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(54) **SOLE STRUCTURE FOR ARTICLE OF FOOTWEAR**

SOHLENSTRUKTUR FÜR SCHUHWERK

STRUCTURE DE SEMELLE POUR ARTICLE CHAUSSANT

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(73) Proprietor: **Nike Innovate C.V.**

Beaverton, OR 97005 (US)

(72) Inventors:

• **CHANG, Leo S.**

Beaverton, OR 97005 (US)

• **DA COSTA PEREIRA MACHADO, Fabricio**

Beaverton, OR 97005 (US)

(74) Representative: **Müller-Boré & Partner**

Patentanwälte PartG mbB

Friedenheimer Brücke 21

80639 München (DE)

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Description

FIELD

[0001] The claimed invention relates generally to an article of footwear and, more particularly, to a sole structure for an article of footwear

BACKGROUND

[0002] This section provides background information related to the claimed invention and is not necessarily prior art.

[0003] Articles of footwear conventionally include an upper and a sole structure. The upper may be formed from any suitable material(s) to receive, secure, and support a foot on the sole structure. The upper may cooperate with laces, straps, or other fasteners to adjust the fit of the upper around the foot. A bottom portion of the upper, proximate to a bottom surface of the foot, attaches to the sole structure.

[0004] Sole structures generally include a layered arrangement extending between a ground surface and the upper. For example, a sole structure may include a midsole and an outsole. The midsole is generally disposed between the outsole and the upper and provides cushioning for the foot. The midsole may include a pressurized fluid-filled chamber that compresses resiliently under an applied load to cushion the foot by attenuating ground-reaction forces. The outsole provides abrasion resistance and traction with the ground surface and may be formed from rubber or other materials that impart durability and wear-resistance, as well as enhance traction with the ground surface.

US 2020/297071 A1 describes that an article of footwear includes an upper and a sole structure secured to an underside of the upper. The sole structure includes a midsole; a ground contacting outsole surface; and a cushioning system disposed between the midsole and the ground contacting outsole surface. The cushioning system includes a plate comprising an upper plate and a lower plate provided in a spaced relationship. The upper plate and lower plate are integrally connected at a posterior portion of the sole structure. A midfoot fluid-filled chamber is provided between the upper plate and the lower plate within the midfoot region, and a forefoot fluid-filled chamber is provided between the upper plate and the lower plate within the forefoot region.

US 2019/320759 A1 describes that a sole structure for an article of footwear includes a first plate, a fluid-filled bladder supported on the first plate, and a second plate supported on the fluid-filled bladder with the fluid-filled bladder disposed between the first plate and the second plate. The first plate ascends rearward of the fluid-filled bladder and the second plate descends rearward of the fluid-filled bladder with a posterior portion of the first plate above a posterior portion of the second plate rearward of the fluid-filled bladder. A method of manufacturing foot-

wear sole structures includes assembling sole structures for plural ranges of footwear sizes, each of the sole structures including a fluid-filled bladder with a predetermined inflation pressure that is different for at least two of the plural ranges.

US 2005/102857 A1 describes that a shoe sole includes a resilient cushioning device engaged in the heel portion for cushioning heel portions of users, the resilient cushioning device includes two frame members cross to each other to form an X-shape structure as seen from side portion and each having an inclined structure and each having a front portion and a rear portion. Each of the frame members has a portion suspended in the shoe sole, to provide a resilience to cushion and support the heel portions of the users. One of the frame members includes one or more arms to support the other frame member. One or more resilient members may further be used to cushion the frame members.

DRAWINGS

[0005] The drawings described herein are for illustrative purposes only of selected configurations and not all possible implementations, and are not intended to limit the scope of the claimed invention.

FIG. 1 is a lateral side elevation view of an article of footwear including an example of a sole structure according to the claimed invention;

FIG. 2 is a medial side elevation view of the article of footwear of FIG. 1;

FIG. 3 is an exploded top-lateral perspective view of the sole structure of FIG. 1;

FIG. 4 is an exploded bottom-medial perspective view of the sole structure of FIG. 1;

FIG. 5 is a bottom plan view of the sole structure of FIG. 1;

FIG. 6 is a cross-sectional view of the sole structure of FIG. 1, taken along Line 6-6 in FIG. 5;

FIG. 7 is a cross-sectional view of the sole structure of FIG. 1, taken along Line 7-7 in FIG. 5;

FIG. 8 is a cross-sectional view of the sole structure of FIG. 1, taken along Line 8-8 in FIG. 5;

FIG. 9 is a cross-sectional view of the sole structure of FIG. 1, taken along Line 9-9 in FIG. 5; and

FIG. 10 is a top plan view of a cushioning element of the sole structure of FIG. 1.

[0006] Corresponding reference numerals indicate

corresponding parts throughout the drawings.

DETAILED DESCRIPTION

[0007] Example configurations will now be described more fully with reference to the accompanying drawings. Example configurations are provided so that this disclosure will be thorough, and will fully convey the scope of the claimed invention to those of ordinary skill in the art. Specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of configurations of the claimed invention. It will be apparent to those of ordinary skill in the art that specific details need not be employed, that example configurations may be embodied in many different forms, and that the specific details and the example configurations should not be construed to limit the scope of the claimed invention.

[0008] The terminology used herein is for the purpose of describing particular exemplary configurations only and is not intended to be limiting. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. Additional or alternative steps may be employed.

[0009] When an element or layer is referred to as being "on," "engaged to," "connected to," "attached to," or "coupled to" another element or layer, it may be directly on, engaged, connected, attached, or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly engaged to," "directly connected to," "directly attached to," or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.). As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0010] The terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections. These elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as "first," "second," and other numerical terms do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second

element, component, region, layer or section without departing from the teachings of the example configurations.

[0011] The claimed invention is a sole structure for an article of footwear as defined in claim 1.

[0012] Implementations of the claimed invention are defined in dependent claims.

[0013] The details of one or more implementations of the claimed invention are set forth in the accompanying drawings and the description below. Other aspects, features, and advantages will be apparent from the description, the drawings, and the claims.

[0014] Referring to FIG. 1, an article of footwear 10 includes a sole structure 100 and an upper 200 attached to the sole structure 100. The footwear 10 may further include an anterior end 12 associated with a forward-most point of the footwear 10 and a posterior end 14 corresponding to a rearward-most point of the footwear 10. As shown in FIG. 5, a longitudinal axis A_{10} of the footwear 10 extends along a length of the footwear 10 from the anterior end 12 to the posterior end 14 parallel to a ground surface, and generally divides the footwear 10 into a medial side 16 and a lateral side 18. Accordingly, the medial side 16 and the lateral side 18 respectively correspond with opposite sides of the footwear 10 and extend from the anterior end 12 to the posterior end 14. As used herein, a longitudinal direction refers to the direction extending from the anterior end 12 to the posterior end 14, while a lateral direction refers to the direction transverse to the longitudinal direction and extending from the medial side 16 to the lateral side 18.

[0015] The article of footwear 10 may be divided into one or more regions. The regions may include a forefoot region 20, a mid-foot region 22, and a heel region 24. The forefoot region 20 may be subdivided into a toe portion 20_T corresponding with phalanges and a ball portion 20_B associated with metatarsal bones of a foot. The mid-foot region 22 may correspond with an arch area of the foot, and the heel region 24 may correspond with rear portions of the foot, including a calcaneus bone.

[0016] The sole structure 100 includes midsole 102 configured to provide cushioning and support and an outsole 104 defining a ground-engaging surface (i.e., contacts the ground during a stance phase of a gait cycle) of the sole structure 100. Unlike conventional sole structures, which include monolithic midsoles and outsoles, the sole structure 100 of the claimed invention is configured as composite structure including a plurality of components joined together. For example, the midsole 102 includes a resilient cushioning element or cushion arrangement 106, one or more bladders 108, and a plate 110. The outsole 104 may also include a plurality of outsole fragments attached to the midsole 102 to provide zonal traction and abrasion resistance.

[0017] With reference to FIGS. 1 and 2, the cushioning element 106 of the midsole 102 extends from a first end 112 at the anterior end 12 of the footwear 10 to a second end 114 at the posterior end 14 of the footwear. Here, the

second end 114 may define a projection 116 extending beyond the upper 200 at the posterior end 14. The cushioning element 106 further includes a top side 118 facing the upper 200 and defining a profile of a footbed of the sole structure 100, a bottom side 120 formed on an opposite side of the cushioning element 106 from the top side 118 and defining a profile of the ground-contacting surface of the sole structure 100, and a peripheral side 122 extending from the top side 118 to the bottom side 120 and defining an outer peripheral profile of the sole structure 100.

[0018] The peripheral side 122 of the cushioning element 106 includes a plurality of dimples 124 arranged along the heel region 24 and between the top side 118 and the bottom side 120. In the illustrated example, the dimples 124 are arranged as an array including a plurality of rows and columns of the dimples 124. When included, the dimples 124 improve aerodynamics of the sole structure by turbulating airflow along the peripheral side 122 to minimize drag as the article of footwear 10 moves through a swing phase of a gait cycle.

[0019] As described in greater detail below, the cushioning element 106 includes a receptacle 126 formed within the cushioning element 106 between the top side 118 and the bottom side 120 in the forefoot region 20. The receptacle 126 is configured to receive and support the one or more bladders 108 within the cushioning element 106. In other words, the cushioning element 106 extends above the bladders 108 (i.e., between the bladders 108 and the upper 200) and beneath the bladders 108 (i.e., between the bladders 108 and the outsole 104).

[0020] While the cushioning element 106 may be formed as a monolithic structure including a homogenous elastomeric material, the cushioning element 106 of the present example may be defined in terms of a plurality of portions or subcomponents. For example, the cushioning element 106 includes an upper cushioning member or cushion 130 disposed adjacent to the upper 200 and a lower cushioning member or cushion 132 disposed adjacent to the outsole 104. The upper cushioning member 130 extends continuously from the first end 112 of the cushioning element 106 to the second end 114 of the cushioning element 106. Conversely, the lower cushioning member 132 may be fragmented and includes an anterior segment 134 disposed at the first end 112 of the cushioning element 106 and a posterior segment 136 disposed at the second end 114 of the cushioning element 106. As discussed in greater detail below, the anterior segment 134 may be spaced apart from the posterior segment by a gap 138 extending from the medial side 16 to the lateral side 18 in the mid-foot region 22.

[0021] Referring now to FIGS. 3-9, the upper cushioning member 130 extends continuously from the first end 112 of the cushioning element 106 to the second end 114 of the cushioning element 106. The upper cushioning member 130 includes the top side 118 of the cushioning element 106 and a lower side 140 formed on an opposite

side of the upper cushioning member 130 than the top side 118. An upper portion of the peripheral side 122 connects the top side 118 to the lower side 140. As shown in FIG. 3, the top side 118 of the upper cushioning member 130 defines the footbed 142 of the sole structure 100. As shown in FIG. 4, the lower surface of the upper cushioning member 130 includes an upper pocket 144 configured to receive an upper portion of the plate 110 when the sole structure 100 is assembled.

[0022] The upper cushioning member 130 also defines an upper portion 116a of the posterior projection 116. As shown, the upper portion 116a is formed where the top side 118 and the peripheral side 122 extend beyond the footbed 142 at the second end 114. Here, a distance from a portion of the peripheral side 122 on the medial side 16 and a portion of the peripheral side 122 on the lateral side 18 define a width of the projection 116 that tapers along a direction from the footbed 142 to the second end 114. Likewise, the top side 118 and the lower side 140 of the upper cushioning member 130 converge with each other to provide the projection 116 with a tapering thickness along the direction from the footbed 142 to the second end 114.

[0023] Referring still to FIGS. 3-9, the lower cushioning member 132 and the segments 134, 136 thereof may be described as including the bottom side 120 of the cushioning element 106. Additionally, the segments 134, 136 may cooperate to define an upper side 150 of the lower cushioning member 132 formed on an opposite side of the lower cushioning member 132 than the bottom side 120. Lower portions of the peripheral side 122 connect the bottom side 120 and the upper side 150 along each of the segments 134, 136. When the sole structure 100 is assembled, the upper side 150 of the lower cushioning member 132 attaches to the lower side 140 of the upper cushioning member 130 to form the cushioning element 106.

[0024] The upper side 150 of the lower cushioning member 132 includes a lower pocket 152 configured to receive a lower portion of the plate 110 when the sole structure 100 is assembled. Because the lower cushioning member 132 may be formed as a fragmentary structure including the anterior segment 134 and the posterior segment 136 spaced apart from each other by the gap 138, a first portion of the lower pocket 152 may be formed in the upper surface 150 of the anterior segment 134 and a second portion of the lower pocket 152 may be formed in the upper surface of the posterior segment 136.

[0025] The anterior segment 134 of the lower cushioning member 132 is disposed adjacent to the first end 112 of the cushioning element 106. The anterior segment 134 extends from the first end 112 and through the forefoot region 20 to a terminal end 154 adjacent to and facing the mid-foot region 22. The anterior segment 134 includes a support portion 156 extending from the first end 112 and through the toe portion 20_T and a tray 158 extending through the ball portion 20_B from the support portion 156 to the terminal end 154. Generally, a thickness of support

portion 156 extends from the upper side 150 to the bottom side 120 such that the support portion 156 provides cushioning and support through the toe portion 20_T. Conversely, the tray 158 is formed by a portion of the anterior segment 134 having a reduced thickness relative to the support portion 156. The tray 158 extends from a posterior wall of the support portion 156 to the free-hanging distal end 154 of the anterior segment 134. Accordingly, the tray 158 may be described as being cantilevered from the posterior wall of the support portion 156.

[0026] The tray 158 includes one or more recessed sockets 160 formed in the upper side 150 of the cushioning element 106. Each of the one or more sockets 160 is configured to receive a corresponding one of the one or more bladders 108 within the anterior segment 134. Thus, the sockets 160 cooperate with the plate 110 and/or the upper cushioning member 130 to define the receptacle 126 of the cushioning element 106, as discussed previously. In the illustrated example, the tray 158 includes a pair of the sockets 160 recessed from the upper side 150 such that the bladders 108 sit flush with the upper side 150 of the lower cushioning member 132 when the sole structure 100 is assembled. Here, a first one of the sockets 160 is disposed adjacent to the medial side 16 of the sole structure 100 in the ball portion 20_B and a second one of the sockets 160 is disposed adjacent to the lateral side 18 of the sole structure 100 in the ball portion 20_B. As shown, the sockets 160 are exposed along the lateral and medial peripheral sides 122 and at the terminal end 154, such that the bladders 108 are displayed and unconstricted along the terminal end 154 and the sides 16, 18 when the sole structure 100 is assembled.

[0027] Optionally, the sockets 160 may extend at least partially into a posterior sidewall of the support portion 156, defining a peninsular region 162 in the posterior sidewall of the support portion 156 that extends at least partially between the medial and lateral sockets 160. Here the peninsular region 162 may include an opening 164 extending through the thickness of the anterior segment 134 from the upper side 150 to the bottom side 120. The terminal end 154 may also include a tapered notch 166 opposing the peninsular region 162 across the tray 158 and extending between the sockets 160. Here, the notch 166 and the hollowed peninsular region 162 cooperate to allow the sockets 160 of the tray 158 to move relative to each other when torsional loading is applied to the tray 158 (i.e., during a turning or cutting movement).

[0028] With continued reference to FIGS. 3-9, the posterior segment 136 of the lower cushioning member 130 extends through the heel region 24 from the second end 114 of the cushioning element 106 to a terminal end 168 facing the anterior segment 134 in the mid-foot region 22. A portion of the upper side 150 of the lower cushioning member 132 formed by the posterior segment 136 defines a portion of the lower pocket 152 in the mid-foot region 22 and the heel region 24. The bottom side 120 of

the posterior segment 136 forms a convex surface having a continuous curvature from the second end 114 to the terminal end 168. Thus, the posterior segment 136 is configured to provide rolling and continuous contact during a heel-strike phase of a gait cycle. Here, the posterior segment 136 forms a lower portion 116b of the projection 116 at the second end 114 of the cushioning element 106. As shown in FIGS. 1 and 2, the curved bottom side 120 of the lower cushioning member 132 converges with the sloped top side 118 of the upper cushioning member 130 to provide the projection 116 with a tapered thickness T_{116} along the direction from the footbed 142 to the second end 114.

[0029] The posterior segment 136 includes an elongate channel 170 formed in the bottom side 120 and extending into the heel region 24 from the terminal end 168 of the posterior segment 136. The channel 170 has a tapered or triangular cross section extending from the bottom side 120 to an apex between the bottom side 120 and the upper surface 150. The channel 170 is formed through the terminal end 168 of the posterior segment 136 such that the channel 170 defines a notch 172 extending through the terminal end 168 from the upper surface 150 to the bottom surface. The channel 170 and the notch 172 cooperate to form articulating medial and lateral lobes 174 extending along the length of the posterior segment 136.

[0030] As described above, the components 132, 134, 136 of the cushioning element 106 are formed of a resilient polymeric material, such as foam or rubber, to impart properties of cushioning, responsiveness, and energy distribution to the foot of the wearer. In the illustrated example, the upper cushioning member 130 includes a first foam material, the anterior segment 134 of the lower cushioning member 132 includes a second foam material, and the posterior segment 136 of the lower cushioning member 132 includes a third foam material. For example, the upper cushioning member 130 and the anterior segment 134 may include first foam materials providing greater cushioning and impact distribution, while the posterior segment 136 includes a foam material having a greater stiffness in order to provide increased stability to the heel region 24 of the sole structure 100.

[0031] Example resilient polymeric materials for the cushioning element 106 may include those based on foaming or molding one or more polymers, such as one or more elastomers (e.g., thermoplastic elastomers (TPE)). The one or more polymers may include aliphatic polymers, aromatic polymers, or mixtures of both; and may include homopolymers, copolymers (including terpolymers), or mixtures of both.

[0032] In some aspects, the one or more polymers may include olefinic homopolymers, olefinic copolymers, or blends thereof. Examples of olefinic polymers include polyethylene, polypropylene, and combinations thereof. In other aspects, the one or more polymers may include one or more ethylene copolymers, such as, ethylene-vinyl acetate (EVA) copolymers, EVOH copolymers,

ethylene-ethyl acrylate copolymers, ethylene-unsaturated mono-fatty acid copolymers, and combinations thereof.

[0033] In further aspects, the one or more polymers may include one or more polyacrylates, such as polyacrylic acid, esters of polyacrylic acid, polyacrylonitrile, polyacrylic acetate, polymethyl acrylate, polyethyl acrylate, polybutyl acrylate, polymethyl methacrylate, and polyvinyl acetate; including derivatives thereof, copolymers thereof, and any combinations thereof.

[0034] In yet further aspects, the one or more polymers may include one or more ionomeric polymers. In these aspects, the ionomeric polymers may include polymers with carboxylic acid functional groups, sulfonic acid functional groups, salts thereof (e.g., sodium, magnesium, potassium, etc.), and/or anhydrides thereof. For instance, the ionomeric polymer(s) may include one or more fatty acid-modified ionomeric polymers, polystyrene sulfonate, ethylene-methacrylic acid copolymers, and combinations thereof.

[0035] In further aspects, the one or more polymers may include one or more styrenic block copolymers, such as acrylonitrile butadiene styrene block copolymers, styrene acrylonitrile block copolymers, styrene ethylene butylene styrene block copolymers, styrene ethylene butadiene styrene block copolymers, styrene ethylene propylene styrene block copolymers, styrene butadiene styrene block copolymers, and combinations thereof.

[0036] In further aspects, the one or more polymers may include one or more polyamide copolymers (e.g., polyamide-polyether copolymers) and/or one or more polyurethanes (e.g., crosslinked polyurethanes and/or thermoplastic polyurethanes). Alternatively, the one or more polymers may include one or more natural and/or synthetic rubbers, such as butadiene and isoprene.

[0037] When the resilient polymeric material is a foamed polymeric material, the foamed material may be foamed using a physical blowing agent which phase transitions to a gas based on a change in temperature and/or pressure, or a chemical blowing agent which forms a gas when heated above its activation temperature. For example, the chemical blowing agent may be an azo compound such as azodicarbonamide, sodium bicarbonate, and/or an isocyanate.

[0038] In some embodiments, the foamed polymeric material may be a crosslinked foamed material. In these embodiments, a peroxide-based crosslinking agent such as dicumyl peroxide may be used. Furthermore, the foamed polymeric material may include one or more fillers such as pigments, modified or natural clays, modified or unmodified synthetic clays, talc glass fiber, powdered glass, modified or natural silica, calcium carbonate, mica, paper, wood chips, and the like.

[0039] The resilient polymeric material may be formed using a molding process. In one example, when the resilient polymeric material is a molded elastomer, the uncured elastomer (e.g., rubber) may be mixed in a Banbury mixer with an optional filler and a curing package

such as a sulfur-based or peroxide-based curing package, calendared, formed into shape, placed in a mold, and vulcanized.

[0040] In another example, when the resilient polymeric material is a foamed material, the material may be foamed during a molding process, such as an injection molding process. A thermoplastic polymeric material may be melted in the barrel of an injection molding system and combined with a physical or chemical blowing agent and optionally a crosslinking agent, and then injected into a mold under conditions which activate the blowing agent, forming a molded foam.

[0041] Optionally, when the resilient polymeric material is a foamed material, the foamed material may be a compression molded foam. Compression molding may be used to alter the physical properties (e.g., density, stiffness and/or durometer) of a foam, or to alter the physical appearance of the foam (e.g., to fuse two or more pieces of foam, to shape the foam, etc.), or both.

[0042] The compression molding process desirably starts by forming one or more foam preforms, such as by injection molding and foaming a polymeric material, by forming foamed particles or beads, by cutting foamed sheet stock, and the like. The compression molded foam may then be made by placing the one or more preforms formed of foamed polymeric material(s) in a compression mold, and applying sufficient pressure to the one or more preforms to compress the one or more preforms in a closed mold. Once the mold is closed, sufficient heat and/or pressure is applied to the one or more preforms in the closed mold for a sufficient duration of time to alter the preform(s) by forming a skin on the outer surface of the compression molded foam, fuse individual foam particles to each other, permanently increase the density of the foam(s), or any combination thereof. Following the heating and/or application of pressure, the mold is opened and the molded foam article is removed from the mold.

[0043] With continued reference to FIGS. 3 and 4, the plate 110 extends from a first end 176 in the toe portion 20_T to a second end 178 in the heel region 24. The plate 110 includes a top side 180 and a bottom side 182 formed on an opposite side than the top side 180. A distance from the top side 180 to the bottom side 182 defines a thickness of the plate 110. An outer periphery extends between the top side 180 and the bottom side 182 and defines a peripheral profile of the plate 110, which corresponds to a peripheral profile of the upper and lower pockets 144, 152. The plate 110 may be embedded between the upper cushioning member 130 and/or the lower cushioning member 132, such that the top side 180 of the plate 110 is received in the upper pocket 144 and the bottom side 182 of the plate 110 is received in the lower pocket 152. Here, the first end 176 of the plate 110 is received within a portion of the lower pocket 152 defined by the anterior segment 134 and the second end 178 of the plate 110 is received within a portion of the lower pocket 152 defined by the posterior segment

136. Thus, the bottom side 182 of the plate 110 is exposed (i.e., visible) to the ground surface through the opening 164 in the anterior segment 134 and the gap 138 formed between the anterior segment 134 and the posterior segment 136.

[0044] The plate 110 includes a material providing relatively high strength and stiffness, such as polymeric material and/or composite materials. In some examples, the plate 110 is a composite material manufactured using fiber sheets or textiles, including pre-impregnated (i.e., "prepreg") fiber sheets or textiles. Alternatively or additionally, the plate 110 may be manufactured by strands formed from multiple filaments of one or more types of fiber (e.g., fiber tows) by affixing the fiber tows to a substrate or to each other to produce a plate having the strands of fibers arranged predominately at predetermined angles or in predetermined positions. When using strands of fibers, the types of fibers included in the strand can include synthetic polymer fibers which can be melted and re-solidified to consolidate the other fibers present in the strand and, optionally, other components such as stitching thread or a substrate or both. Alternatively or additionally, the fibers of the strand and, optionally the other components such as stitching thread or a substrate or both, can be consolidated by applying a resin after affixing the strands of fibers to the substrate and/or to each other.

[0045] In some implementations, the plate 110 includes a substantially uniform thickness. In some examples, the thickness of the plate 110 ranges from about 0.6 millimeters (mm) to about 3.0 mm. In one example, the thickness of the plate 110 is substantially equal to one 1.0 mm. In other implementations, the thickness of the plate 110 is non-uniform such that the plate 110 may have a greater thickness in one region 20, 22, 24 of the sole structure 200 than the thicknesses in the other regions 20, 22, 24.

[0046] With particular reference to FIGS. 1-4 and 8, the one or more bladders 108 are shown to include a medial bladder 108 and a lateral bladder 108 received within the receptacle 126 of the cushioning element 106 between the upper cushioning member 130 and the lower cushioning member 132. More specifically, the bladders 108 are received within respective ones of the sockets 160. Thus, the medial bladder 108 is disposed in a first socket 160 proximate to the medial side 16 of the sole structure 100 while the lateral bladder 108 is disposed in a second socket 160 proximate to the lateral side 16 of the sole structure 100.

[0047] Each of the bladders 108 may include a pair of barrier layers 184a, 184b formed and joined together along a peripheral seam to define a chamber 186 within the bladder 108. Here, an upper barrier layer 184a defines a top side of the bladder 108 and a lower barrier layer 184b defines a bottom side of the bladder 108. When the sole structure 100 is assembled, the lower barrier layer 184b is received within one of the sockets 160 of the tray 158 such that the bladder 108 is supported

on the foam material of the anterior segment 134. The top side of the upper barrier layer 184a is flush with the upper side 150 of the cushioning element 106 and attaches to the bottom side 182 of the plate 110 within the gap 138.

[0048] As used herein, the term "barrier layer" (e.g., barrier layers 184a, 184b) encompasses both monolayer and multilayer films. In some embodiments, one or both of the barrier layers 184a, 184b are each produced (e.g., thermoformed or blow molded) from a monolayer film (a single layer). In other embodiments, one or both of the barrier layers 184a, 184b are each produced (e.g., thermoformed or blow molded) from a multilayer film (multiple sublayers). In either aspect, each layer or sublayer can have a film thickness ranging from about 0.2 micrometers to about 1 millimeter. In further embodiments, the film thickness for each layer or sublayer can range from about 0.5 micrometers to about 500 micrometers. In yet further embodiments, the film thickness for each layer or sublayer can range from about 1 micrometer to about 100 micrometers.

[0049] One or both of the barrier layers 184a, 184b can independently be transparent, translucent, and/or opaque. As used herein, the term "transparent" for a barrier layer and/or a fluid-filled chamber means that light passes through the barrier layer in substantially straight lines and a viewer can see through the barrier layer. In comparison, for an opaque barrier layer, light does not pass through the barrier layer and one cannot see clearly through the barrier layer at all. A translucent barrier layer falls between a transparent barrier layer and an opaque barrier layer, in that light passes through a translucent layer but some of the light is scattered so that a viewer cannot see clearly through the layer.

[0050] The barrier layers 184a, 184b can each be produced from an elastomeric material that includes one or more thermoplastic polymers and/or one or more cross-linkable polymers. In an aspect, the elastomeric material can include one or more thermoplastic elastomeric materials, such as one or more thermoplastic polyurethane (TPU) copolymers, one or more ethylene-vinyl alcohol (EVOH) copolymers, and the like.

[0051] As used herein, "polyurethane" refers to a copolymer (including oligomers) that contains a urethane group (-N(C=O)O-). These polyurethanes can contain additional groups such as ester, ether, urea, allophanate, biuret, carbodiimide, oxazolidinyl, isocyanurate, urethane, carbonate, and the like, in addition to urethane groups. In an aspect, one or more of the polyurethanes can be produced by polymerizing one or more isocyanates with one or more polyols to produce copolymer chains having (-N(C=O)O-) linkages.

[0052] Examples of suitable isocyanates for producing the polyurethane copolymer chains include diisocyanates, such as aromatic diisocyanates, aliphatic diisocyanates, and combinations thereof. Examples of suitable aromatic diisocyanates include toluene diisocyanate (TDI), TDI adducts with trimethylolpropane (TMP), methylene diphenyl diisocyanate (MDI), xylene diisocya-

nate (XDI), tetramethylxylene diisocyanate (TMXDI), hydrogenated xylene diisocyanate (HXDI), naphthalene 1,5-diisocyanate (NDI), 1,5-tetrahydronaphthalene diisocyanate, para-phenylene diisocyanate (PPDI), 3,3'-dimethyldiphenyl-4,4'-diisocyanate (DDDI), 4,4'-dibenzyl diisocyanate (DBDI), 4-chloro-1,3-phenylene diisocyanate, and combinations thereof. In some embodiments, the copolymer chains are substantially free of aromatic groups.

[0053] In particular aspects, the polyurethane polymer chains are produced from diisocyanates including HMDI, TDI, MDI, H12 aliphatics, and combinations thereof. In an aspect, the thermoplastic TPU can include polyester-based TPU, polyether-based TPU, polycaprolactone-based TPU, polycarbonate-based TPU, polysiloxane-based TPU, or combinations thereof.

[0054] In another aspect, the polymeric layer can be formed of one or more of the following: EVOH copolymers, poly(vinyl chloride), polyvinylidene polymers and copolymers (e.g., polyvinylidene chloride), polyamides (e.g., amorphous polyamides), amide-based copolymers, acrylonitrile polymers (e.g., acrylonitrile-methyl acrylate copolymers), polyethylene terephthalate, polyether imides, polyacrylic imides, and other polymeric materials known to have relatively low gas transmission rates. Blends of these materials as well as with the TPU copolymers described herein and optionally including combinations of polyimides and crystalline polymers, are also suitable.

[0055] The barrier layers 184a, 184b may include two or more sublayers (multilayer film) such as shown in Mitchell et al., U.S. Patent No. 5,713,141 and Mitchell et al., U.S. Patent No. 5,952,065. In embodiments where the barrier layers 184a, 184b include two or more sublayers, examples of suitable multilayer films include microlayer films, such as those disclosed in Bonk et al., U.S. Patent No. 6,582,786. In further embodiments, barrier layers 184a, 184b may each independently include alternating sublayers of one or more TPU copolymer materials and one or more EVOH copolymer materials, where the total number of sublayers in each of the barrier layers 184a, 184b includes at least four (4) sublayers, at least ten (10) sublayers, at least twenty (20) sublayers, at least forty (40) sublayers, and/or at least sixty (60) sublayers.

[0056] The fluid-filled chamber 186 can be produced from the barrier layers 184a, 184b using any suitable technique, such as thermoforming (e.g. vacuum thermoforming), blow molding, extrusion, injection molding, vacuum molding, rotary molding, transfer molding, pressure forming, heat sealing, casting, low-pressure casting, spin casting, reaction injection molding, radio frequency (RF) welding, and the like. In an aspect, the barrier layers 184a, 184b can be produced by co-extrusion followed by vacuum thermoforming to produce an inflatable chamber 186, which can optionally include one or more valves (e.g., one way valves) that allows the chamber 186 to be filled with the fluid (e.g., gas).

[0057] The chamber 186 can be provided in a fluid-

filled (e.g., as provided in footwear 10) or in an unfilled state. The chamber 186 can be filled to include any suitable fluid, such as a gas or liquid. In an aspect, the gas can include air, nitrogen (N₂), or any other suitable gas. In other aspects, the chamber 186 can alternatively include other media, such as pellets, beads, ground recycled material, and the like (e.g., foamed beads and/or rubber beads). The fluid provided to the chamber 186 can result in the chamber 186 being pressurized. Alternatively, the fluid provided to the chamber 186 can be at atmospheric pressure such that the chamber 186 is not pressurized but, rather, simply contains a volume of fluid at atmospheric pressure.

[0058] The fluid-filled chamber 186 desirably has a low gas transmission rate to preserve its retained gas pressure. In some embodiments, the fluid-filled chamber 186 has a gas transmission rate for nitrogen gas that is at least about ten (10) times lower than a nitrogen gas transmission rate for a butyl rubber layer of substantially the same dimensions. In an aspect, fluid-filled chamber 186 has a nitrogen gas transmission rate of 15 cubic-centimeter/square-meter-atmosphere-day (cm³/m²•atm•day) or less for an average film thickness of 500 micrometers (based on thicknesses of the barrier layers 184a, 184b). In further aspects, the transmission rate is 10 cm³/m²•atm•day or less, 5 cm³/m²•atm•day or less, or 1 cm³/m²•atm•day or less.

[0059] The chamber 186 of each of the bladders 108 may receive a tensile element 188 (FIG. 8) therein. Each tensile element 188 may include a series of tensile strands 190 extending between an upper tensile sheet 192 and a lower tensile sheet 192. The upper tensile sheet 192 may be attached to a first one of the barrier layers 184a while the lower tensile sheet 192 may be attached to a second one of the barrier layers 184b. In this manner, when the chamber 186 receives the pressurized fluid, the tensile strands 190 of the tensile element 188 are placed in tension. Because the upper tensile sheet 192 is attached to the upper barrier layer 184a and the lower tensile sheet 192 is attached to the lower barrier layer 184b, the tensile strands 190 retain a desired shape of the bladders 108 when the pressurized fluid is injected into the chambers 186.

[0060] The outsole 104 is formed of a resilient polymeric material and is attached to the bottom side 120 of the lower cushioning member 132. In the illustrated example, the outsole 104 includes a forefoot segment 194 attached to the bottom side 120 of the anterior segment 134 and a pair of heel segments 196 respectively attached to the bottom side 120 each of the lobes 174. Optionally, the forefoot segment 194 of the outsole 104 includes an aperture 198 formed therethrough, which corresponds to the opening 164 formed through the anterior segment 134 of the lower cushioning member 132. Thus, the bottom side 182 of the plate 110 is exposed through the outsole opening 198 and the cushioning element opening 164.

[0061] The upper 200 forms an enclosure having plur-

ality of components that cooperate to define an interior void 202 and an ankle opening 204, which cooperate to receive and secure a foot for support on the sole structure 200. The upper 200 may be formed from one or more materials that are stitched or adhesively bonded together to define the interior void 202. Suitable materials of the upper 200 may include, but are not limited to, textiles, foam, leather, and synthetic leather. The example upper 200 may be formed from a combination of one or more substantially inelastic or non-stretchable materials and one or more substantially elastic or stretchable materials disposed in different regions of the upper 200 to facilitate movement of the article of footwear 10 between the tightened state and the loosened state. The one or more elastic materials may include any combination of one or more elastic fabrics such as, without limitation, spandex, elastane, rubber or neoprene. The one or more inelastic materials may include any combination of one or more of thermoplastic polyurethanes, nylon, leather, vinyl, or another material/fabric that does not impart properties of elasticity.

Claims

1. A sole structure for an article of footwear, the sole structure comprising:

an upper cushion (130) extending from a first end (112) to a second end (114);
 a lower cushion (132) having a first segment attached to the upper cushion (130) adjacent to the first end (112) and including a tray (158) extending towards the second end (114) of the upper cushion (130); and
 at least one bladder (108) disposed between the tray (158) of the lower cushion (132) and the upper cushion (130),
characterised in that
 at least one of the upper cushion (130) and the lower cushion (132) includes a peripheral side (122) having a plurality of dimples (124).

2. The sole structure of Claim 1, further comprising a plate (110) disposed between the at least one bladder (108) and the upper cushion (130).
3. The sole structure of Claim 2, wherein a first side of the at least one bladder (108) is attached to the tray (158) and an opposite second side of the at least one bladder (108) is attached to the plate (110).
4. The sole structure of any of the preceding Claims, wherein the lower cushion (132) includes a support portion (156) attached to the upper cushion (130), the tray (158) being cantilevered from the support portion (156).

5. The sole structure of any of the preceding Claims, wherein the at least one bladder (108) includes a first bladder disposed at a medial side of the sole structure and a second bladder disposed at a lateral side of the sole structure.
6. The sole structure of Claim 5, wherein the tray (158) includes a first socket (160) receiving the first bladder and a second socket (160) receiving the second bladder.
7. The sole structure of any of the preceding Claims, wherein the dimples (124) are arranged in a plurality of rows and columns.
8. The sole structure of any of the preceding Claims, further comprising an outsole (104) disposed on an opposite side of the lower cushion (132) from the at least one bladder.
9. The sole structure of any of the preceding Claims, wherein the tray (158) of the lower cushion (132) includes a foam material.

Patentansprüche

1. Eine Sohlenstruktur für einen Fußbekleidungsartikel, wobei die Sohlenstruktur Folgendes umfasst:

ein oberes Polster (130), das sich von einem ersten Ende (112) zu einem zweiten Ende (114) erstreckt;
 ein unteres Polster (132), das ein erstes Segment aufweist, das am oberen Polster (130) benachbart zum ersten Ende (112) angebracht ist und eine Schale (158) beinhaltet, die sich in Richtung des zweiten Endes (114) des oberen Polsters (130) erstreckt; und
 mindestens eine Blase (108), die zwischen der Schale (158) des unteren Polsters (132) und dem oberen Polster (130) angeordnet ist,
dadurch gekennzeichnet, dass
 zumindest eines von dem oberen Polster (130) und dem unteren Polster (132) einen umlaufenden Seitenbereich (122) der eine Vielzahl von Vertiefungen (124) aufweist.

2. Die Sohlenstruktur nach Anspruch 1, ferner umfassend eine Platte (110), die zwischen der mindestens einen Blase (108) und dem oberen Polster (130) angeordnet ist.
3. Die Sohlenstruktur nach Anspruch 2, wobei eine erste Seite der mindestens einen Blase (108) an der Schale (158) angebracht ist und eine gegenüberliegende zweite Seite der mindestens einen Blase (108) an der Platte (110) angebracht ist.

4. Die Sohlenstruktur nach irgendeinem der vorstehenden Ansprüche, wobei das untere Polster (132) einen Stützabschnitt (156) beinhaltet, der am oberen Polster (130) angebracht ist, wobei die Schale (158) vom Stützabschnitt (156) ausragt.
5. Die Sohlenstruktur nach irgendeinem der vorstehenden Ansprüche, wobei die mindestens eine Blase (108) eine erste Blase, die an einer medialen Seite der Sohlenstruktur angeordnet ist, und eine zweite Blase, die an einer lateralen Seite der Sohlenstruktur angeordnet ist, beinhaltet.
6. Die Sohlenstruktur nach Anspruch 5, wobei die Schale (158) eine erste Aufnahme (160), die die erste Blase aufnimmt, und eine zweite Aufnahme (160), die die zweite Blase aufnimmt, beinhaltet.
7. Die Sohlenstruktur nach irgendeinem der vorstehenden Ansprüche, wobei die Vertiefungen (124) in einer Vielzahl von Reihen und Spalten angeordnet sind.
8. Die Sohlenstruktur nach irgendeinem der vorstehenden Ansprüche, ferner umfassend eine Laufsohle (104), die auf einer der mindestens einen Blase gegenüberliegenden Seite des unteren Polsters (132) angeordnet ist.
9. Die Sohlenstruktur nach irgendeinem der vorstehenden Ansprüche, wobei die Schale (158) des unteren Polsters (132) ein Schaumstoffmaterial beinhaltet.

Revendications

1. Une structure de semelle pour un article chaussant, la structure de semelle comprenant :

un coussin supérieur (130) s'étendant d'une première extrémité (112) à une deuxième extrémité (114) ;

un coussin inférieur (132) présentant un premier segment fixé au coussin supérieur (130) de manière adjacente à la première extrémité (112) et incluant un plateau (158) s'étendant vers la deuxième extrémité (114) du coussin supérieur (130) ; et

au moins une vessie (108) disposée entre le plateau (158) du coussin inférieur (132) et le coussin supérieur (130),

caractérisée en ce que

au moins l'un parmi le coussin supérieur (130) et le coussin inférieur (132) inclut un côté périphérique (122) présentant une pluralité de renforcements ou encore d'alvéoles (*dimples*) (124).

2. La structure de semelle d'après la revendication 1,

comprenant en outre une plaque (110) disposée entre la au moins une vessie (108) et le coussin supérieur (130).

3. La structure de semelle d'après la revendication 2, sachant qu'un premier côté de la au moins une vessie (108) est fixé au plateau (158) et qu'un deuxième côté opposé de la au moins une vessie (108) est fixé à la plaque (110).

4. La structure de semelle d'après l'une quelconque des revendications précédentes, sachant que le coussin inférieur (132) inclut une portion de support (156) fixée au coussin supérieur (130), le plateau (158) étant en porte-à-faux à partir de la portion de support (156).

5. La structure de semelle d'après l'une quelconque des revendications précédentes, sachant que la au moins une vessie (108) inclut une première vessie disposée sur un côté médian de la structure de semelle et une deuxième vessie disposée sur un côté latéral de la structure de semelle.

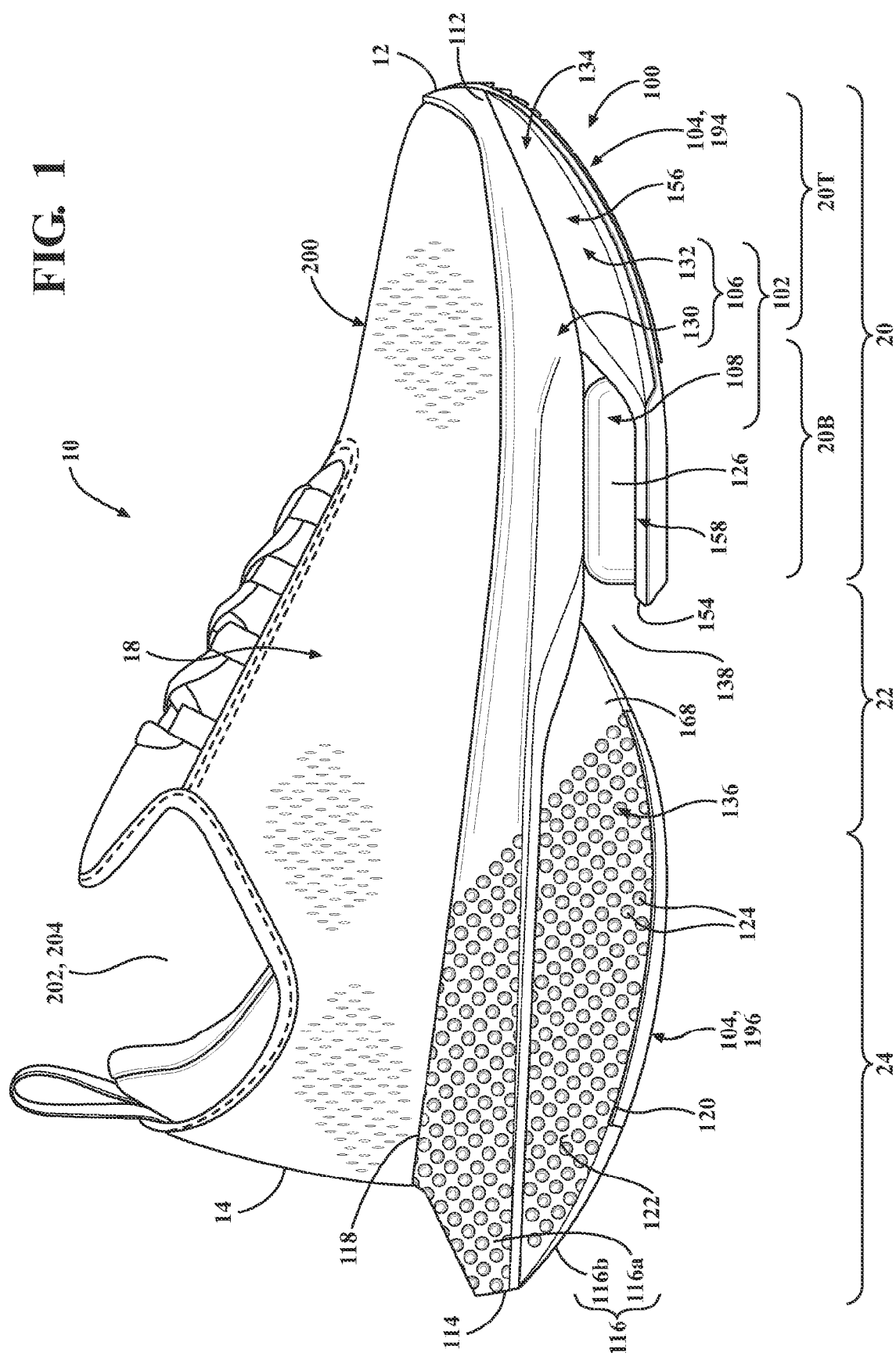
6. La structure de semelle d'après la revendication 5, sachant que le plateau (158) inclut un premier logement (160) recevant la première vessie et un deuxième logement (160) recevant la deuxième vessie.

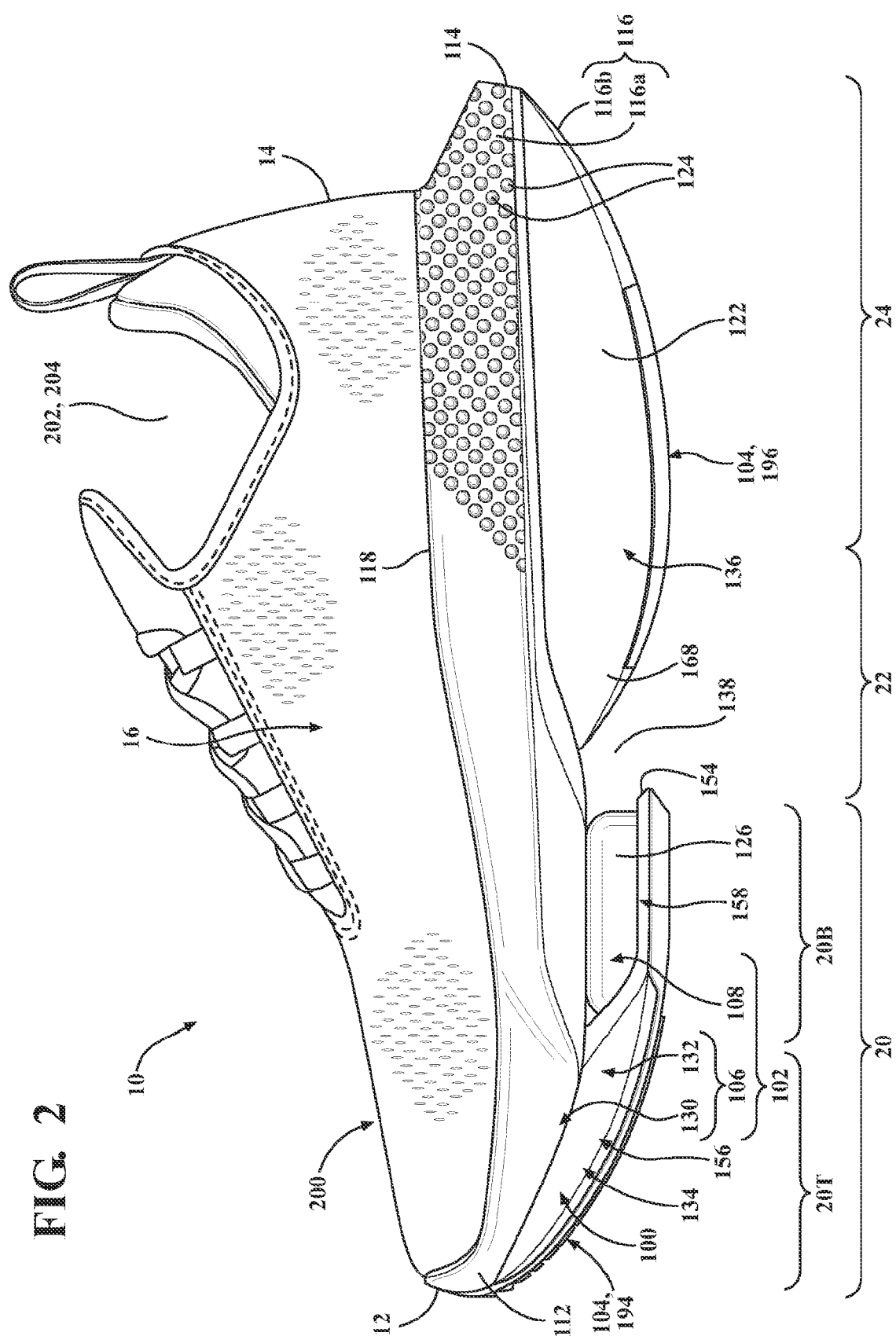
7. La structure de semelle d'après l'une quelconque des revendications précédentes, sachant que les alvéoles (124) sont disposées en une pluralité de rangées et de colonnes.

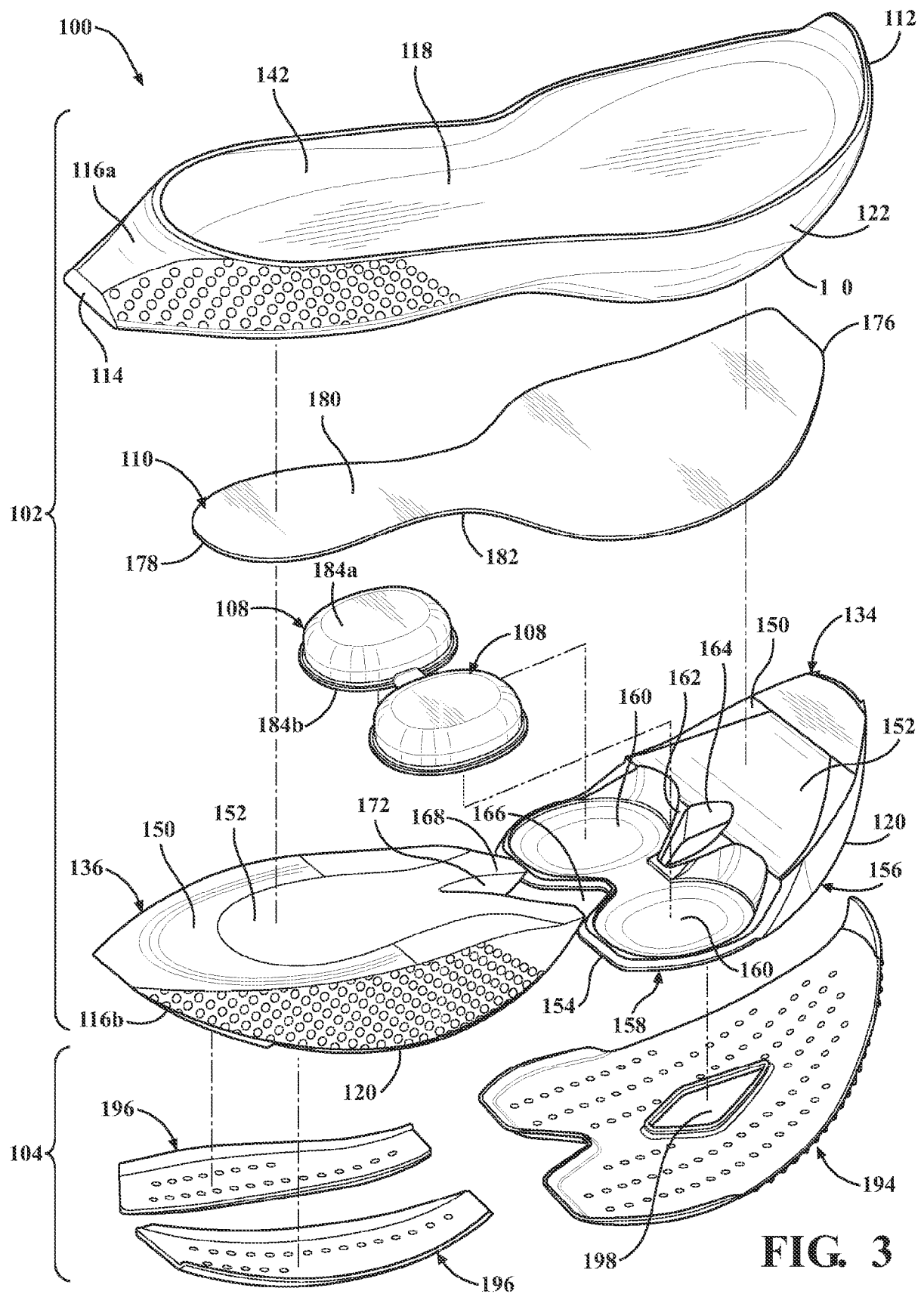
8. La structure de semelle d'après l'une quelconque des revendications précédentes, comprenant en outre une semelle extérieure (104) disposée sur un côté du coussin inférieur (132) opposé à la au moins une vessie.

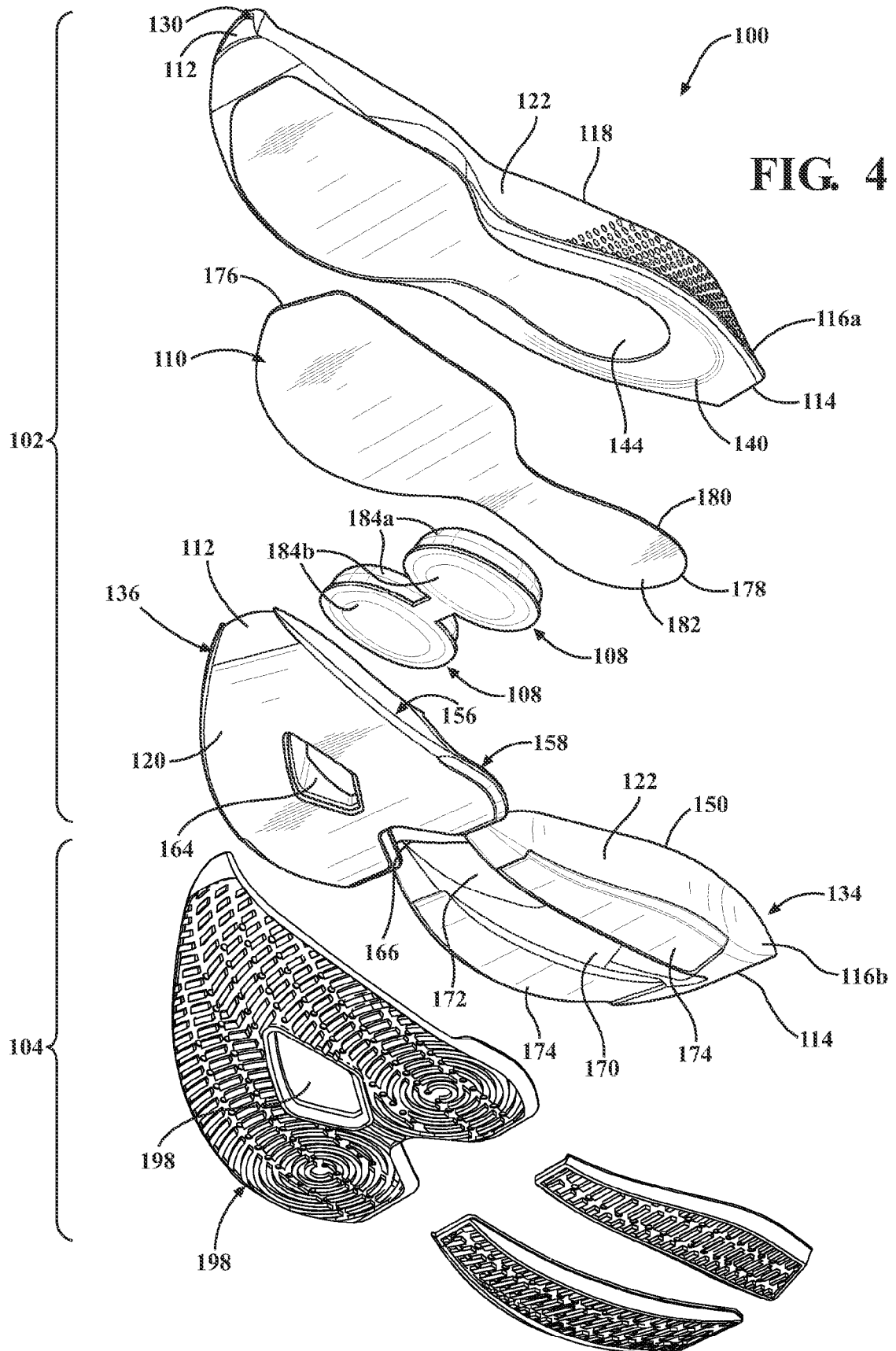
9. La structure de semelle d'après l'une quelconque des revendications précédentes, sachant que le plateau (158) du coussin inférieur (132) inclut un matériau en mousse.

FIGURE









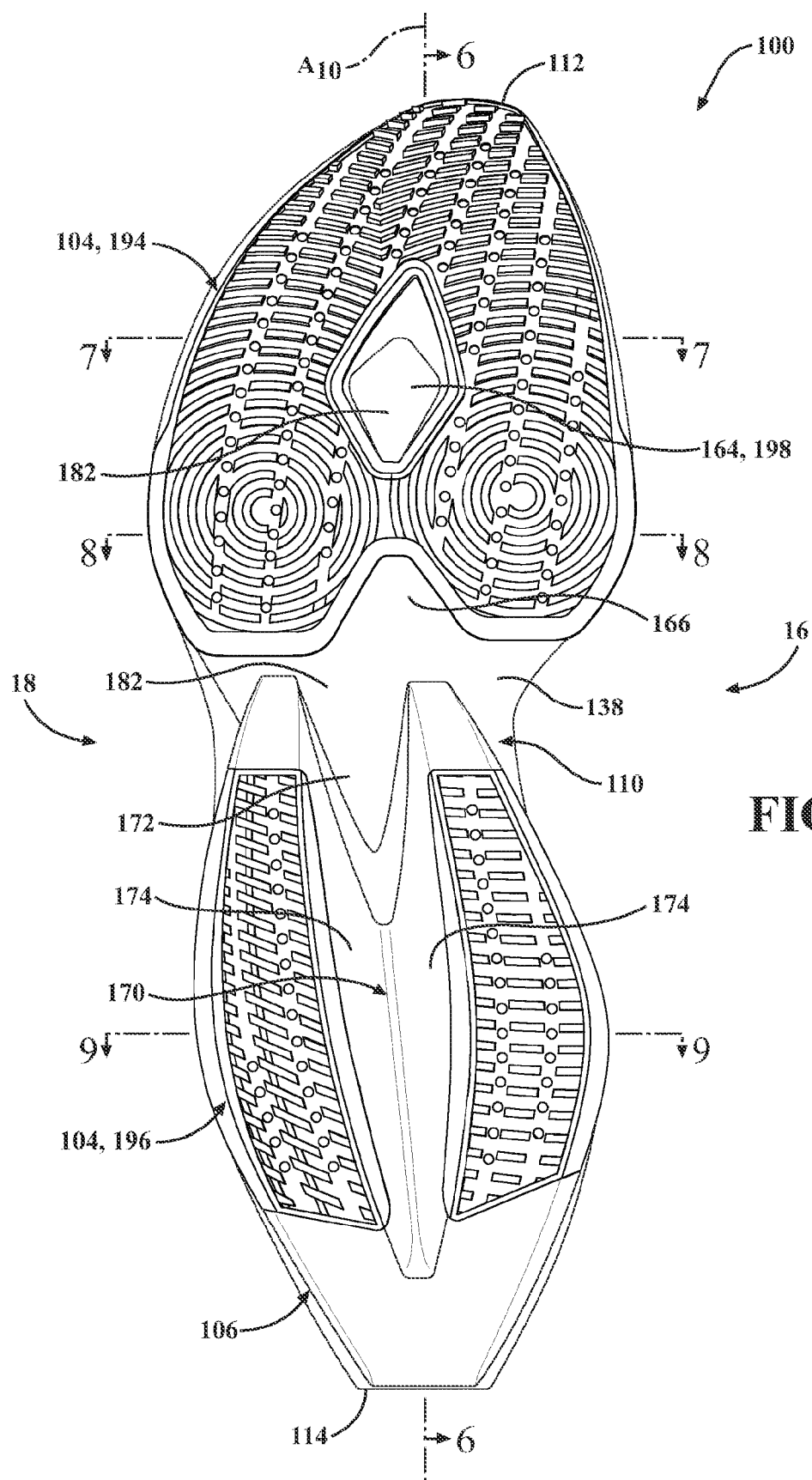


FIG. 5

FIG. 6

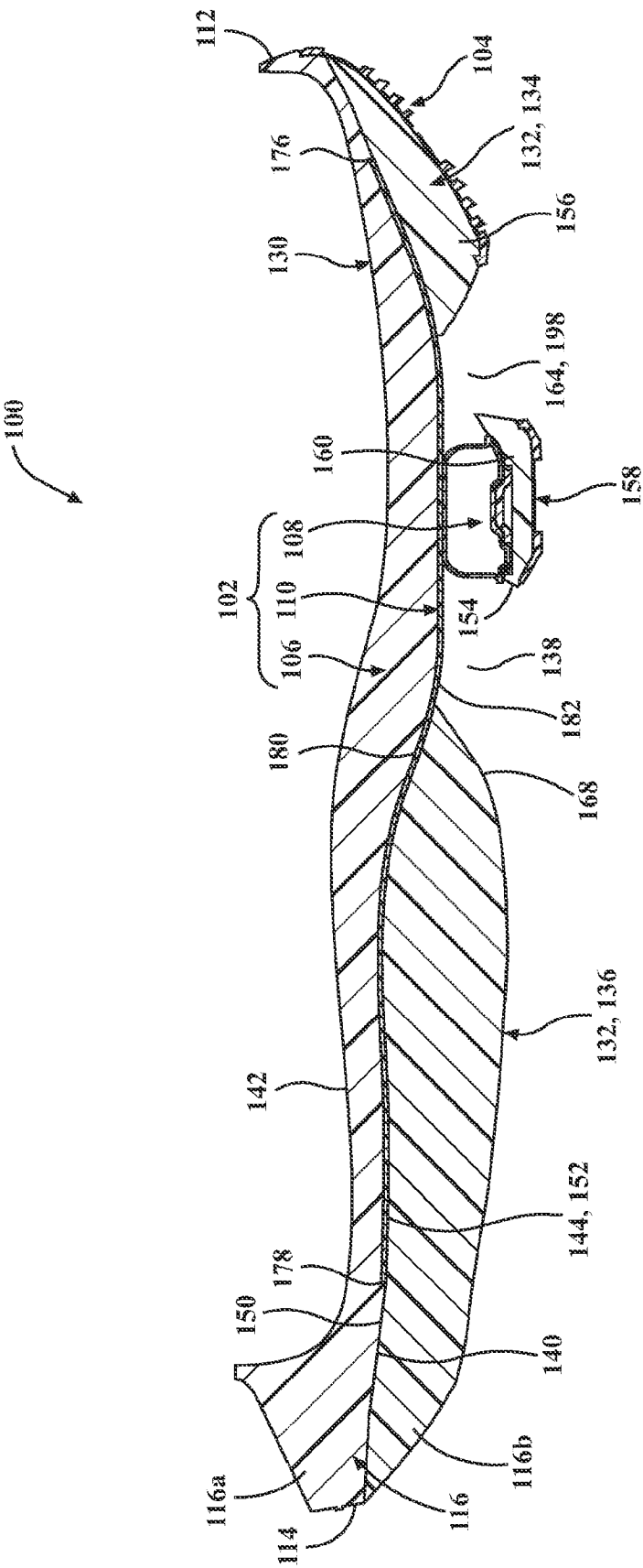


FIG. 7

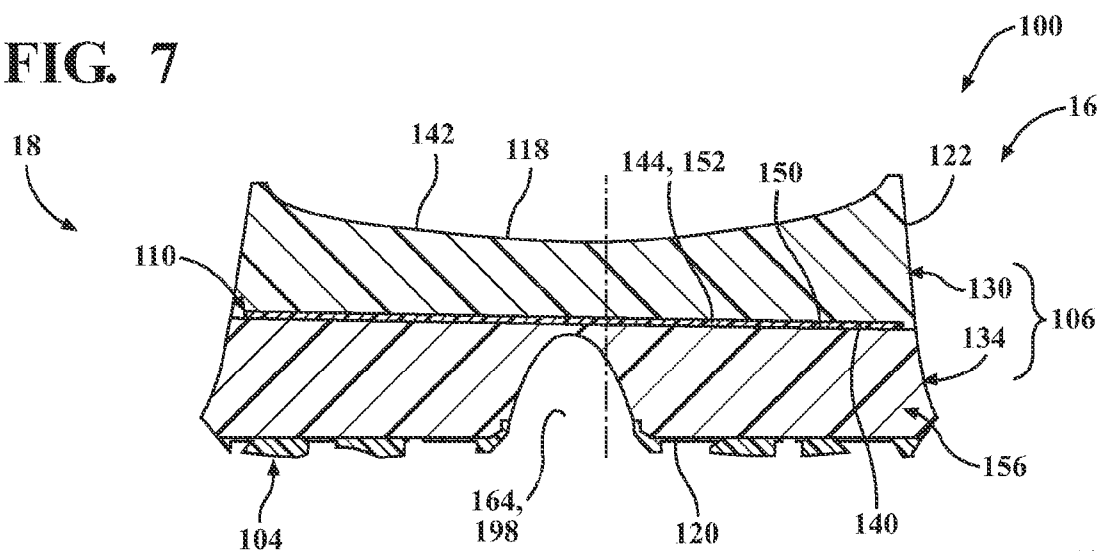


FIG. 8

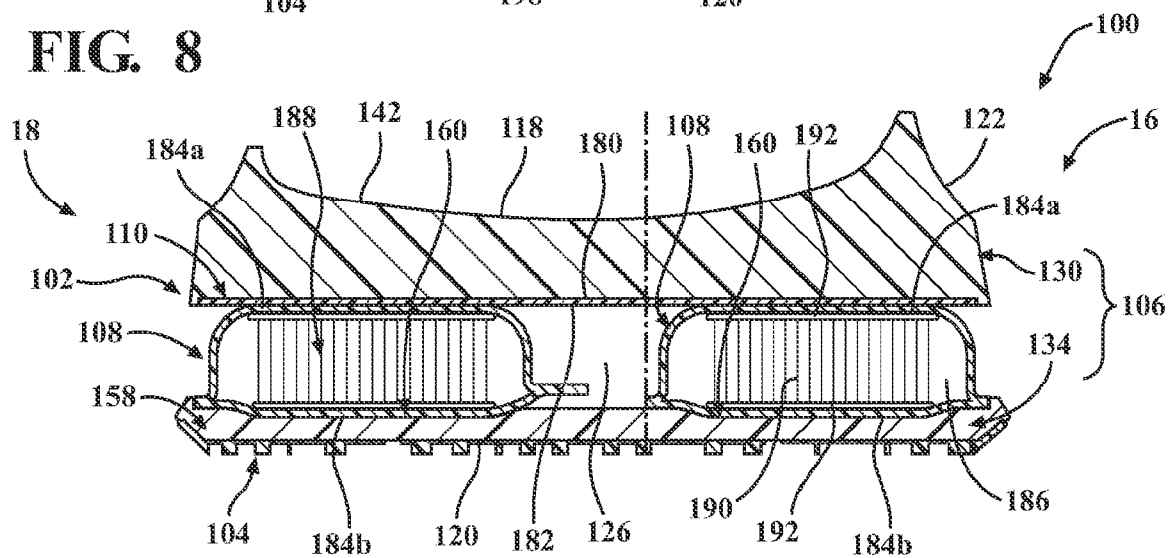


FIG. 9

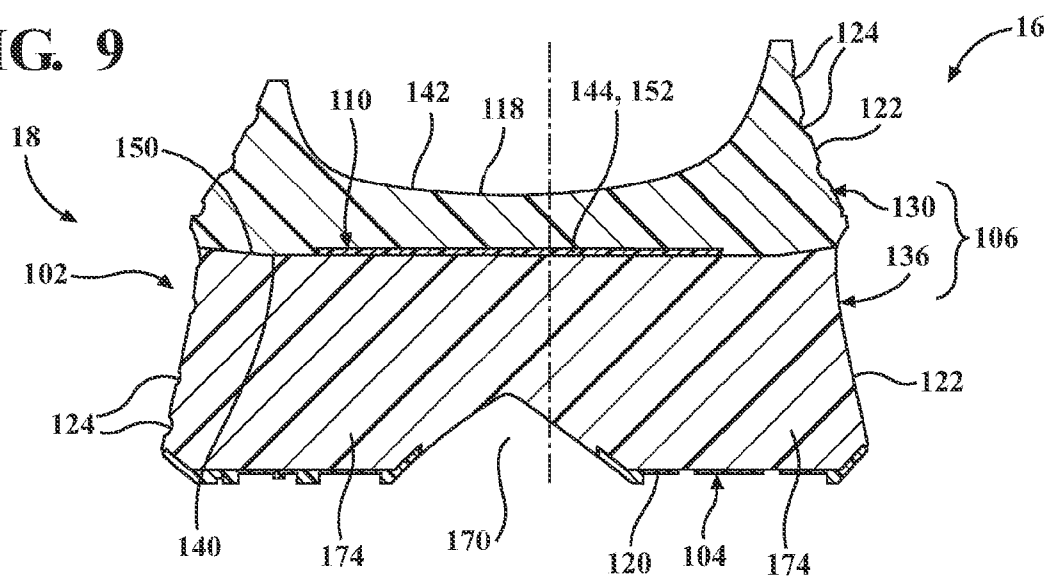
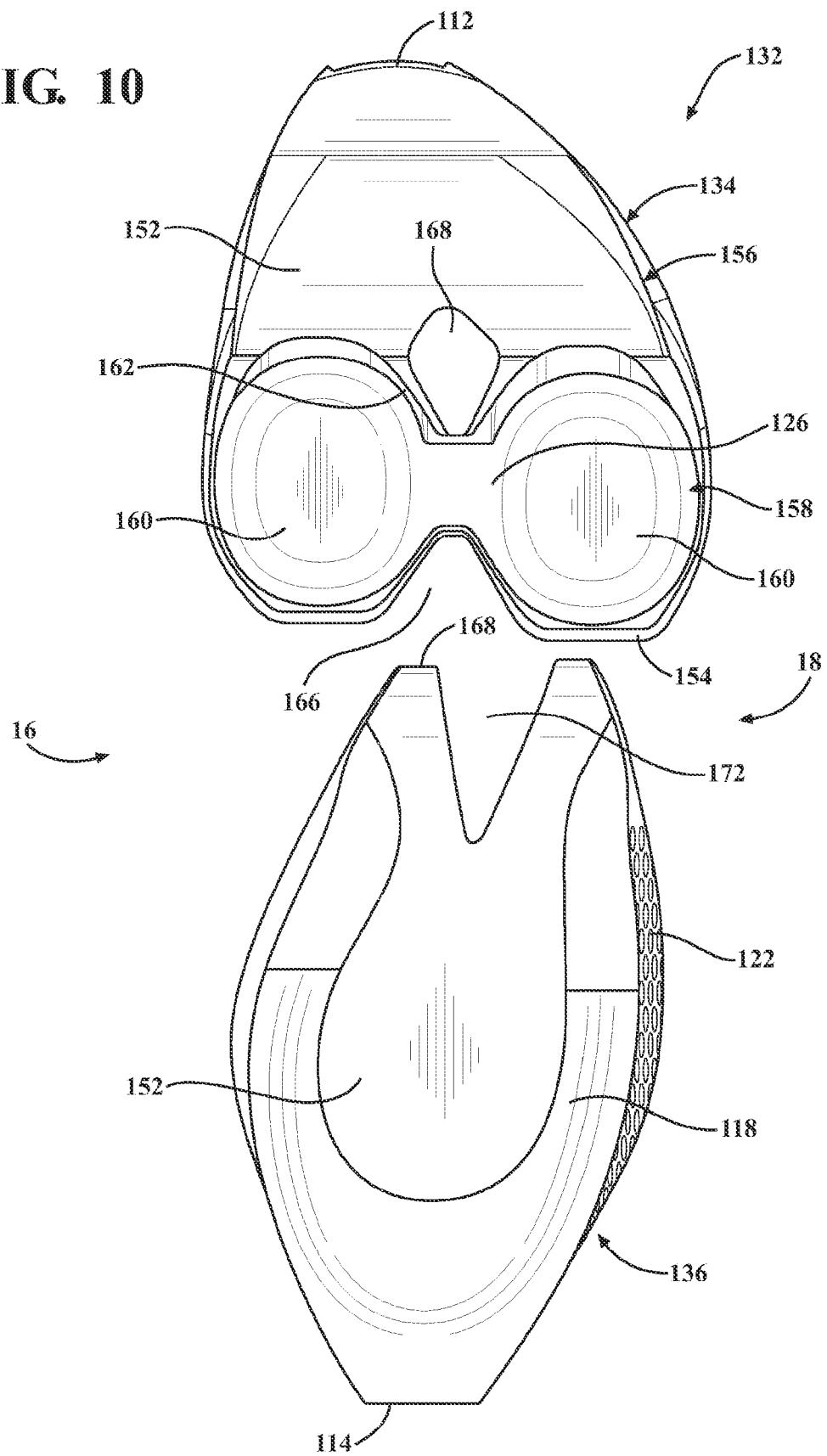


FIG. 10



REFERENCES CITED IN THE DESCRIPTION

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