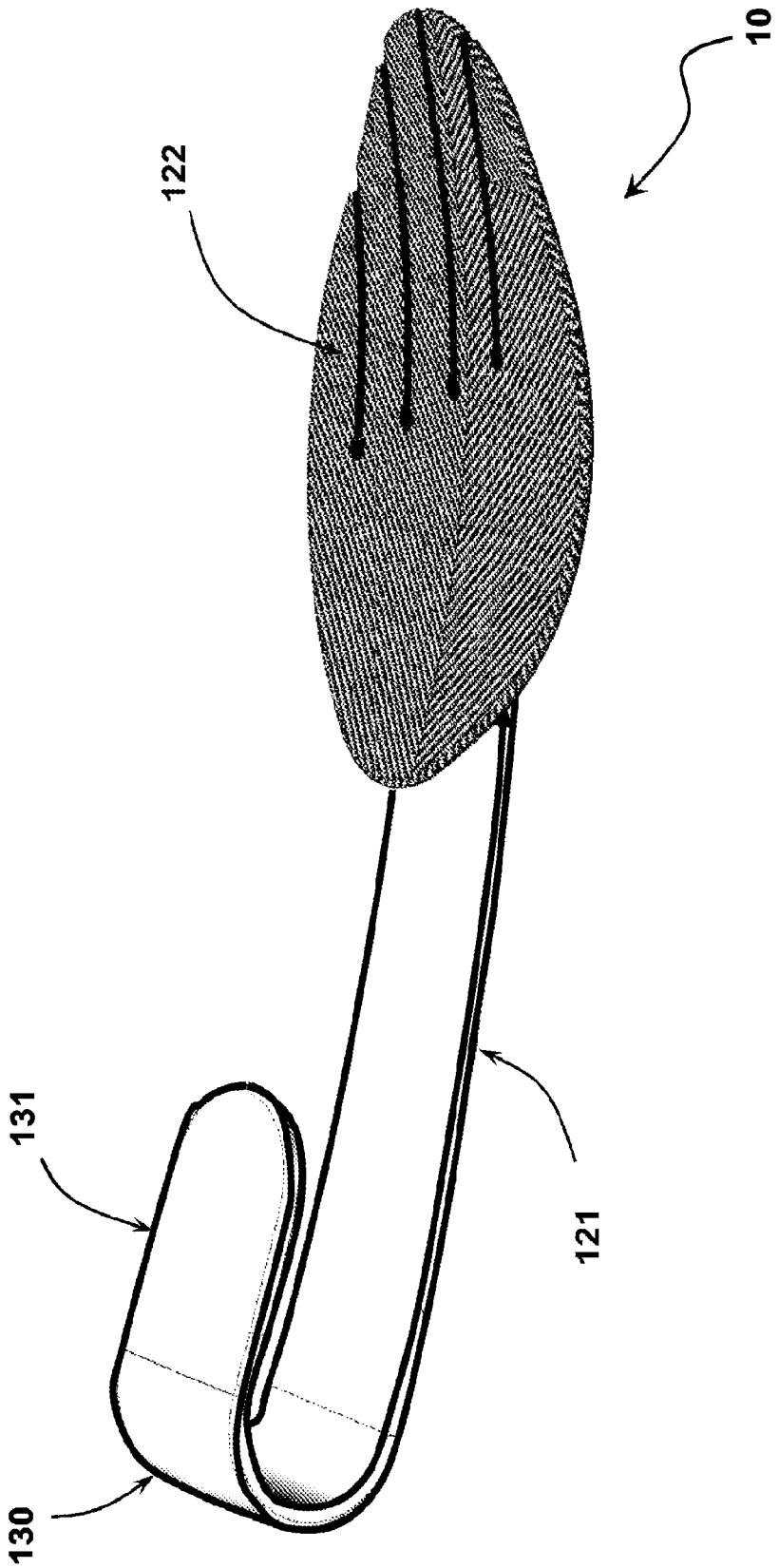

FIG. 5a

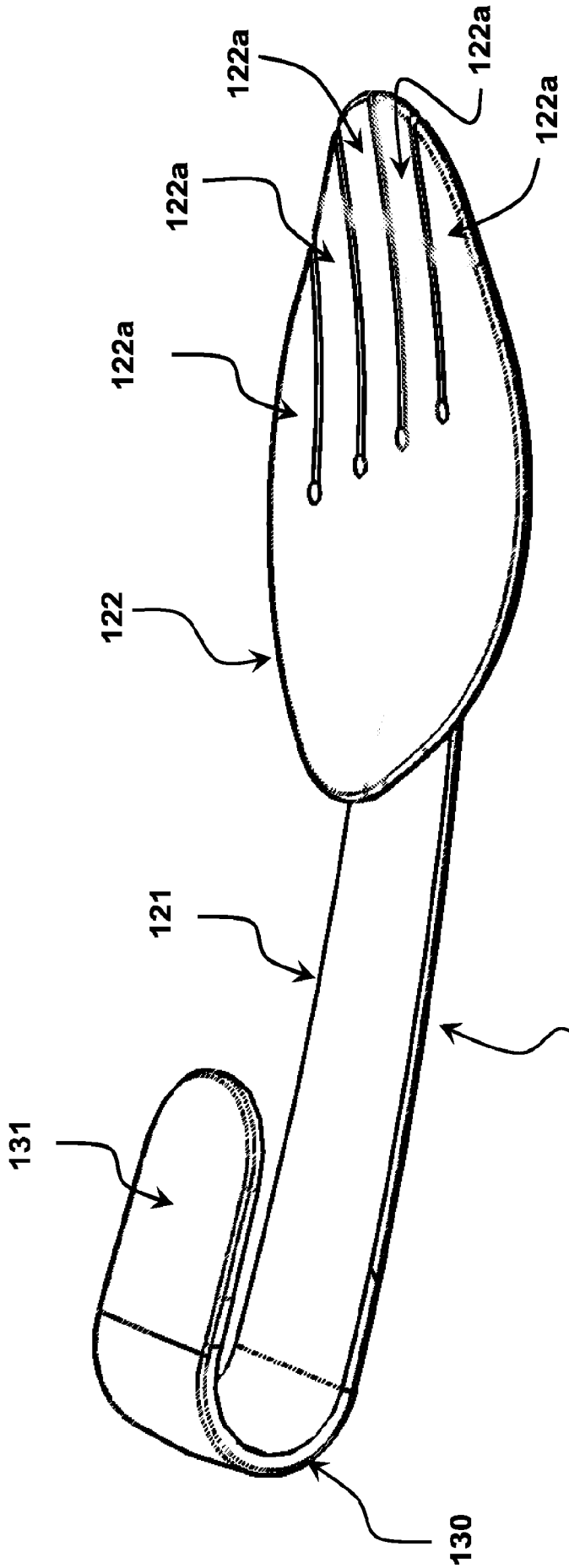

FIG. 5b

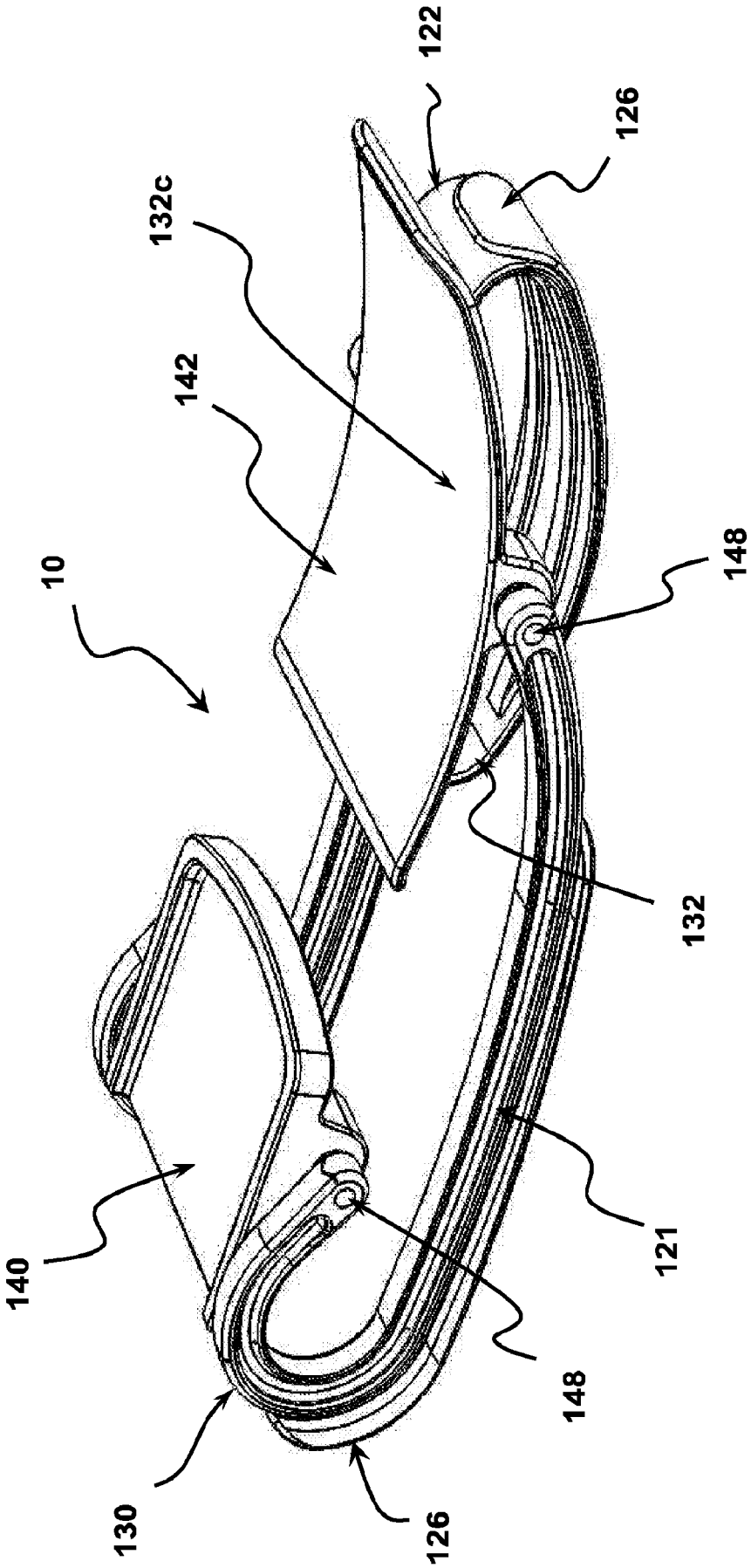

FIG. 6a

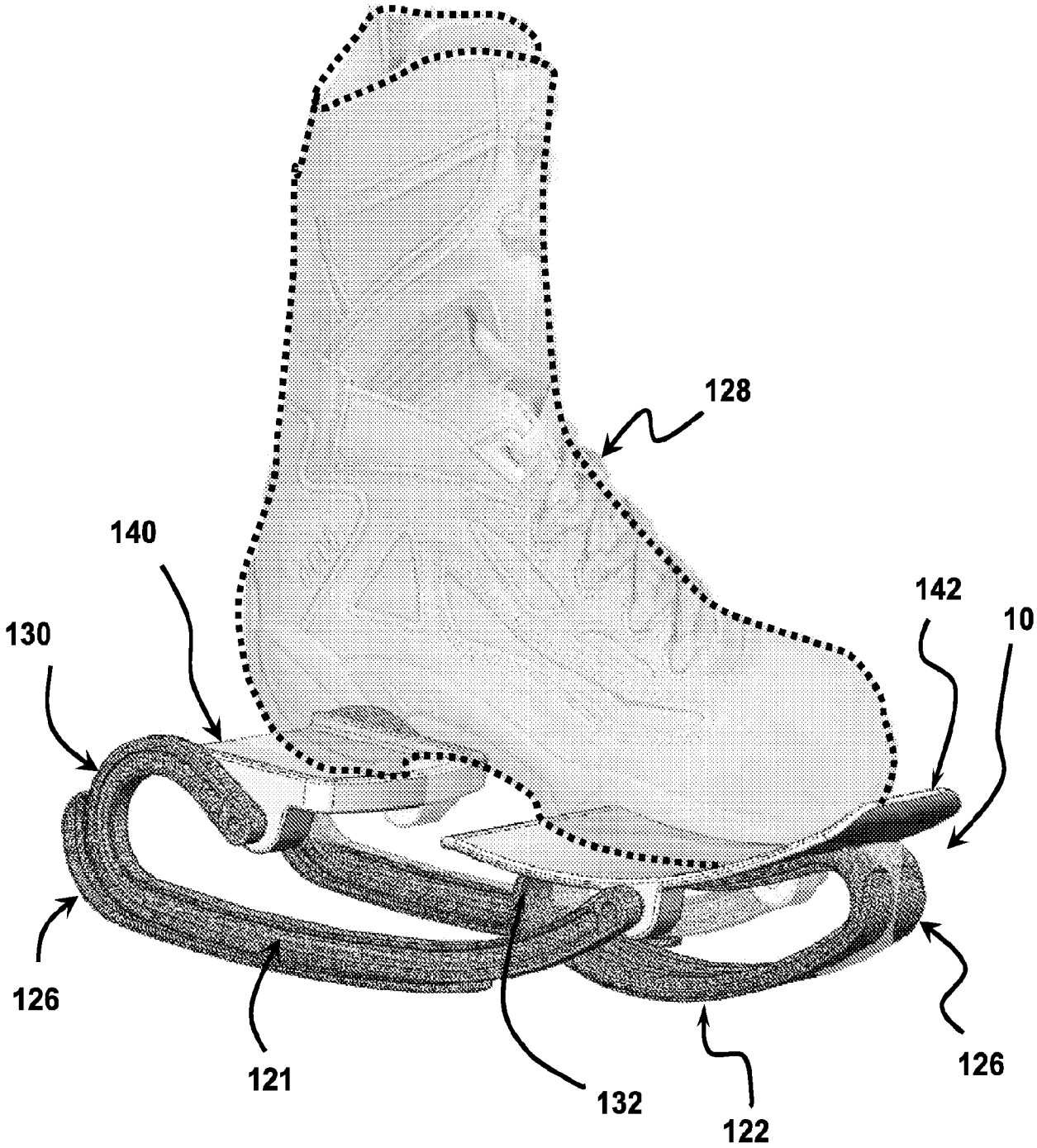

FIG. 6b

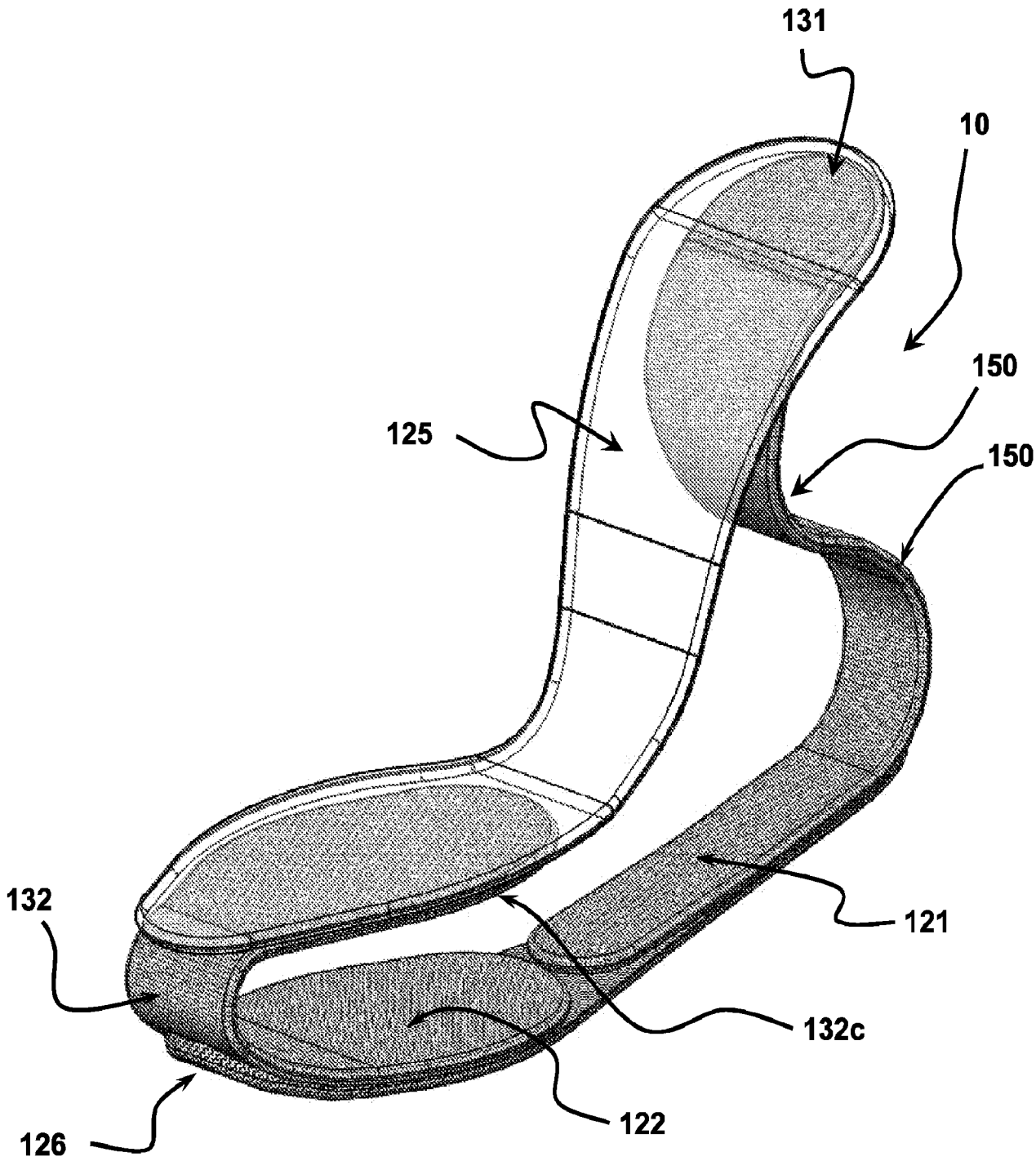

FIG. 7a

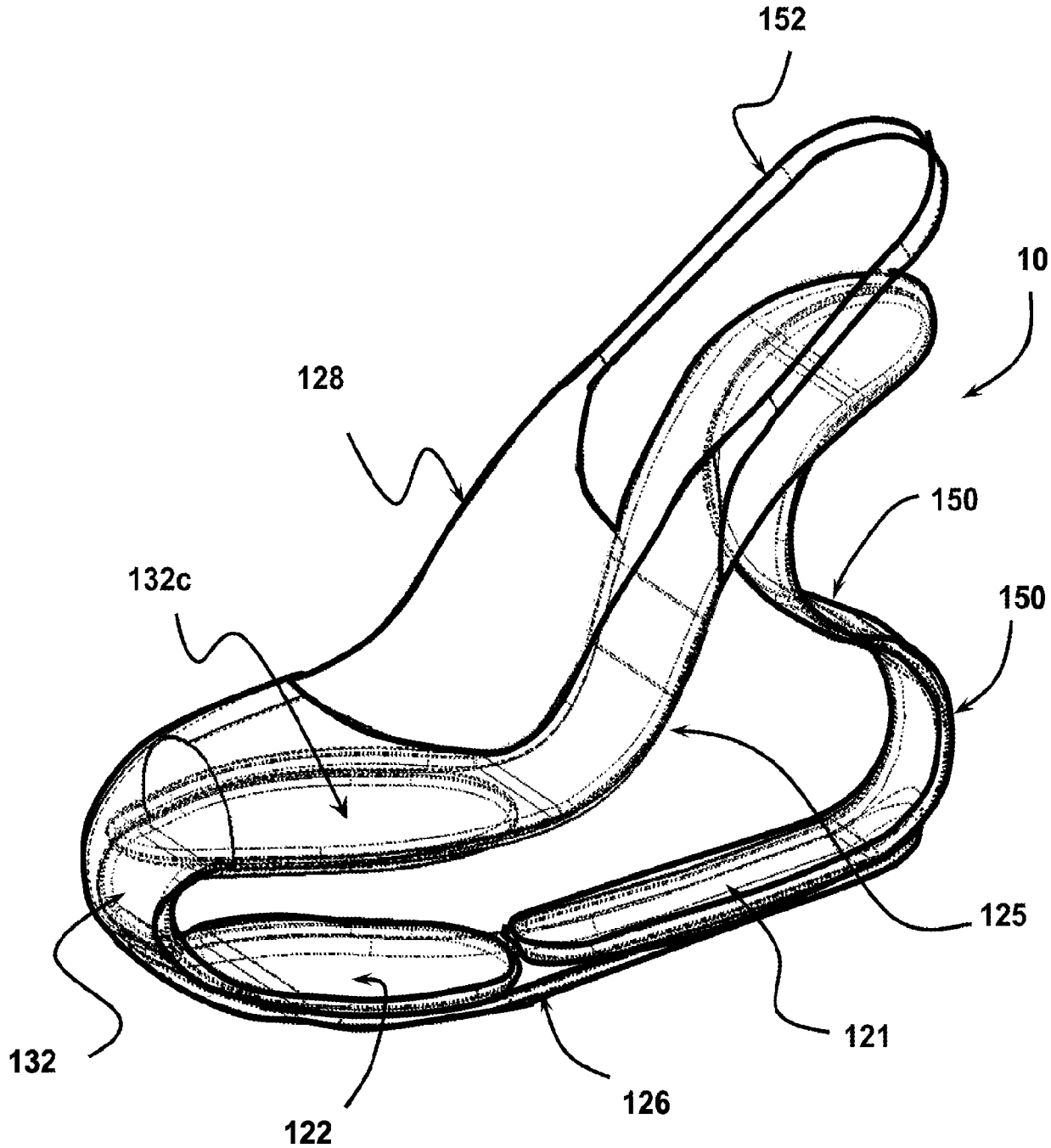

FIG. 7b

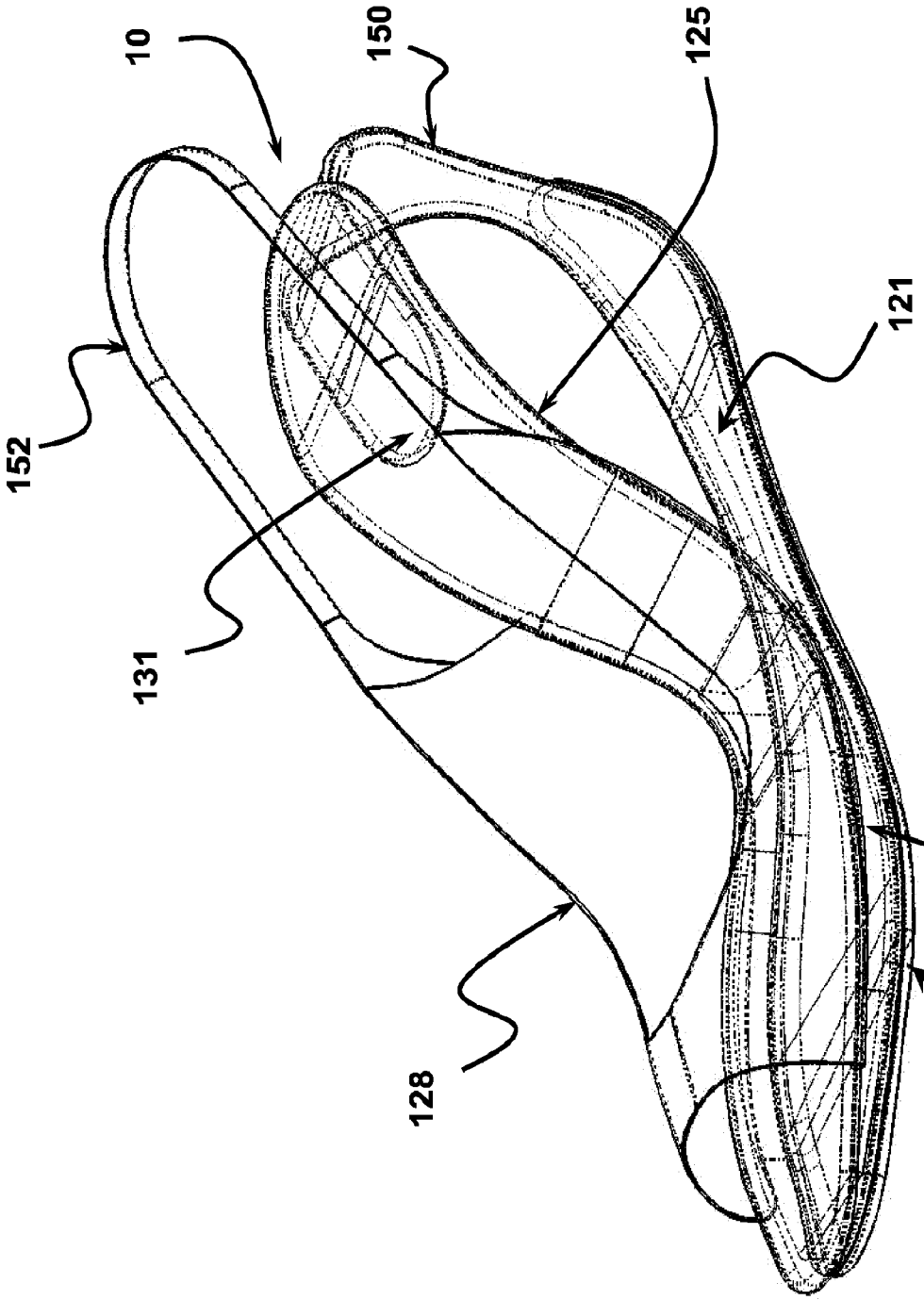

FIG. 7c