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

(57) A sole structure for an article of footwear includes a plurality of sole elements, including recesses and protrusions, which are arranged on the sole structure to provide a plurality of zones with different properties. The plurality of zones includes a first zone positioned in a heel region and surrounding a first impact region, a second zone positioned between a thinnest portion of the sole structure in a midfoot region and a widest portion of the sole structure in a forefoot region, and a third zone positioned in the forefoot region and surrounding a toe off region. The first zone is configured to provide greater cushioning and relative traction than the second zone, and the second zone is configured to provide greater cushioning than the third zone.

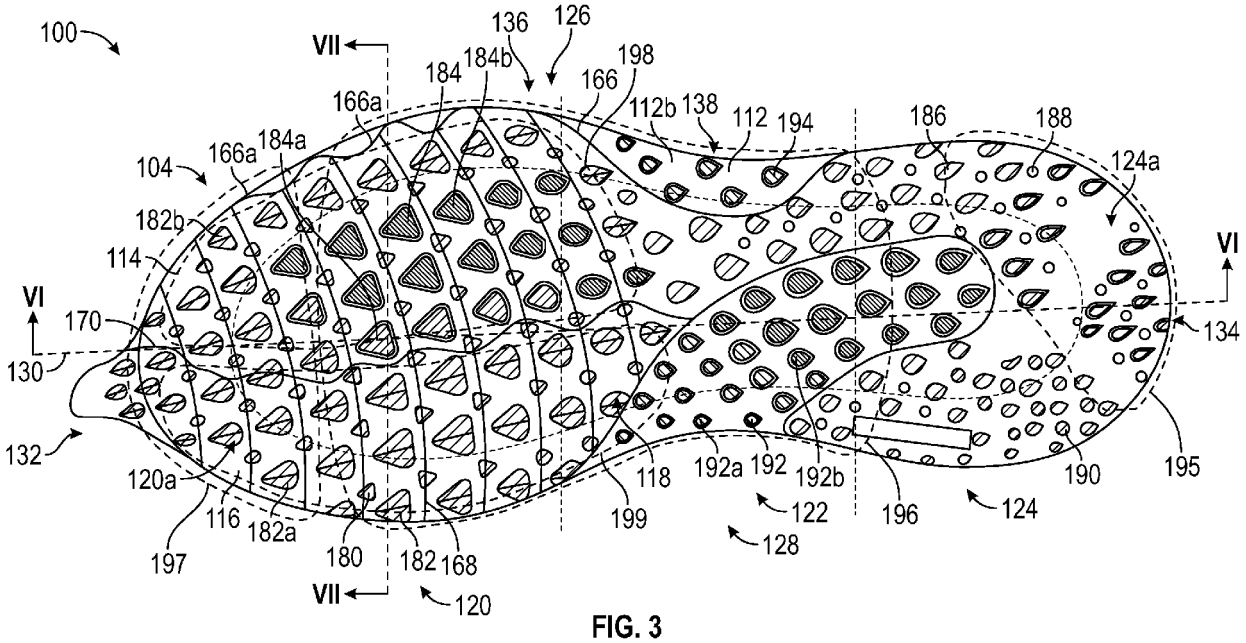


FIG. 3

EP 4 218 481 A1

Description

BACKGROUND

Field of the Disclosure

[0001] The present disclosure relates generally to a sole structure for an article of footwear with holes or recesses to provide enhanced flexibility characteristics, including an article of footwear having an upper and a sole structure. The sole structure includes a midsole and an outsole. The sole structure also includes a number of sole elements, some of which are recesses to provide the sole structure with areas of increased flexibility, and others of which are bumps or protrusions to provide traction in addition to providing areas of the sole that are firm and more supportive. Additionally, the sole structure defines a bottom surface that includes a thickest portion disposed along a medial side of a forefoot portion, which extends lower than the remaining portion of the forefoot section, and which can provide additional support to help to reduce pronation.

Description of the Background

[0002] Many conventional shoes or other articles of footwear generally comprise an upper and a sole attached to a lower end of the upper. Conventional shoes further include an internal space *(i.e.,* a void or cavity) which is created by interior surfaces of the upper and sole that receives a foot of a user before securing the shoe to the foot. The upper generally extends upward from the sole and defines an interior cavity that completely or partially encases a foot. In most cases, the upper extends over instep and toe regions of the foot, and across medial and lateral sides thereof. Many articles of footwear may also include a tongue that extends across the instep region to bridge a gap between edges of medial and lateral sides of the upper, which define an opening into the cavity. The tongue may also be disposed below a lacing or other closure system and between medial and lateral sides of the upper, to allow for adjustment of shoe tightness. The tongue may further be manipulable by a user to permit entry or exit of a foot from the internal space or cavity. In addition, the lacing system may allow a user to adjust certain dimensions of the upper or the sole, thereby allowing the upper to accommodate a wide variety of foot types having varying sizes and shapes.

[0003] The upper may comprise a wide variety of materials, which may be chosen based on one or more intended uses of the shoe. The upper may also include portions comprising varying materials specific to a particular area of the upper. For example, added stability may be desirable at a front of the upper or adjacent a heel region so as to provide a higher degree of resistance or rigidity. In contrast, other portions of a shoe may include a soft woven textile to provide an area with stretch-resistance, flexibility, air-permeability, or moisture-wicking properties.

[0004] The sole is attached to a lower surface or boundary of the upper and is positioned between the upper and the ground. As a result, the sole typically provides stability and cushioning to the user when the shoe is being worn. In some instances, the sole may include multiple components, such as an outsole, a midsole, and an insole. The outsole may provide traction to a bottom surface of the sole, and the midsole may be attached to an inner surface of the outsole and may provide cushioning or added stability to the sole. For example, a sole may include a particular foam material that may increase stability at one or more desired locations along the sole or a foam material that may reduce stress or impact energy on the foot or leg when a user is running, walking, or engaged in another activity.

[0005] Sole assemblies generally extend between a ground surface and the upper. In some examples, the sole assembly includes an outsole that provides abrasion-resistance and traction with the ground surface. The outsole may be formed from rubber or other materials that impart durability and wear-resistance, as well as enhancing traction with the ground surface.

[0006] However, while many currently available shoes have varying features related to the above-noted properties, many shoes, including athletic shoes, and even more so running shoes, have sole structures that lack sufficient support to aid in stability while also maintaining adequate flexibility to promote the natural movement of a foot of a user, for example, while running or engaging in other strenuous athletic activities. This can be especially problematic for individuals who suffer from pronation and supination, which results in the foot rolling inward and outward, respectively, during normal motion of the foot. Such pronation and supination can result in injuries if not compensated for.

[0007] Therefore, articles of footwear having features that aid in both stability and flexibility along both the upper and sole structure thereof are desired. These and other deficiencies with the prior art are outlined in the following disclosure.

SUMMARY

[0008] A number of advantages of the articles of footwear described herein will be apparent to those having ordinary skill in the art. For example, the various components that comprise the sole structure, in particular, a plurality of sole elements including openings or recesses for increasing flexibility and protrusions for increasing traction and support.

[0009] According to an aspect of the disclosure, an article of footwear can include an upper and a sole structure that can be coupled to the upper. The sole structure can extend through each of a forefoot region, a midfoot region, and a heel region, from a heel end to a toe end, and between a lateral side and a medial side. The sole structure can include a midsole coupled to the upper and

an outsole coupled with the midsole, opposite the upper. The midsole can include a first plurality of protrusions and a first plurality of recesses, which can be disposed along each of the lateral side and the medial side of the midsole. At least a portion of the first plurality of recesses can extend along a bottom surface of the sole structure. The outsole can include a second plurality of protrusions disposed along a medial half of the forefoot region, a second plurality of recesses disposed along a medial half of the forefoot region, and a third plurality of recesses extending through each of the midfoot region and the heel region.

[0010] In some embodiments, the first plurality of protrusions can be configured as elongate protrusions that extend in a heel-to-toe direction. The first plurality of recesses are arranged to form a plurality of curvilinear rows that extend in a heel to toe direction. The recesses of the first plurality of recesses can be shaped to define a gradient that transitions from a first shape at a heel end to a second shape at the toe end.

[0011] In some embodiments, at least one of the second plurality of recesses can extend through the outsole and into the midsole. The protrusions of the second plurality of protrusions can be shaped to define a gradient that transitions from a first shape at the toe end, to a second shape at the heel end. In some cases, the gradient can further include a third shape between the first shape and the second shape. As one particular example, the first shape can be a first teardrop shape that is oriented with a pointed end oriented closer to the toe end than is a rounded end, the second shape can be a second teardrop shape that is oriented with a pointed end oriented closer to the heel end than is a rounded end, and the third shape can be a rounded triangular shape with a pointed end oriented closer to the toe end than is a flat end.

[0012] In some embodiments, the second plurality of protrusions and the second plurality of recesses can be arranged to form a first plurality transverse arcuate rows. The outsole can include a third plurality of protrusions that can be arranged to form a second plurality transverse arcuate rows that alternate with the first plurality transverse arcuate rows. The protrusions of the third plurality of protrusions can be shaped to define a first gradient and a second gradient. The first gradient can transition from a first shape at the toe end to a second shape proximate a widest portion of the sole structure. The second gradient can transition from a third shape proximate the widest portion of the sole structure to a fourth shape at about the midfoot region. The first shape can be a first rounded shape, the second shape can be a first rounded triangular shape with a pointed end oriented toward the toe end, the third shape can be a second rounded triangular shape with a pointed end oriented toward the heel end, and the fourth shape can be a second rounded shape.

[0013] According to another aspect of the disclosure, a sole structure for an article of footwear can include a midsole having a first layer coupled to a second layer. The midsole can include a first plurality of plurality of protrusions disposed along each of a lateral side and a medial side of the midsole, a first plurality of recesses disposed along each of the lateral side and the medial side of the midsole, and a second plurality of recesses is disposed along a bottom surface of the sole structure. At least one of the second plurality of recesses can extend through the second layer to expose the first layer. The sole structure can further include an outsole coupled to the midsole along the second layer to define the bottom surface. The outsole can extend throughout a forefoot region from a toe end to a midfoot region, and can narrow at the midfoot region to form a J-shaped portion that can extend across a lateral half of the midfoot region to wrap around a periphery of a heel region to terminate along a medial periphery of the heel region adjacent the midfoot region. The outsole can include a second plurality of protrusions disposed along a medial half of the forefoot region, a third plurality of recesses disposed along a medial half of the forefoot region, and a third plurality of protrusions disposed along the J-shaped portion.

[0014] In some embodiments, the at least one of the third plurality of recesses can extend through the outsole and the second layer of the midsole to expose the first layer of the midsole.

[0015] According to yet another aspect of the disclosure, a sole structure for an article of footwear can include a plurality of sole elements, including recesses and protrusions, that are arranged on the sole structure to provide a plurality of zones. The plurality of zones can include a first zone positioned in a heel region and surrounding a first impact region, a second zone positioned between a thinnest portion of the sole structure in a midfoot region and a widest portion of the sole structure in a forefoot region, and a third zone positioned in the forefoot region and surrounding a toe off region. The first zone can be configured to provide greater cushioning and relative traction than the second zone, and the second zone can be configured to provide greater cushioning than the third zone. The third zone can be configured to provide greater relative traction than the second zone.

[0016] In some embodiments, the first zone can include a first plurality of protrusions along a bottom surface and a first plurality of recesses along each of a lateral side and a medial side of the sole structure. The second zone can include a second plurality of protrusions and a second plurality of recesses along the bottom surface, which can have a larger average cross-sectional area than the first plurality of protrusions. The third zone can include a third plurality of protrusions that can have a lower average cross-sectional area than the second plurality of protrusions and the second plurality of recesses.

[0017] In some embodiments, the plurality of zones can further include a fourth zone extending along a lateral half of the forefoot region and a fifth zone extending along a medial half of the forefoot region. The fourth zone can be configured to have greater flexibility than the fifth zone.

[0018] An article of footwear, as described herein, may have various configurations. The article of footwear may have an upper that is coupled with sole structure. The sole structure may include a midsole that is coupled with an outsole. A plurality of sole elements may be disposed on the midsole and the outsole. The plurality of sole elements may include both a plurality of recesses and a plurality of protrusions.

[0019] In other embodiments, a sole structure for an article of footwear may include a midsole and an outsole coupled with the midsole. The outsole may include a plurality of recesses and a plurality of protrusions. The plurality of recesses may be disposed in a central portion of a heel region, a midfoot region, and a forefoot region proximate a lateral side. The plurality of protrusions is disposed around a periphery of the heel region, along the center of the midfoot region, and throughout a forefoot region.

[0020] In other embodiments, an article of footwear may include an upper and a sole structure coupled with the upper. The sole structure can further include a midsole and an upper coupled with the midsole. The midsole may have a first plurality of protrusions and a first plurality of recesses. The first plurality of protrusions may be configured as curvilinear ridges that are disposed along each of a lateral side and a medial side of the midsole. The first plurality of recesses may be configured as teardrop shaped recesses that are disposed along each of the lateral side and the medial side of the midsole. The outsole may include a second plurality of protrusions and a second plurality of recesses. The second plurality of protrusions may be disposed around a periphery of the heel region, along the center of the midfoot region, and throughout a forefoot region. The second plurality of recesses may be disposed in a central portion of a heel region, a midfoot region, and a forefoot region proximate a lateral side.

[0021] Other aspects of the articles of footwear described herein, including features and advantages thereof, will become apparent to one of ordinary skill in the art upon examination of the figures and detailed description herein. Therefore, all such aspects of the articles of footwear are intended to be included in the detailed description and this summary.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022]

FIG. 1 is a bottom and lateral isometric exploded view of a sole structure for an article of footwear according to aspects of the disclosure;

FIG. 2 is a top and medial isometric exploded view of the sole structure of FIG. 1;

FIG. 3 is a bottom view of the sole structure of FIG. 1;

FIG. 4 is a lateral side view of the sole structure of FIG. 1;

FIG. 5 is a medial side view of the sole structure of FIG. 1;

FIG. 6 is a cross-sectional view of the sole structure taken along line VI-VI of FIG. 3;

FIG. 7 is a cross-sectional view of the sole structure taken along line VII-VII of FIG. 3;

FIG. 8 is a bottom and lateral isometric exploded view of another sole structure for an article of footwear according to aspects of the disclosure;

FIG. 9 is a top and medial isometric exploded view of the sole structure of FIG. 8;

FIG. 10 is a bottom view of the sole structure of FIG. 8;

FIG. 11 is a lateral side view of the sole structure of FIG. 8;

FIG. 12 is a medial side view of the sole structure of FIG. 8;

FIG. 13 is a cross-sectional view of the sole structure taken along line XIII-XIII of FIG. 10;

FIG. 14 is a cross-sectional view of the sole structure taken along line XIV-XIV of FIG. 10;

FIG. 15 is a bottom view of an outsole for use with a sole structure for an article of footwear according to aspects of the disclosure;

FIG. 16 is a lateral side partial view of an article of footwear according to aspects of the disclosure;

FIG. 17 is a medial side partial view of the article of footwear of FIG. 16;

FIG. 18 is a bottom view of the article of footwear of FIG. 16;

FIG. 19 is a lateral side view of an article of footwear according to aspects of the disclosure;

FIG. 20 is a medial side view of the article of footwear of FIG. 19;

FIG. 21 is a bottom view of the article of footwear of FIG. 19;

FIG. 22 is a lateral side view of an article of footwear according to aspects of the disclosure;

FIG. 23 is a medial side view of the article of footwear of FIG. 22;

FIG. 24 is a bottom view of the article of footwear of FIG. 22;

FIG. 25 is a cross-sectional view of the article of footwear taken along line XXV-XXV of FIG. 24; and

FIG. 26 is a cross-sectional view of the article of footwear taken along line XXVI-XXVI of FIG. 24.

DETAILED DESCRIPTION

[0023] The following discussion and accompanying figures disclose various embodiments or configurations of a shoe having an upper and a sole structure. Although embodiments are disclosed with reference to a sports shoe, such as a running shoe, tennis shoe, basketball shoe, etc., concepts associated with embodiments of the shoe may be applied to a wide range of footwear and footwear styles, including basketball shoes, cross-train-

ing shoes, football shoes, golf shoes, hiking shoes, hiking boots, ski and snowboard boots, soccer shoes and cleats, walking shoes, and track cleats, for example. Concepts of the shoe may also be applied to articles of footwear that are considered non-athletic, including dress shoes, sandals, loafers, slippers, and heels.

[0024] The term "about," as used herein, refers to variations in the numerical quantity that may occur, for example, through typical measuring and manufacturing procedures used for articles of footwear or other articles of manufacture that may include embodiments of the disclosure herein; through inadvertent error in these procedures; through differences in the manufacture, source, or purity of the ingredients used to make the compositions or mixtures or carry out the methods; and the like. Throughout the disclosure, the terms "about" and "approximately" refer to a range of values ± 5% of the numeric value that the term precedes.

[0025] Further, as used herein, unless otherwise defined or limited, directional terms are used for convenience of reference for discussion of particular figures or examples. For example, references to "downward," or other directions, or "lower" or other positions, may be used to discuss aspects of a particular example or figure, but do not necessarily require similar orientation or geometry in all installations or configurations.

[0026] 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.

[0027] The present disclosure is directed to an article of footwear or specific components of the article of footwear, such as an upper or a sole or sole structure. The upper may comprise a knitted component, a woven textile, a non-woven textile, leather, mesh, suede, or a combination of one or more of the aforementioned materials. The knitted component may be made by knitting of yarn, the woven textile by weaving of yarn, and the non-woven textile by manufacture of a unitary non-woven web. Knitted textiles include textiles formed by way of warp knitting, weft knitting, flat knitting, circular knitting, or other suitable knitting operations. The knit textile may have a plain knit structure, a mesh knit structure, or a rib knit structure, for example. Woven textiles include, but are not limited to, textiles formed by way of any of the numerous weave forms, such as plain weave, twill weave, satin weave, dobbin weave, jacquard weave, double weaves, or double cloth weaves, for example. Non-woven textiles include textiles made by air-laid or spun-laid methods, for example. The upper may comprise a variety of materials, such as a first yarn, a second yarn, or a third yarn, which may have varying properties or varying visual characteristics.

[0028] In some embodiments, the upper may comprise an inner layer and an outer layer, which may provide a mixture of stretch and stability. The inner layer and the outer layer may be attached to one another by stitching, an adhesive, welding, or other connection methods as are known in the art. The inner layer may be made of material that allows the upper to stretch in multiple directions, for example, a 4-way stretch material, so that the upper is both snug and comfortable, and can conform to the foot of a user. In addition to providing the upper with a layer that is flexible and can better conform to a foot of a user, the inner layer may provide for a more comfortable upper that reduces friction or other rubbing between the foot of a user and the upper. The outer layer is made from a resilient woven material, which may resist stretching. The outer layer may contain a number of holes that may have a rounded (*e.g.*, ellipsoidal) perimeter. The size and spacing of the hole may be varied to provide the upper with some areas that are more flexible, such as in the forefoot, and other areas which provide more support such as in the heel. Further, the orientation of the holes may be varied to allow the upper to stretch or flex to a greater degree in some directions, while providing lower flexion and/or increased support and stability in others.

[0029] The upper may include a heel cup coupled to and substantially surrounding the heel of a user. The heel cup is a rigid or semi-rigid structure that may provide additional support for the foot of a user. The heel cup may be made of a plastic, for example, TPU, or a composite material. In some cases, the heel cup is transparent or translucent.

[0030] In addition, the present disclosure relates to an article of footwear having a sole structure attached to the upper. The sole structure includes a midsole that may be attached to the upper, an outsole attached below the midsole and defining a bottom of the article of footwear, and a number of sole elements. In some embodiments, the midsole and the outsole may be a unitary body made from a foam or a rubber material, which cushion the user's foot as it impacts the ground and gives the user traction. In other embodiments, the midsole and the outsole may constitute different components which may be co-molded or adhered together by a glue or other adhesive. The midsole may be made of a foam material, such as EVA, to provide cushioning, and the outsole may be a rubber material to increase traction and durability. In some cases, the midsole can be a multi-density midsole with two or more layers having different densities to provide tuned cushioning characteristics. The midsole may vary in thickness, for example, by providing a thickest portion along a medial side of a forefoot region to reduce and/or prevent pronation. Additionally, the outsole may be formed from one or more outsole sections, which can be

received within a corresponding recess formed in a bottom of the midsole.

[0031] The sole elements may be provided in any of the midsole, outsole, or both. Some of the sole elements are recesses that can reduce weight and increase flexibility of the sole structure, while other sole elements are protrusions that can increase traction, firmness, and support. The recesses may be disposed anywhere along the outsole and midsole; however, it may be preferable to include recesses in any or all of a lateral side of a forefoot region, lateral and/or medial sides of a midfoot, and generally throughout a heel region to allow the foot of a user to move in a more natural way by providing regions of increased flexibility and cushioning. Similarly, while the protrusions may be disposed anywhere across the outsole and midsole, it may be preferable to provide protrusions throughout and along a bottom surface of an outsole. In this way, traction can be increased while also providing firmer and more supportive regions where the user's heel first contacts the ground, and where the user toes-off, or pushes off.

[0032] With regard to the recesses, the size of the recesses may be varied in depth and width/length (*e.g.*, a cross-sectional area perpendicular to the depth), and the spacing between recesses may also be varied. Deeper and wider *(i.e.,* with a large cross-sectional area) recesses provide greater flexibility and weight reduction, while shallower and narrower *(i.e.,* with a comparatively small cross-sectional area) recesses provide flexibility and weight reduction to a lesser extent. Similarly, by spacing the recesses closer together, greater flexibility and weight reduction can be achieved as compared to a similar portion of the sole that does not contain any recesses, while spacing the recesses farther apart can achieve a slightly firmer and stiffer region that still maintains some increased flexibility. The recesses may be located in both the midsole and the outsole and may extend onto the medial and lateral sides of the outsole. Further, some of the recesses may extend through the outsole and into the midsole, and the recesses may be provided in one or more groups. For example, groups may be delineated by recesses disposed within a certain region of a shoe (*e.g.,* a forefoot region, a midfoot region, a heel region, a lateral side, or a medial side), or separated by an intervening structure (*e.g.*, an outsole or a portion thereof). Alternatively or additionally, groups may be defined as recesses that are adjacent to one another and that have similar depths, widths, or spacing between adjacent recesses. In one aspect, groups may be defined as recesses or protrusions having generally the same shape as one another and/or generally the same size and/or generally the same orientation.

[0033] With regard to the protrusions, the protrusions can be varied in both height and width/length (*e.g.*, cross-sectional area), and the spacing between protrusions may also be varied. By adjusting the size of and spacing between protrusions, the sole structure can be made more or less firm. For example, the spacing between protrusions may be decreased to increase firmness in some areas of the sole structure as compared to similar areas of the sole without any protrusions, while the spacing may be increased in other areas of the sole structure to increase firmness to a lesser extent. Additionally, while protrusions may be primarily located on the outsole adjacent the bottom surface, they may also extend onto any part of the midsole, including the lateral and medial sides of the midsole.

[0034] FIGS. 1-7 depict an exemplary embodiment of an article of footwear 100 including an upper 102 *(see* FIG. 6) and a sole structure 104. As will be discussed in further detail below, the upper 102 is coupled with the sole structure 104 and together with the sole structure 104 defines an interior cavity 106 *(see* FIG. 6) into which a foot of a user may be inserted. The upper 102 may also include an insole 108 (shown in phantom in FIG. 6) positioned within the interior cavity 106 that may be connected to or in contact with an interior surface of the article of footwear 100. The insole 108 may directly contact a user's foot while the article of footwear 100 is being worn. In some embodiments, an upper may include a liner (not shown) that makes the article of footwear 100 more comfortable to wear, for example, by reducing friction between the foot of user and the article of footwear 100 when the article of footwear 100 is being worn, and/or providing moisture wicking properties. The liner may line the entire interior cavity 106 or only a portion of the interior cavity 106. In other embodiments, a binding (not shown) may surround the opening of the interior cavity 106 to secure the liner to the upper 102 and/or to provide an aesthetic element on the article of footwear 100. Furthermore, the sole structure 104 includes a midsole 112, an outsole 114 coupled to and disposed generally below the midsole 112, which defines a bottom surface 116 of the article of footwear 100 that is configured to contact the ground, and a plurality of sole elements 118.

[0035] For reference, the article of footwear 100 generally defines a forefoot region 120, a midfoot region 122, and a heel region 124. The forefoot region 120 generally corresponds with portions of the article of footwear 100 that encase portions of the foot that include the toes, the ball of the foot, and joints connecting the metatarsals with the toes or phalanges. In addition, the forefoot region 120 defines a toe-off region 120a disposed along the bottom surface 116, which generally corresponds with the portions of the article of footwear 100 that are in contact with the ground as the user pushes off to take a step. The midfoot region 122 is proximate and adjoining the forefoot region 120, and generally corresponds with portions of the article of footwear 100 that encase the arch of a foot, along with the bridge of a foot. The heel region 124 is proximate and adjoining the midfoot region 122 and generally corresponds with portions of the article of footwear 100 that encase rear portions of the foot, including the heel or calcaneus bone, the ankle, or the Achilles tendon. The heel region 124 further defines a first impact region 124a proximate the bottom surface 116, and disposed

on the lateral periphery of the heel region 124 adjacent the heel end 134.

[0036] For reference, the article of footwear 100 also defines a lateral side 126 *(see* FIGS. 1, 3, and 4), and a medial side 128 *(see* FIGS, 1, 3, and 5). Further, the article of footwear 100 defines a longitudinal axis 130 *(see* FIG. 3) that extends from a toe end 132, located at a distal end of the forefoot region 120, to a heel end 134, located at a distal end of the heel region opposite the toe end 132. The longitudinal axis 130 defines a middle of the article of footwear 100 with the lateral side 126 extending from one side of the longitudinal axis 130 and the medial side 128 extending from the other. Put another way, the lateral side 126 and the medial side 128 adjoin one another along the longitudinal axis 130. In particular, the lateral side 126 corresponds to an outside portion of the article of footwear 100 and the medial side 128 corresponds to an inside portion of the article of footwear 100. As such, left and right articles of footwear have opposing lateral 126 and medial 128 sides, such that the medial sides 128 are closest to one another when a user is wearing the article of footwear 100, while the lateral sides 126 are defined as the sides that are farthest from one another while being worn.

[0037] The forefoot region 120, the toe-off region 120a, the midfoot region 122, the heel region 124, the first impact region 124a, the medial side 128, and the lateral side 126 are intended to define boundaries or areas of the article of footwear 100, and collectively span an entire length of the article of footwear 100, from the toe end 132 to the heel end 134. It should be appreciated that aspects of the disclosure may refer to portions or elements that are coextensive with one or more of the forefoot region 120, the midfoot region 122, the heel region 124, the medial side 128, or the lateral side 126. The forefoot region 120 extends from the toe end 132 to a widest portion 136 of the article of footwear 100 *(i.e.,* a distance between the medial side 128 and the lateral side 126 of the sole structure 104). The midfoot region 122 extends from the widest portion 136 to a thinnest portion 138 of the article of footwear 100 *(i.e.,* a distance between the medial side 128 and the lateral side 126 of the sole structure 104). The heel region 124 extends from the thinnest portion 138 to the heel end 134 of the article of footwear 100.

[0038] With reference to FIGS. 1, 3, and 4, the lateral side 126 begins where the toe end 132 intersects the longitudinal axis 130 and bows outward *(i.e.,* away from the longitudinal axis 130) along the forefoot region 120 toward the midfoot region 122. At the widest portion 136, the lateral side 126 bows inward *(i.e.,* toward the longitudinal axis 130) toward the thinnest portion 138, entering the midfoot region 122. Upon reaching the thinnest portion 138, the lateral side 126 bows outward and extends into the heel region 124. The lateral side 126 then bows back inward toward the heel end 134 and terminates where the heel end 134 intersects with the longitudinal axis 130.

[0039] With continued reference to FIGS. 1, 3, and 5, the medial side 128 begins where the toe end 132 intersects the longitudinal axis 130 and bows outward *(i.e.,* away from the longitudinal axis 130) along the forefoot region 120 toward the midfoot region 122. At the widest portion 136, the medial side 128 bows inward *(i.e.,* toward the longitudinal axis 130) toward the thinnest portion 138, entering the midfoot region 122. Upon reaching the thinnest portion 138, the medial side 128 bows outward and extends into the heel region 124. The medial side 128 then bows back inward toward the heel end 134 and terminates where the heel end 134 intersects with the longitudinal axis 130.

[0040] It should be understood that numerous modifications may be apparent to those skilled in the art in view of the foregoing description, and individual components thereof, may be incorporated into numerous articles of footwear. Accordingly, aspects of the article of footwear 100 and components thereof, may be described with reference to general areas or portions of the article of footwear 100, with an understanding the boundaries of the forefoot region 120, the midfoot region 122, the heel region 124, the toe-off region 120a, the first impact region 124a, the lateral side 126, and/or the medial side 128 as described herein may vary between articles of footwear. Furthermore, aspects of the article of footwear and individual components thereof, may also be described with reference to exact areas or portions of the article of footwear 100 and the scope of the appended claims herein may incorporate the limitations associated with these boundaries of the forefoot region 120, the midfoot region 122, the heel region 124, the toe-off region 120a, the first impact region 124a, the lateral side 126, and/or the medial side 128 discussed herein.

[0041] An upper is configured to at least partially enclose the foot of a user and may be made from one or more materials. As shown in FIG. 6, the upper 102 is disposed above and is coupled to the sole structure 104. The upper 102 extends along the entirety of each of the medial 128 and lateral 126 sides, as well as extending over the top of the forefoot region 120 and around the heel region 124. An upper can be formed from one or more layers. For example, many conventional uppers are formed from multiple elements (*e.g.*, textiles, polymer foam, polymer sheets, leather, and synthetic leather) that are joined through bonding or stitching at a seam. In various embodiments, a knitted component may incorporate various types of yarn that may provide different properties to an upper. In other embodiments, the upper may incorporate multiple layers of different materials, each having different properties, for example, increased breathability or moisture wicking.

[0042] A number of other features may also be coupled to or included in an upper to provide or enhance certain properties of the upper. For example, an upper can include a tongue (not shown) that may include a tongue lining and/or a foam pad to increase comfort. The tongue may be a separate component that is attached to the upper or it may be integrally formed with one or more

layers of the upper. Additionally, an upper can also include a tensioning system (not shown) that allows a user to adjust the upper to fit a foot of a user. The tensioning system can extend through a midfoot region and/or a forefoot region of the upper and may be attached to the upper by an attachment structure. For example, an upper may include a plurality of holes (e.g., punch holes) and/or eyelets that are configured to slidably receive laces so that the user can secure (*e.g.*, by tightening and tying the laces) the article of footwear to a foot. In other embodiments, a tensioning system may be another laceless fastening system known in the art.

[0043] The upper 102 is joined with the sole structure 104, which extends between the upper 102 and the ground. The sole structure 104 includes the midsole 112, the outsole 114, and the plurality of sole elements 118. In other embodiments, a sole structure may also include one or more other components, which may include a lasting board, a plate, or a strobel board (not shown), that are disposed between a midsole and an upper. Additionally, in some cases, a sole structure can further include a heel cup that couples with the upper in the heel region via an adhesive or stitching and provides additional support to a heel of a user. More specifically, a heel cup may be made from a rigid or semi-rigid material, for example TPU or a composite that allows the heel cup to flex or give as needed when a user is running or engaging in other activities, but otherwise provide more rigid support to the heel of a user. In some embodiments, a heel cup can be made of a translucent or clear TPU and may be used to enhance the aesthetic appeal.

[0044] For example, as can be seen in FIGS. 1, 2, and 4-6, the sole structure 104 includes a heel cup 150 that surrounds an outer periphery of the heel region 124 of the upper 102. The heel cup 150 includes a lateral leg 150a disposed along the lateral side 126 of the heel region 124 of the upper 102 and a medial leg 150b disposed along the medial side 128 of the heel region 124 of the upper 102. The lateral leg 150a and the medial leg 150b are adjoined with one another at the heel end 134 of the upper 102, with both lateral leg 150a and the medial leg 150b extending forward from the heel end 134 to respective distal ends disposed adjacent the midfoot region 122. In other embodiments, the lateral leg 150a and/or the medial leg 150b may extend into the midfoot region 122 and/or the forefoot region 120. Both the lateral leg 150a and the medial leg 150b include an apex located proximate an ankle of a user when the article of footwear 100 is worn, thereby providing increased support for the ankle. The lateral leg 150a and the medial leg 150b slope downward and rearward toward the heel end 134 from the respective apexes to form a saddle at the heel end 134 of the upper 102, where the lateral leg 150a and medial leg 150b connect. Further, each of the lateral leg 150a and the medial leg 150b extend downward and forward from the respective apexes, coming to points adjacent the midfoot region 122.

[0045] The midsole 112 is defined as the portion of the sole structure 104 that extends between the upper 102 and the outsole 114. That is, the midsole 112 is coupled with the upper 102 at an upper surface of the midsole 112 and is coupled with the outsole 114 on a lower surface of the midsole 112, opposite the upper 102. The midsole 112 extends along the length of the sole structure 104, throughout a forefoot region 120, a midfoot region 122, and a heel region 124. Additionally, the midsole 112 extends across the width of the sole structure 104 from a lateral side 126 to a medial side 128. In this way, the midsole 112 acts to cushion a user from the impact caused by the user's foot striking the ground. Put another way, the midsole 112 absorbs the impact resulting from a foot of a user coming into contact with the ground. To provide the desired cushion characteristics, the thickness of the midsole 112 *(e.g.,* a dimension taken along direction that is normal to the bottom surface 116) can be varied, with thicker regions providing greater cushioning and stability, and thinner regions providing lesser cushioning and greater flexibility.

[0046] For example, the midsole 112 may be thickest in the heel region 124 to provide increased cushion in that area, where a user's foot first contacts the ground. The midsole 112 then may become thinner in a tapered fashion as the midsole 112 extends forward in the direction taken from the heel end 134 to the toe end 132. More specifically, the thickness of the midsole 112 combined with the thickness of the outsole 114 defines a stack height, which, taken in the heel region 124, can range from about 15 mm to about 30 mm. The thickness of the midsole 112 and the outsole 114 can then be gradually reduced going from the heel region 124 to the forefoot region 120, where the stack height may range from about 6 mm to about 22 mm. In a preferred embodiment, the stack height may be about 27 mm in the heel region 124 and gradually taper to about 18 mm in the forefoot region 120.

[0047] Similarly, a portion of a forefoot region may be thicker than a remaining portion of the forefoot region to help reduce pronation and/or supination. For example, in the present embodiment, the midsole 112 includes a thickened strip 152 *(see* FIGS. 1 and 7) that runs along an outer periphery of the medial side 128 of the forefoot region 120 *(e.g.,* from a midfoot region 122 to the toe end 132). More specifically, the thickened strip 152 defines a flattened area that extends from a lateral edge of the forefoot region 120 toward the medal side 128. Proximate a central portion of a lateral half of the forefoot region 120, thickened strip 152 gradually thins to form a sloped area that extends between the flattened area of the thickened strip 152 and the remaining portion of the forefoot region 120. As a result of this additional thickness, the thickened strip 152 causes the outsole to extend lower *(e.g.,* to be disposed further away from the upper 102) along the periphery of the medial side 128, as compared with the remaining portion of the forefoot region 120. Further, the thickened strip 152 has the effect of raising the medial side 128 to cause the foot of a user to roll toward

the lateral side 126, thereby counteracting any pronation that a user may have.

[0048] In other embodiments, the thickened strip 152 may alternatively be disposed along an outer periphery of the lateral side 126 of the forefoot region 120 to counteract any supination that a user may have. Similarly, the thickened strip 152 may extend into any of the forefoot region 120, the midfoot region 122, and/or the heel region 124, including, for example, extending along only along a portion of an outer periphery of the medial side 128 of the forefoot region 120, or along other portions of the sole structure 104. In addition to counteracting pronation/supination, the thickened strip 152 can additionally provide increased cushioning. In yet other embodiments, a thickened strip may not be present so that the sole structure is substantially flat along the direction extending between the lateral and medial sides, which may be beneficial for users without a neutral step *(i.e.,* without pronation or supination).

[0049] Additionally, the density and material of a midsole may be changed to provide greater or lesser cushioning. For example, a midsole can be configured as a multi-layer or multi-density midsole. Looking to FIGS. 6 and 7 in particular, the midsole 112 is configured as a dual-density midsole having a first or inner layer 112a with a low density to increase impact absorption and a second or outer layer 112b with a comparatively higher density to provide increased stability and support. In the present embodiment, the first layer 112a and the second layer 112b are each made of an EVA foam, but they may alternatively be made of different materials. Each of the first layer 112a and the second layer 112b extend throughout the forefoot region 120, the midfoot region 122, and the heel region 124, although other configurations are possible. For example, the first layer 112a may be comprised of multiple, separate portions. The first layer 112a is disposed within a cavity 154 *(see* FIG. 2) of the second layer 112b so that the first layer 112a is surrounded along each of the lateral side 126, the medial side 128, and a lower surface by the second layer 112b. The first layer 112a and the second layer 112b can be co-molded or coupled together by an adhesive, and together define an upper midsole recess 156 *(see* FIG. 2) that is configured to receive and couple with the upper 102. Additionally, the relative thicknesses of the first layer 112a and the second layer 112b can be varied to achieve the desired balance of support and cushioning. In the present embodiment, the first layer 112a and the second layer 112b have similar thicknesses in the forefoot region 120, while the first layer 112a has a greater thickness than the second layer 112b in both the midfoot region 122 and the heel region 124.

[0050] As shown in FIG. 1, in some embodiments, the second layer 112b may further define a lower midsole recess 158 that is configured to receive and couple with the outsole 114. The lower midsole recess 158 is shaped to correspond with the shape of the outsole 114, and therefore may be comprised of one or more recesses. Additionally, the lower midsole recess 158 has a depth *(e.g.,* a dimension taken normal to the bottom surface 116) that is less than a corresponding thickness of the outsole 114, so that the outsole 114 can make initial contact with the ground instead of the midsole 112. Furthermore, in some embodiments, the lower midsole recess 158 can include a depression 160 to help secure and align the outsole 114 within the lower midsole recess 158. Here, the depression 160 is configured as a wavy, curvilinear depression that is disposed within the forefoot region 120 and extends generally along the longitudinal axis 130 from the toe end 132 to the midfoot region 122, although other configurations are also possible. Where a lower midsole recess 158 is not present, the outsole 114 may instead be attached to a lower surface of the midsole 112 *(e.g.,* the second layer 112b of the midsole 112).

[0051] An outsole can have a variety of shapes to provide a sole structure of an article of footwear with areas of increased traction and stability. With additional reference to FIGS. 2 and 3, in the present embodiment, the outsole 114 is a single element that extends along the sole structure 104 from the toe end 132 to the heel end 134 to define the bottom surface 116. More specifically, moving from the toe end 132 to the heel end 134, the outsole 114 extends substantially across the entirety of the forefoot region 120. That is, the outsole 114 widens with the forefoot region 120 from the toe end 132 to the widest portion 136 and then narrows with the forefoot region 120 to the midfoot region 122. Upon reaching the midfoot region 122, the outsole 114 angles across the midfoot region 122 towards the lateral side 126 of the heel region 124, while also narrowing so that a thinnest portion of the outsole 114 corresponds with the thinnest portion 138 of the sole structure 104. The outsole 114 narrows at a faster rate than the sole structure 104 as a whole so that the outsole 114 is disposed substantially along a lateral half of the midfoot region 122. Upon reaching the heel region 124 at a forwardmost *(i.e.,* a portion that is closest to the toe end 132) lateral periphery, the outsole 114 wraps rearward around a periphery of the heel region 124 from the lateral side 126, across the heel end 134, and forward along the medial periphery of the heel region 124, where it terminates adjacent the midfoot region 122. In this way, the midfoot and heel portions of the outsole 114 form a J-like shape. In other embodiments, an outsole may be comprised of multiple portions that are disposed in select areas, for example, a periphery of a heel region and a forefoot or toe-off region.

[0052] In some embodiments, an outsole can include one or more locking or locating structures to help attach and/or locate the outsole onto a midsole. For example, as shown in FIG. 2, the outsole 114 includes an upper ridge 162 on an upper surface 164 of the outsole 114 that is configured to be received within the depression 160 of the midsole 112. Accordingly, the upper ridge 162 is a wavy, curvilinear ridge that is disposed within the forefoot region 120 and extends generally along the lon-

gitudinal axis 130 from the toe end 132 to the midfoot region 122.

[0053] Additionally, an outer edge of an outsole can have a variety of profiles, for example, wavy portions, straight portions, and/or curvilinear portions, amongst others. In the present embodiment, the outsole 114 has a predominantly smooth outer edge 166, except for a wavy portion 166a that is disposed along the lateral side 126 of the forefoot region 120.

[0054] Furthermore, the outsole 114 defines a thickness (*e.g.*, a dimension taken normal to the bottom surface 116), which can be varied to provided increased stability and wear resistance. For example, in some embodiments, it may be desirable that an outsole have an increased thickness in a heel region where the outsole first contacts the ground and/or in a toe-off region to increase longevity of the outsole. Conversely, it may be desirable to reduce the thickness of an outsole along a lateral side of a forefoot region and/or through a midfoot region to balance traction and stability with flexibility to allow for a more natural movement of the foot of a user.

[0055] Moreover, an outsole can include one or more grooves in the bottom surface to increase traction and to provide increased and directional flexibility (*e.g.*, a groove extending from a lateral side to a medial side can increase flexibility perpendicularly to the groove). In the present embodiment, the outsole 114 includes a plurality of parallel, arcuate transverse grooves 168 in the forefoot region 120, which curve away from the toe end 132 and extend between the lateral side 126 and the medial side 128. Each of the plurality of transverse grooves 168 has a depth of approximately 0.5 mm, but the depth may be greater or lesser in other embodiments. Additionally, the outsole 114 has a longitudinal groove 170 that corresponds with the upper ridge 162 and the depression 160. Accordingly, the longitudinal groove 170 is a wavy, curvilinear groove that is disposed within the forefoot region 120 and extends generally along the longitudinal axis 130 from the toe end 132 to the midfoot region 122. In some embodiments, additional grooves can be used, for example, to create one or more symbols, words, logos, and/or trademarks.

[0056] As mentioned above, a sole structure, including both a midsole and an outsole, can include sole elements to provide the sole structure with zones of varying stability, traction, and flexibility. Such sole elements can include both recesses and protrusions, which may be subdivided into different groups based on various factors, for example, shape, size, depth, spacing, location, and/or orientation. In this way, the sole elements can be arranged to tune the flexibility and stability characteristics of a sole structure for a specific activity, such as running or hiking. For example, including recesses can reduce weight while increasing flexibility, while including protrusions can increase stability and traction.

[0057] For example, with reference to FIG. 4 in particular, the sole structure 104 includes sole elements 118, and, more specifically, a first or lateral side group of protrusions 172 and a first or lateral side group of recesses 174 disposed along the lateral side 126 of the midsole 112. The first group of protrusions 172 are configured as a plurality of rounded, linear ridges, which extend diagonally downward *(i.e.,* from the upper 102 towards the outsole 114) and forward *(i.e.,* from the heel end 134 to the toe end 132) in both the heel region 124 and the midfoot region 122. The first group of protrusions 172 are further arranged to form substantially parallel and curvilinear rows that extend along the lateral side 126 of the midsole 112 in the forefoot region 120. Additionally, the first group of protrusions 172 are arced along their respective lengths *(e.g.,* a dimension taken along the protrusion from a rearmost portion or heel end to a forwardmost portion or toe end) to form apexes that can range between 1 mm and 10 mm in height *(e.g.,* a direction normal surface of the midsole 112), although other configurations (*e.g.*, non-arced protrusions) are possible. In the present embodiment, the protrusions in the first group of protrusions 172 have apexes that are approximately 2 mm in height.

[0058] The first group of recesses 174 are similarly arranged to form substantially parallel and curvilinear rows between the respective rows of the first group of protrusions 172. The first group of recesses 174 are generally tear or rain drop shaped near the heel end 134, with the pointed end being disposed closer to the heel end 134 than the rounded end, and gradually become more elongated *(i.e.,* ellipsoidal) and spaced apart moving toward the toe end 132. That is, the shapes of the recesses in the first group of recesses 174 define a gradient, in which the recesses have a first shape at the heel end 134, which gradually transitions to have a second shape at the toe end 132. For example, as show in FIG. 4, first group of recesses 174 defines a gradient over which the first group of recesses 174 transitions from a teardrop shape at the heel end 134 to an ellipsoidal shape at the toe end 132.

[0059] Additionally, the first group of recesses 174 vary in depth between about 2 mm and about 3 mm and the cross-sectional area of the respective recesses narrows or becomes smaller along the depth so that the bottom or inner portion of the recess is smaller than the exterior opening. More specifically, the first group of recesses 174 is comprised of a plurality of sub-groups, namely, a first portion 174a, a second portion 174b, a third portion 174c and a fourth portion 174d. The first portion 174a includes teardrop-shaped recesses and extends from the heel end 134 and along the heel region 124 and into a lower half of the midfoot region 122. The recesses in the first portion 174a have depths of approximately 3 mm, lengths ranging between about 3 mm and about 10 mm, and widths ranging between about 2 mm and about 5 mm, although other configurations are possible. The second portion 174b includes teardrop-shaped recesses in an upper half of the midfoot region 122 and generally ellipsoidal recesses extending into the forefoot region 120 proximate the widest portion 136. The recesses in the second portion 174b have depths of approximately

2 mm, lengths ranging between about 3 mm and about 8 mm, and widths ranging between about 2 mm and about 3 mm, although other configurations are possible. The spacing between the respective recesses in the second portion 174b gradually increases moving from the heel end 134 toward the toe end 132. The third portion 174c includes ellipsoidal recesses that are disposed generally around the widest portion. The recesses in the third portion 174c have depths of approximately 3 mm, lengths ranging between about 3 mm and about 5 mm, and widths ranging between about 2 mm and about 3 mm, although other configurations are possible. The recesses in the third portion 174c become more elongated and spaced apart moving from the heel end 134 to the toe end 132. The fourth portion 174d includes ellipsoidal recesses that are disposed between the third portion 174c (*i.e.*, proximate the widest portion) and the toe end 132 in the forefoot region 120. The recesses in the fourth portion 22d have depths of approximately 2 mm, lengths ranging between about 3 mm and about 10 mm, and widths ranging between about 0.5 mm and about 1 mm, although other configurations are possible.

[0060] The arrangement of the first group of recesses 174 impart the sole structure 104 with areas of differing stability, flexibility, and cushioning. For example, in the heel region 124, the relatively close spacing, and increased depth and size of the first portion 174a of recesses reduces weight while also increasing cushioning. In the midfoot region 122, the mixture of recesses from the first portion 174a and the shallower recesses of the second portion 174b gives a balance of flexibility and stability. Furthermore, in the midfoot region 122 and the forefoot region 120, respectively, the second portion 174b and the fourth portion 174d provide increased stability and reduced cushioning for improved energy transfer during toe off, while the third portion 174c provides increased flexibility and cushioning near the ball of a user's foot to allow for a more natural feel. In other embodiments, the first group of recesses 174 may include more or fewer portions, which can also have different characteristics (*e.g.*, size, spacing, depth, etc.) to impart the sole structure 104 with differing stability and flexibility.

[0061] Turning briefly to FIG. 5, the medial side 128 of the sole structure 104 also has sole elements 118, including a second group of protrusions 176 and a second group of recesses 178. Each of the second group of protrusions 176 and the second group of recesses 178 are similar to the first group of protrusions 172 and the first group of recesses 174, respectively. That is, the second group of protrusions 176 is like the first group of protrusions 172 and the second group of recesses 178 is like the first group of recesses 174, but substantially mirrored over the longitudinal axis 130 to follow the contours of the midsole 112 on the medial side 128. More specifically, with regard to the second group of recesses 178, the second group of recesses 178 includes a fifth portion 178a, a sixth portion 178b, a seventh portion 178c, and an eighth portion 178d, which correspond with the first portion 174a, the second portion 174b, the third portion 174c, and the fourth portion 174d, respectively. In other embodiments, the lateral side 126 and the medial side 128 may not be substantial mirror images of one another.

[0062] With reference now to FIG. 3, the sole structure 104 includes additional sole elements 118 disposed along the bottom surface 116 and throughout each of the forefoot region 120, the midfoot region 122, and the heel region 124. In particular, the sole structure 104 includes a third group of protrusions 180, a fourth group of protrusions 182, and a third group of recesses 184 within the forefoot region 120 and extending partially into the midfoot region 122. Such an arrangement allows for a more stable and tractive medial forefoot to improve toe-off, while also allowing a lateral forefoot to remain comparatively more flexible, which can provide the article of footwear 100 with a more natural feel by allowing the foot of a user to move more naturally.

[0063] The third group of protrusions 180 are arranged and spaced apart along each of the transverse grooves 168 of the outsole 114 to form rows extending from the toe end 132 towards the heel end 134. Moving from the toe end 132 to the heel end 134, the third group of protrusions 180 gradually changes to define a gradient in which the shape of the third group of protrusions 180 transitions from having a first, rounded cross-sectional shape at the toe end 132 to having a second, rounded triangular shape near the widest portion 136, and then to having a third, rounded shape proximate the midfoot region 122. More specifically, proximate the widest portion 136, the rounded triangular-shaped protrusions of the third group of protrusions 180 flip from having a point oriented toward the toe end 132 and a flat side oriented toward the heel end 134, to having a flat side oriented toward the toe end 132 and a point oriented toward the heel end 134.

[0064] Correspondingly, put another way, the third group of protrusions 180 can define a first gradient from the toe end 132 to about the widest portion 136 and a second gradient from about the widest portion 136 to about the midfoot region 128. Within the first gradient, the shape of the third group of protrusions 180 transitions from having a first, ellipsoidal cross-sectional shape at the toe end 132 to having a second, rounded triangular shape near the widest portion 136, with a point oriented toward the toe end 132. The second gradient can be the reverse of the first gradient so that, within the second gradient, the shape of the third group of protrusions 180 transitions from having a third, rounded triangular shape near the widest portion 136, with a point oriented toward the heel end 134, to a fourth, ellipsoidal cross-sectional shape at the toe end 132 at about the midfoot region 128. In other embodiments, the second gradient may not be the reverse of the first gradient.

[0065] Additionally, the third group of protrusions 180 have heights *(e.g.,* a dimension taken normal to the bottom surface 116) of approximately 2 mm, and lengths *(e.g.,* a largest dimension) and widths *(e.g.,* a largest di-

mension taken perpendicular to the length) that range between about 2 mm and about 4 mm, although other configurations are possible.

[0066] The fourth group of protrusions 182 are arranged and spaced apart between each of the transverse grooves 168 of the outsole 114 to form rows extending from the toe end 132 towards the heel end 134. In particular, the fourth group of protrusions 182 includes a first portion 182a that extends along a medial half *(e.g.,* on a medial side of the longitudinal groove 170) of the forefoot region 120 and a second portion 182b that extends from the lateral half *(e.g.,* on the lateral side 126 of the longitudinal groove 170) of toe end 132 and along a peripheral strip to the midfoot region 122. Moving from the toe end 132 to the heel end 134, the fourth group of protrusions 182 gradually changes to define a gradient in which the shape of the fourth group of protrusions 182 transitions from having a first, teardrop shape at the toe end 132, with a pointed end oriented closer the toe end 132 than is a rounded end, to having a second, rounded triangular shape at the widest portion 136, with a flat side oriented toward the heel end 134 and a point oriented toward the toe end 132, and then to having a third, teardrop shape proximate the midfoot region 122, with a rounded end oriented closer the toe end 132 than is a pointed end. The fourth group of protrusions 182 have heights *(e.g.,* a dimension taken normal to the bottom surface 116) of approximately 2 mm and are generally larger in cross-sectional area than the third group of protrusions 180, with lengths (*e.g.*, a largest dimension) and widths *(e.g.,* a largest dimension taken perpendicular to the length) that range between about 3 mm and about 6 mm, although other configurations are possible. Additionally, the fourth group of protrusions 182 are more closely spaced as compared to the third group of protrusions 180. Furthermore, each of the protrusions in the fourth group of protrusions 182 has a flat top with a longitudinal cut running along its length to further increase traction.

[0067] The third group of recesses 184 are disposed within a central portion of the lateral half of the forefoot region 120 so that they are surrounded on all sides by the fourth group of protrusions 182. Additionally, a third group of recesses 184 are arranged and spaced apart between each of the transverse grooves 168 of the outsole 114, similar to the fourth group of protrusions 182, thereby forming rows with the fourth group of protrusions 182 that extend from the toe end 132 towards the heel end 134. Likewise, the third group of recesses 184 change in shape and size in a manner similar to the fourth group of protrusions 182. That is, moving from the toe end 132 to the heel end 134, the third group of recesses 184 gradually changes from having a rounded triangular shape with a flat side oriented toward the heel end 134 and a pointed end oriented toward the toe end 132 to having a teardrop shape with a rounded end oriented closer the toe end 132 than a pointed end. The third group of recesses 184 includes a first or medial portion 184a with depths *(e.g.,* a dimension taken normal to the bottom surface 116) of approximately 0.5 mm to extend partially into the outsole 114 and a second or lateral portion 184b with depths of approximately 40 mm to extend completely through the second layer 112b of the midsole 112, thereby exposing the first layer 112a. The cross-sectional areas of the third group of recesses 184 are similar to that of the fourth group of protrusions 182 with lengths *(e.g.,* a largest dimension) and widths *(e.g.,* a largest dimension taken perpendicular to the length) that range between about 3 mm and about 6 mm, although other configurations are possible.

[0068] With continued reference to FIG. 3, the sole structure 104 also includes a fifth group of protrusions 186 and a sixth group of protrusions 188 disposed along the outsole 114 in each of the midfoot region 122 and the heel region 124 *(i.e.,* the J-shaped portion of the outsole 114), which can increase traction and stability when a user's heel first contacts the ground during a step. Additionally, the sole structure 104 includes a fourth group of recesses 190 disposed within the medial half of the outsole 114 and proximate the heel end 134. Such recesses can help to provide increased cushioning as the user's weight is transferred to the heel region 124 of the article of footwear 100 during a step.

[0069] The fifth group of protrusions 186 may have a teardrop shape with a rounded end oriented closer the toe end 132 than a pointed end and are arranged to form rows that extend diagonally rearward from the lateral side 126 to the medial side 128 along the bottom surface 116. The fifth group of protrusions 186 have heights *(e.g.,* a dimension taken normal to the bottom surface 116) of approximately 2 mm, with lengths *(e.g.,* a largest dimension) and widths *(e.g.,* a largest dimension taken perpendicular to the length) that range between about 3 mm and about 6 mm, although other configurations are possible. It is appreciated that the protrusions in the fifth group of protrusions 186 generally reduce in cross-sectional area *(i.e.,* reduce in length and/or width) moving from the toe end 132 to the heel end 134.

[0070] The sixth group of protrusions 188 are configured as rounded bumps and are arranged to form diagonal rows that extend between the corresponding rows formed by the fifth group of protrusions 186. However, some of the rows only extend along a portion of the outsole 114 between the lateral side 126 and the medial side 128. The sixth group of protrusions 188 have heights *(e.g.,* a dimension taken normal to the bottom surface 116) of approximately 2 mm, with lengths *(e.g.,* a largest dimension) and widths *(e.g.,* a largest dimension taken perpendicular to the length) of approximately 2 mm, although other configurations are possible.

[0071] The fourth group of recesses 190 are configured as rounded holes extending along rows that are generally aligned with the rows of the sixth group of protrusions 188. The fourth group of recesses 190 have depths *(e.g.,* a dimension taken normal to the bottom surface 116) of approximately 4 mm to extend through the outsole 114 to the midsole 112, with lengths *(e.g.,* a largest dimen-

sion) and widths *(e.g.,* a largest dimension taken perpendicular to the length) of approximately 2 mm, although other configurations are possible.

[0072] Still referring to FIG. 3, the bottom surface 116 of the sole structure 104 further includes a fifth group of recesses 192 and a sixth group of recesses 194 disposed in and along the exposed portions of the midsole 112 *(i.e.,* the portions of the midsole 112 along the bottom surface 116 that are not covered by the outsole 114). The recesses in each of the fifth group of recesses 192 and the sixth group of recesses 194 are arranged to form rows that, in conjunction with the fifth group of protrusions 186, extend rearward and diagonally across from the lateral side 126 to the medial side 128. Additionally, both the fifth group of recesses 192 and the sixth group of recesses 194 have teardrop shapes similar to the fifth group of protrusions 186, with a rounded end oriented closer the toe end 132 than a pointed end. Furthermore, the sizes of the individual recesses of both the fifth group of recesses 192 and the sixth group of recesses 194 are configured so that, in conjunction with the fifth group of protrusions 186, the size of the respective recesses and protrusions increases along the rows from the lateral side 126 to the longitudinal axis 130 before once again reducing in size moving toward the medial side 128.

[0073] More specifically, the fifth group of recesses 192 extends inward toward the longitudinal axis 130 and rearward toward the heel end 134 from the medial side 128 of the midfoot region 122 and into the heel region 124. Put another way, the fifth group of recesses 192 fill the gap between the legs of the "J" formed by the outsole 114 in the midfoot region 122 and the heel region 124. The fifth group of recesses 192 includes two sub-groups, namely, a medial or first portion 192a that is disposed closer to the medial side 128 than a central or second portion 174b. The recesses of the first portion 192a have depths *(e.g.,* a dimension taken normal to the bottom surface 116) of approximately 3 mm, lengths *(e.g.,* a largest dimension) ranging between about 3 mm and about 6 mm, and widths *(e.g.,* a largest dimension taken perpendicular to the length) ranging between about 2 mm and about 4 mm, although other configurations are possible. The recesses of the second portion 192b are generally larger than the recesses of the first portion 192a, having depths of approximately 8 mm to 10 mm to extend through the second layer 112b of the midsole 112 to expose the first layer 112a, lengths ranging between about 4 mm and about 8 mm, and widths ranging between about 3 mm and about 6 mm, although other configurations are possible.

[0074] The sixth group of recesses 194 is disposed along the bottom surface 116 within the midfoot region 122 and extends inward to a lateral edge of the outsole 114 from the lateral side 126. The sixth group of recesses 194 are similar in size to the first portion 192a of the fifth group of recesses 192, with depths of approximately 3 mm, lengths ranging between about 3 mm and about 6 mm, and widths ranging between about 2 mm and about 4 mm, although other configurations are possible.

[0075] It is appreciated that, while the above description refers to multiple groups of both recesses and protrusions, such distinctions between groups are used for convenience only and one or more groups can be considered together to form different groups not expressly discussed above. For example, the first group of recesses 174 and the sixth group of recesses 194 can be considered as a single, lateral midsole group, the second group of recesses 178 and the fifth group of recesses 192 can be considered as a single, medial midsole group. Likewise, all of the groups of protrusions may be considered as single group of protrusions.

[0076] As mentioned above, sole elements can be arranged to impart a sole structure with zones of differing traction, flexibility, and stability. For example, referring again to FIG. 3, the sole structure 104 can define a first zone 195 disposed generally within the heel region 124, and more specifically, around the area of first impact 124a, a second zone 196 disposed generally within the midfoot region 122 and the forefoot region 120 (e.g., to extend generally between the thinnest potion 138 and the widest portion 136), and a third zone 197 disposed generally within the forefoot region 120, and more specifically, around the area of toe-off region 120a. The zones can include various combinations or subsets of the sole elements 118, as generally described above, as can impart the zones with specific properties (e.g., performance characteristics).

[0077] The first zone 195 can include large recesses 174, 178 (e.g., a first plurality of recesses) along the sides of the midsole 112 (see FIGS. 4 and 5), which have lower aspect ratios as compared with recesses in the other zones, to enhance cushioning to absorb energy from impact with the ground. Additionally, the first zone 195 also may include many smaller protrusions 186, 188 (e.g., a first plurality of protrusions) along the outsole 114 to provide increased traction. The protrusions in the first zone 195 can have a high aspect ratio as compared with protrusions in other zones, which may allow the protrusions 186, 188 to flex more easily, and in some cases, along a particular direction.

[0078] The second zone 196 can include comparatively smaller and more elongated recesses 174, 178 (e.g., a second plurality of recesses) along the sides of the midsole 112 (see FIGS. 4 and 5), which have high aspect ratios, as compared with recesses in the other zones. The more elongated recess 174, 178 in the second zone 196 can result in lower cushioning and greater stability as compared with the first zone 195. Additionally, the second zone 196 can include comparatively larger protrusions 182 and recesses 184 (e.g., a second plurality of protrusions and a third plurality of recesses) along the bottom surface 116. That is, the protrusions 182 and recess 184 have a greater average cross sectional area than the protrusions 186, 188 in the first zone 185, and can have comparatively lower aspect ratios to further enhance stability.

[0079] The larger protrusions 182 and recesses 184 can result in lower relative traction in the second zone 196, as compared with the first zone 195. That is, for a given contact patch of a predefined area, the first zone 195 may exhibit increased traction as compared with the second zone 196. Accordingly, in some cases, smaller protrusions 180 can be interspersed amongst the larger protrusions 182, as may provide increased traction as compared with only providing the larger protrusions 182. Accordingly, the protrusions 180 can increase the relative traction provided within the second zone 196. The protrusions 180 can have an average cross-sectional area that is less than the protrusions 182 and recesses 184, and possibly less than the protrusions 186 in the first zone 196.

[0080] The third zone 197 can include smaller and more elongated recesses 174, 178 (e.g., a fourth plurality of recesses) along the sides of the midsole 112 (see FIGS. 4 and 5), which have comparatively higher aspect ratios to reduce cushioning and improve energy transfer to the ground. Additionally, the third zone 197 can include smaller protrusions 182 (e.g., a third plurality of protrusions). The protrusions 182 in the third zone 197 can have a lower average cross-sectional area than the protrusions 182 and recess 184 in the second zone 196, and can have a comparatively higher aspect ratios, as may provide for more efficient transfer of energy to the ground during toe-off and increase traction. Accordingly, the third zone 197 can provide increased relative traction and lesser cushioning than the second zone 196. Further, the third zone 197 can provide and lesser cushioning and similar traction as compared with the first zone 195. In other embodiments, traction within the third zone 197 may be greater or lesser than in the first zone 195.

[0081] Similar principles can be applied to other areas of the sole structure 104 to provide additional zones with particular properties. For example, the sole structure 104 can include a fourth zone 198 along the lateral side 126 of the forefoot region 120 and a fifth zone 199 along the medial side 128 of the forefoot region 120. The fourth zone 198 can include recesses 184 and protrusions 182b (e.g., a fifth plurality of recesses and a fourth plurality of protrusions) to provide enhanced flexibility. The fifth zone 199 can include primarily protrusions 182 (e.g., a fifth plurality of protrusions) for enhanced traction and stability.

[0082] FIGS. 8-14 depict another exemplary embodiment of an article of footwear 200 having an upper 202 that is coupled above a sole structure 204, which extends between the upper 202 and the ground. The article of footwear 200 is similar to the article of footwear 100, with like numerals referring to like features, except as otherwise indicated below. In particular, the sole structure 204 extends between a toe end 232 and a heel end 234, and defines a forefoot region 220, a midfoot region 222, a heel region 224, a lateral side 226, and a medial side 228. The sole structure 204 includes a midsole 212 that is coupled with the upper 202 at an upper surface of the midsole 212 and is coupled with an outsole 214 on a lower surface of the midsole 212, which defines a bottom surface 216 of the sole structure 204.

[0083] As shown in FIGS. 13 and 14, the midsole 212 is a dual density midsole 212 comprised of a first or inner layer 212a having a first density, which is disposed within a cavity of a second or outer layer 212b having a second density that is greater than the first density. The first layer 212a is thicker than the second layer 212b throughout the forefoot region 220, the midfoot region 222, and the heel region 224. The second layer 212b defines a lower midsole recess 258 that is configured to receive and couple with the outsole 214.

[0084] In the present embodiment, the outsole 214 includes a predominantly wavy outer edge 266, except for smooth curvilinear portions 266a, 266b disposed along the medial side 228 of the forefoot region 220 and the heel region 224, respectively. Additionally, the outsole 214 includes a plurality of parallel, arcuate transverse grooves 268 that curve away from the toe end 232 and extend between the lateral side 226 and the medial side 228, and a longitudinal groove 270 configured as a wavy, curvilinear groove that is disposed within the forefoot region 220 and extends generally along the longitudinal axis 230 from the toe end 232 to the midfoot region 222.

[0085] The sole structure 204 further includes a plurality of sole elements 218 arranged similarly to the sole elements 118. Referring to FIG. 11 in particular, the lateral side 226 of the midsole 212 includes a first group of protrusions 272 and a first group of recesses 274. The first group of protrusions 272 are configured as ridges that are arranged to form a plurality of parallel, curvilinear rows. The first group of recesses 274 are configured as a plurality of teardrop-shaped recesses that are oriented so that a pointed end is disposed closer to the heel end 234 than a rounded end, and which are arranged to form substantially parallel and curvilinear rows between the respective rows of the first group of protrusions 272. The first group of recesses 274 includes a first portion 274a, a second portion 274b, a third portion 274c and a fourth portion 274d, some of which include deeper recesses as compared to the previous embodiment to provide increased flexibility and cushioning. In particular, the first portion 274a is similar to the first portion 174a but includes a ninth or central sub-portion 274e disposed within and substantially surrounded by the remainder of the first portion 274a. The ninth portion 274e includes a deeper set of recesses with depths of approximately 25 mm so that the recesses extend through the second layer 212b of the midsole 212 to expose the first layer 212a. The sizes of recesses of the ninth portion 274e are similar to the corresponding recesses in the first portion 174a. Likewise, the recesses of the third portion 274c are all approximately 15 mm deep so that the recesses extend through the second layer 212b of the midsole 212 to expose the first layer 212a.

[0086] Turning briefly to FIG. 12, the medial side 228 of the sole structure 204 also has sole elements 218,

including a second group of protrusions 276 and a second group of recesses 278. Each of the second group of protrusions 276 and the second group of recesses 278 are similar to the first group of protrusions 272 and the first group of recesses 274, respectively. That is, the second group of protrusions 276 is like the first group of protrusions 272, and the second group of recesses 278 is similar to the first group of recesses 274, but substantially mirrored over the longitudinal axis 230 to follow the contours of the midsole 212 on the medial side 228. More specifically, with regard to the second group of recesses 278, the second group of recesses 278 includes a fifth portion 278a, a sixth portion 278b, a seventh portion 278c, an eighth portion 278d, and a tenth portion 278e which correspond with the first portion 274a, the second portion 274b, the third portion 274c, the fourth portion 274d, and the ninth portion 274e respectively. In other embodiments, the lateral side 226 and the medial side 228 may not be substantial mirror images of one another.

[0087] Referring now to FIG. 10, the sole structure 204 includes additional sole elements 218 disposed along the bottom surface 216 and throughout each of the forefoot region 220, the midfoot region 222, and the heel region 224. The sole elements 218 along the bottom surface 216 are substantially similar in size and shape to the corresponding sole elements 218 of the previous embodiment, except that the spacing between the respective elements is decreased so that a greater number of sole elements 218 are present. In particular, the sole structure 204 includes a third group of protrusions 280, a fourth group of protrusions 282, and a third group of recesses 284 within the forefoot region 220 and extending partially into the midfoot region 222 (while third and fourth groups of protrusions 280, 282 are depicted as recesses in FIG. 8, they alternatively may comprise protrusions, similar to third and fourth groups of protrusions 180, 182 shown in FIG. 1). Likewise, the sole structure 204 further includes a fifth group of protrusions 286 (while the fifth group of protrusions 286 are depicted as recesses, they, too may alternatively comprise protrusions), a fourth group of recesses 290, a fifth group of recesses 292, and a sixth group of recesses 294. However, in this aspect, the sole structure 204 may not include a sixth group of protrusions.

[0088] Rather, in place of the sixth group of protrusions, the sole structure 204 may include a seventh group of recesses 288 configured as round holes. The seventh group of recesses 288 are arranged similarly to the sixth group of recesses 194 in that they form rows that extend diagonally rearward from the lateral side 226 to the medial side 228 along the bottom surface 216, between the corresponding rows formed by the fifth group of protrusions 286. Additionally, the seventh group of recesses 288 are similarly sized, having lengths *(e.g.,* a largest dimension) and widths *(e.g.,* a largest dimension taken perpendicular to the length) of approximately 2 mm. However, instead of protruding away from the outsole 214, the seventh group of recesses 288 extend partially into the outsole 214, with depths *(e.g.,* a dimension taken normal to the bottom surface 216) of approximately 2 mm.

[0089] Correspondingly, similar to above, sole elements can be arranged to impart a sole structure with zones of differing traction, flexibility, and stability. For example, referring again to FIG. 10, the sole structure 204 can define a first zone 295 disposed generally within the heel region 224 to provide enhanced cushioning and traction, and more specifically, a second zone 296 disposed generally within the midfoot region 222 and the forefoot region 220 to provide enhanced stability, and a third zone 297 disposed generally within the forefoot region 220 provide for more efficient transfer of energy to the ground during toe-off and enhanced traction, a fourth zone 298 along the lateral side 226 of the forefoot region 220 to provide enhanced flexibility, and a fifth zone 299 along the medial side 228 of the forefoot region 220 to provide enhanced traction and stability. Here, the recesses 288 can provide for further cushioning in the first zone 295.

[0090] FIG. 15 depicts another embodiment of an outsole 314, which can be incorporated into an article of footwear having an upper and a midsole (e.g., articles of footwear 100, 200). For example, the outsole 314 is similar to the outsole 214, with like numerals referring to like features, except as otherwise indicated below, and, therefore, can be used with the sole structure 204 of the article of footwear 200. In particular, the outsole 314 includes sole elements 318 but does not include any protrusions. Rather, in place of each of the third group of protrusions 280, the fourth group of protrusions 282, and the fifth group of protrusions 286, the outsole includes a seventh group of recesses 380, an eighth group of recesses 382, and a ninth group of recesses 386, respectively. That is, the seventh group of recesses 380, eighth group of recesses 382, and ninth group of recesses 386 are similarly shaped to the corresponding groups of protrusions but extend partially into the outsole 314. In this case, each of the seventh group of recesses 380, eighth group of recesses 382, and ninth group of recesses 386 have depths *(e.g.,* a dimension taken normal to the bottom surface 316) of approximately 2 mm, although other configurations are possible. Additionally, with regard to the eighth group of recesses 382, each recess includes a ridge extending from a toe end 332 to a heel end 334, which effectively divides each of the recesses into a lateral half and a medial half.

[0091] By replacing protrusions with recesses, a lighter, more flexible sole structure can be provided, which can also provide enhanced stability. For example, referring back to FIG. 10, by replacing the outsole 214 with the outsole 314, stability can be maintained within the second zone 296, while also providing increased flexibility in the fourth zone 298.

[0092] FIGS. 16-18 depict another embodiment of a sole structure 404, which is configured to couple to an upper 402 (shown in phantom) of an article of footwear 400 so that the sole structure 404 extends between the upper 402 and the ground. The sole structure 404 is sim-

ilar to previously described sole structures (*e.g.*, sole structures 104 and 204), with like numerals referring to like features, except as otherwise indicated below. In particular, the sole structure 404 includes a plurality of sole elements 418 configured as recesses and protrusions. Additionally, the sole structure 404 extends between a toe end 432 and a heel end 434, and defines a forefoot region 420, a midfoot region 422, a heel region 424, a lateral side 426, and a medial side 428. Furthermore, the sole structure 404 includes a midsole 412 that is configured to couple to the upper 402 along an upper surface of the midsole 412 and to an outsole 414 along a lower surface of the midsole 412, which defines a bottom surface 416 of the sole structure 404. The sole structure 404 further includes a heel cup 450.

[0093] However, in the present embodiment, the midsole 412 is configured as a single density midsole having a single foam component that extends between the upper 402 and the outsole 414. Additionally, with particular reference to FIG. 16, the midsole 412 includes sole elements 418 configured as a first or lateral side group of protrusions 472 and a first or lateral side group of recesses 474 that are disposed along the lateral side of the midsole 412. The first group of protrusions 472 *(e.g.,* a first sub-group of first protrusions) are configured as a plurality of rounded, linear ridges, which extend diagonally downward *(i.e.,* from the upper 402 towards the outsole 414) and forward *(i.e.,* from the heel end 434 to the toe end 432) in both the heel region 424 and the midfoot region 422. The first group of protrusions 472 *(e.g.,* a second sub-group of first protrusions) are further arranged to form substantially parallel and curvilinear rows that extend along the lateral side 426 of the midsole 412 in the forefoot region 420.

[0094] The first group of recesses 474 are similarly arranged to form substantially parallel and curvilinear rows between the respective rows of the first group of protrusions 472. The first group of recesses 474 are generally tear or rain drop shaped near the heel end 434, with the pointed end being disposed closer to the heel end 434 than the rounded end, and gradually become more elongated *(i.e.,* ellipsoidal) and spaced apart moving toward the toe end 432. Additionally, the first group of recesses 474 vary in depth between about 0.5 mm and about 2 mm and the cross-sectional area of the respective recesses narrows or becomes smaller along the depth so that the bottom or inner portion of the recess is smaller than the exterior opening.

[0095] More specifically, the first group of recesses 474 includes a plurality of sub-groups, namely, a first portion 474a and a second portion 474b. The first portion 474a includes teardrop-shaped recesses that become more elongated (e.g., ellipsoidal) and as the first portion 474a extends from the heel end 434 and along the heel region 424 and into a lower half of the midfoot region 422. The recesses in the first portion 474a have depths of approximately 2 mm, lengths ranging between about 3 mm and about 10 mm, and widths ranging between about 2 mm and about 5 mm, although other configurations are possible. The second portion 474b includes teardrop-shaped recesses in an upper half of the midfoot region 422 that gradually become generally ellipsoidal recesses extending into and throughout the forefoot region 420 to the toe end 32. The recesses in the second portion 474b have depths of approximately 1.5 mm, lengths ranging between about 3 mm and about 8 mm, and widths ranging between about 2 mm and about 3 mm, although other configurations are possible. The spacing between the respective recesses in the second portion 474b gradually increases moving from the heel end 434 toward the toe end 432.

[0096] The midsole 412 also includes additional sole elements 418 disposed along the medial side 428 of the midsole 412. Specifically, with reference to FIG. 17, the midsole 412 includes including a second group of protrusions 476 and a second group of recesses 478. The second group of protrusions 476 is arranged and configured to be substantially similar to the first group of protrusions 472. Likewise, the second group of recesses 478 are arranged in a manner similar to that of the first group of protrusions 476. Specifically, the second group of recesses 478 includes a third portion 478a extending substantially throughout the heel region 424 and into a bottom half of the midfoot region 422 and the forefoot region 420, proximate a widest portion 436, and a fourth portion 478b extending from an upper half of the heel region 424, and through the midfoot region 422 and the forefoot region 420 to the toe end 432. The third portion 478a of recesses is generally disposed below the fourth portion 478b of recesses (*e.g.*, closer to the outsole 414), except in a rear half *(e.g.,* a half closest to the heel end 434) of the heel region 424 where only recesses of the third portion 478a are provided, and in a front half of the forefoot region 420 *(e.g.,* a half closest to the toe end 432) where only recesses of the fourth portion 478b are disposed. Additionally, the recesses of the third and fourth portions 478a, 478b are comparatively more ellipsoidal and elongated, and the relative spacing between adjacent recesses is generally greater than on the lateral side 426, particularly in the longitudinal direction (*e.g.*, along a longitudinal axis 430, see FIG. 18).

[0097] Referring now to FIG. 18, the outsole 414 is shaped similarly to the outsoles of previously discussed embodiments (e.g., outsoles 114, 214, 314) but includes a predominately wavy outer peripheral edge. The outsole 414 includes a plurality of parallel, arcuate transverse grooves 468 in the forefoot region 420 that extend between the lateral side 426 and the medial side 428, and that curve away from the toe end 432. Additionally, the outsole 414 includes a curvilinear, longitudinal groove 470 within the forefoot region 420, which extends generally along the longitudinal axis 430 from the toe end 432 to the midfoot region 422. Further, the outsole 414 includes yet additional sole elements 418 disposed along the bottom surface 416.

[0098] Specifically, outsole 414 includes a third group

of protrusions 480 and a fourth group of protrusions 482 disposed throughout a medial half 420a of the of the forefoot region 420 *(e.g.,* a portion of the forefoot region 420 extending from the longitudinal groove 470 to the medial side 428), similar to the third and fourth groups of protrusions 180, 182. However, the third and fourth groups of protrusions 480, 482 are formed by recessing the medial half 420a of the forefoot region 420 of the outsole 414 to define each of the projections of the third and fourth groups of protrusions 480, 482. That is, the medial half 420a of the outsole 414 is recessed to form the third and fourth groups of protrusions 480, 482 so that a distal end *(e.g.,* a surface at a distal end) defines the bottom surface 416 of the outsole 414. Accordingly, the third and fourth groups of protrusions 480, 482 are approximately uniform in height, for example, between about 1 mm and about 10 mm, and more specifically, approximately 3 mm. Additionally, each of the fourth group of protrusions 480 defines a cut extending through the protrusion in a longitudinal direction, effective splitting each protrusion in half.

[0099] Along a lateral half 420b of the forefoot region 420 *(e.g.,* a portion of the forefoot region 420 extending from the longitudinal groove 470 to the lateral side 426) the outsole 414 further includes a third group of recesses 484, which are arranged and shaped in a manner similar to that of the recesses 380, 382, 384. The third group of recesses 484 extend partially into the midfoot region 422. The third group of recesses 484 include a first or central portion 484a that does not extend along an outer edge of the outsole 414, and a second portion 484b that extends throughout the lateral half 420b of the forefoot region 420. The recesses of the first portion 484a are approximately 5 mm deep and extend through the outsole 414 and into the midsole 412. The recesses of the second portion 484b are approximately 1 mm to 2 mm deep and extend partially into the outsole 414. A portion or all of the recesses of the second portion 484b can have a longitudinal ridge protruding from a bottom of a respective recess toward the bottom surface 416. The ridge may or may not extend to the bottom surface 416.

[0100] The midfoot and heel regions 422, 424 of the outsole 414 further include a fourth group of recesses 486, which are arranged and shaped similarly to the combination of the fifth and sixth groups of protrusions 186, 188, and the fourth group of recesses 190. However, in the present embodiment each of the recesses of the fourth group of recesses 486 have a depth of approximately 1 mm to 2 mm to extend partially into the outsole 414.

[0101] With continued reference to FIG. 18, the portions of the midsole 412 that are exposed along the bottom surface 416 can also include sole elements 418. Specifically, the midsole 412 further includes a fifth group of recesses 492 *(e.g.,* a bottom medial group) and a sixth group of recesses 494 *(e.g.,* a bottom lateral group) disposed in and along the exposed portions of the midsole 412. The recesses in each of the fifth group of recesses 492 and the sixth group of recesses 494 are arranged and shaped similarly to the fifth and sixth groups of recesses 192, 194, respectively, but have approximately uniform depths that can range between about 0.5 mm and about 3 mm. In the present embodiment, the recesses in each of the fifth group of recesses 492 and the sixth group of recesses 494 have depths of approximately 2 mm. In that regard, the recesses in each of the fifth group of recesses 492 and the sixth group of recesses 494 may also be considered as part of the first portion 474a of the first group of recesses 474 and the third portion 478a of the second group of recesses 478, respectively. That is, the first portion 474a of the first group of recesses 474 may wrap around the medial side 428 of the midsole 412 to form the fifth group of recesses 492 and the third portion 478a of the second group of recesses 478 may wrap around the lateral side 426 of the midsole 412 to form the sixth group of recesses 494.

[0102] Similar to above, sole elements can be arranged to impart a sole structure with zones of differing traction, flexibility, and stability. For example, still referring to FIG. 18, the sole structure 404 can define a first zone 495 disposed generally within the heel region 424 to provide enhanced cushioning and traction, and more specifically, a second zone 496 disposed generally within the midfoot region 422 and the forefoot region 420 to provide enhanced stability, and a third zone 497 disposed generally within the forefoot region 420 provide for more efficient transfer of energy to the ground during toe-off and enhanced traction, a fourth zone 498 along the lateral side 426 of the forefoot region 420 to provide enhanced flexibility, and a fifth zone 499 along the medial side 428 of the forefoot region 420 to provide enhance traction and stability.

[0103] Turning now to FIGS. 19-21, another exemplary embodiment of an article of footwear 500 is illustrated. The article of footwear is similar in some respects to previously described articles of footwear (*e.g.*, articles of footwear 100, 200, 400), with like numerals referring to like features, except as otherwise indicated below. In particular, the article of footwear 500 has an upper 502 that is coupled above a sole structure 504, which extends between the upper 502 and the ground.

[0104] The sole structure 504 extends between a toe end 532 and a heel end 534, and defines a forefoot region 520, a midfoot region 522, a heel region 524, a lateral side 526, and a medial side 528. Additionally, the sole structure 504 includes midsole 512 that is configured to couple to the upper 502 at an upper surface of the midsole 512 and to couple to an outsole 514 on a lower surface of the midsole 512, which defines a bottom surface 516 of the sole structure 504. The sole structure 504 further includes a plurality of sole elements 518 and a heel cup 550.

[0105] In the present embodiment, the midsole 512 is configured as a dual-density midsole having a single foam component that extends between the upper 502 and the outsole 514. More specifically, the midsole 512

includes a first layer 512a having a first density and a second layer 512b having a second density, which is disposed below the first layer 512a. Accordingly, the first layer 512a couples to the upper 502 and the second layer 512b couples to the outsole 514. The first layer 512a and the second layer 512b are co-molded and coextensive with one another to form a single foam component that extends throughout the forefoot region 520, the midfoot region 522, and the heel region 524, between toe end 532 and the heel end 534, and between the lateral and medial sides 526, 528. Correspondingly, each of the first layer 512a and the second layer 512b are exposed along an outer periphery of the midsole 512. Additionally, the relative thickness of each of the first layer 512a and the second layer 512b can be selected to provide more or less support in specific regions of the article of footwear. This effect can be further enhanced through the inclusion of sole elements 518, which can also affect the amount of support and flexibility of the sole structure 504.

[0106] In the regard, each of the lateral side 526 and the medial side 528 of the midsole 512 includes sole elements 518 arranged similarly to that of the midsole 412. Specifically, as illustrated in FIG. 19, the lateral side 526 of the midsole 512 includes a first group of protrusions 572 and a first group of recesses 574. The first group of recesses 574 is comprised of a plurality of sub-groups, namely, a first portion 574a and a second portion 574b. Likewise, as illustrated in FIG. 20, the medial side 528 of the midsole 512 includes a second group of protrusions 576 and a second group of recesses 578. The second group of recesses 578 includes a plurality of sub-groups, namely, a third portion 578a and a fourth portion 578b.

[0107] Referring now to FIG. 21, the outsole 514 also include sole elements 518 arranged along the bottom surface 516. Additionally, similar to previously discussed embodiments, the outsole 514 includes a plurality of parallel, arcuate transverse grooves 568 in the forefoot region 520, along with a curvilinear, longitudinal groove 570 that extends generally along the longitudinal axis 530 from the toe end 532 to the midfoot region 422. The groove 570 defines a boundary between a medial half 520a and a lateral half 520b of the forefoot region 520. The medial half 520a includes a third group of protrusions 580 and a fourth group of protrusions 582, which are formed and arranged similarly to the third group of protrusions 480 and the fourth group of protrusions 482, respectively.

[0108] The lateral half 520b includes a third group of recesses 584 that extend in the forefoot region 520 from the toe end 532 and into the midfoot region 522. The third group of recesses 584 are shaped and arranged similarly to the groups of recesses 380, 382, 384, and includes a number of sub-groups or portions having differing depths. In particular, recesses of a first portion 584a of the third group of recesses 584 have depths of approximately 0.5 mm to 2 mm, and are disposed generally throughout the lateral half 520b of the forefoot region 520. Additionally, recesses of a second portion 584b of the third group of recesses 584 have depths of approximately 1.5 mm to 10 mm to extend through the outsole 514 to expose, and in some cases extend into, the second layer 512b of the midsole 512. The recesses of the second portion 584b are generally disposed proximate a lateral side of the outsole 514 and along the groove 570. Further, the recesses of a third portion 584c of the third group of recesses 584 have depths of approximately 5 mm to 50 mm, or more specifically, approximately 5 mm to 25, or approximately 5 mm to 10 mm, to extend through both the outsole 514 and the second layer 512b of the midsole 512 to expose, and in some cases extend into, the first layer 512a of the midsole 512. The third portion 512c is generally centrally disposed within the lateral half 520b of the forefoot region 520. In other embodiments, the various recesses of the third group of recesses 584 can be arranged differently. Relatedly, the midfoot and heel regions 522, 524 of the outsole 514 further include a fourth group of recesses 586, which are similar to the fourth group of recesses 486.

[0109] With continued reference to FIG. 21, the portions of the midsole 512 that are exposed along the bottom surface 516 can also include sole elements 518. Specifically, the midsole 512 further includes a fifth group of recesses 592 *(e.g.,* a bottom medial group) and a sixth group of recesses 594 *(e.g.,* a bottom lateral group) disposed in and along the exposed portions of the midsole 512. Similar to the fifth group of recesses 192, the fifth group of recesses 592 includes two sub-groups, namely, a medial or first portion 592a that is disposed closer to the medial side 528 than a central or second portion 574b. The recesses of the first portion 592a have depths of approximately 0.5 mm to 3 mm. The recesses of the second portion 592b have depths of approximately 8 mm to 50 mm, or more specifically, approximately 5 mm to 25, or approximately 5 mm to 10 mm, to extend into the second layer 512b or through the second layer 512b of the midsole 512 to expose the first layer 512a. The sixth group of recesses 594 are similar to the sixth group of recesses 494.

[0110] Similar to above, sole elements can be arranged to impart a sole structure with zones of differing traction, flexibility, and stability. For example, still referring to FIG. 21, the sole structure 504 can define a first zone 595 disposed generally within the heel region 524 to provide enhanced cushioning and traction, and more specifically, a second zone 596 disposed generally within the midfoot region 522 and the forefoot region 520 to provide enhanced stability, and a third zone 597 disposed generally within the forefoot region 520 provide for more efficient transfer of energy to the ground during toe-off and enhanced traction, a fourth zone 598 along the lateral side 526 of the forefoot region 520 to provide enhanced flexibility, and a fifth zone 599 along the medial side 528 of the forefoot region 520 to provide enhance traction and stability.

[0111] Turning now to FIGS. 22-26, another exemplary embodiment of an article of footwear 600 is illustrated.

The article of footwear is similar in many respects to previously described articles of footwear (*e.g.*, articles of footwear 100, 200, 400), with like numerals referring to like features, except as otherwise indicated below. In particular, the article of footwear 600 has an upper 602 that is coupled above a sole structure 604, which extends between the upper 602 and the ground. The sole structure 604 extends between a toe end 632 and a heel end 634, and defines a forefoot region 620, a midfoot region 622, a heel region 624, a lateral side 626, and a medial side 628. Additionally, the sole structure 604 includes midsole 612 that is configured to couple to the upper 602 at an upper surface of the midsole 612 and to couple to an outsole 614 on a lower surface of the midsole 612, which defines a bottom surface 616 of the sole structure 604. The sole structure 604 further includes a plurality of sole elements 618 and a heel cup 650.

[0112] Similar to midsoles 112, 212, the midsole 612 is a dual density midsole 612 comprised of a first or inner layer 612a having a first density, which is disposed within a cavity of a second or outer layer 612b having a second density that is greater than the first density. In some cases, the first layer 612a can be configured as a drop-in insert (see FIG. 25). Each of the lateral side 626 and the medial side 628 of the midsole 612 *(e.g.,* the exposed surfaces of the second midsole layer 612b) include sole elements 618 arranged similarly to that of previously described midsoles 412, 512. Specifically, as illustrated in FIG. 22, the lateral side 626 of the midsole 612 includes a first or lateral side group of protrusions 672 and a first or lateral side group of recesses 674. The first group of recesses 674 is comprised of a plurality of sub-groups, namely, a first portion 674a and a second portion 674b. Likewise, as illustrated in FIG. 23, the medial side 628 of the midsole 612 includes a second group of protrusions 676 and a second group of recesses 678. The second group of recesses 678 includes a plurality of sub-groups, namely, a third portion 678a and a fourth portion 678b.

[0113] Referring now to FIG. 24, the outsole 614 also includes sole elements 618 arranged along the bottom surface 616. Additionally, the outsole 614 includes a pair of parallel, curvilinear grooves 670a, 670b that extend generally along the longitudinal axis 630 from the toe end 632 to the midfoot region 622, forming a curvilinear ridge 670c therebetween. The grooves 670a, 670b define a boundary between a medial half 620a and a lateral half 620b of the forefoot region 620. Also, similar to previously discussed embodiments, the outsole 614 includes a plurality of parallel, arcuate transverse grooves 668 in the forefoot region 620, however, the grooves 668 only extend along the medial half 620a of the forefoot region 620. The medial half 620a includes a third group of protrusions 680 and a fourth group of protrusions 682, which are formed and arranged similarly to the third group of protrusions 480, 580 and the fourth group of protrusions 482, 582, respectively.

[0114] The lateral half 620b includes a third group of recesses 684 that extend along the lateral half 620b of the forefoot region 620 from the toe end 632 and into the midfoot region 622. The third group of recesses 684 includes a number of sub-groups or portions having differing depths. In particular, recesses of a first portion 684a of the third group of recesses 684 have depths of approximately 0.5 mm to 2 mm, and are disposed generally throughout the lateral half 620b of the forefoot region 620, similar to the recesses 584. Further, the recesses of a second portion 684b of the third group of recesses 684 have depths of approximately 5 mm to 50 mm, or more specifically, approximately 5 mm to 25, or approximately 5 mm to 10 mm, to extend through both the outsole 614 and the second layer 612b of the midsole 612 to expose, and in some cases extend into, the first layer 612a of the midsole 612. The recesses of the second portion 684b are generally centrally disposed within the lateral half 620b of the forefoot region 620 to form a longitudinally oriented row, which can be curved. In other embodiments, the various recesses of the third group of recesses 684 can be arranged differently. Additionally, the recesses of the second portion 684b generally have a larger cross-sectional area *(e.g.,* an area normal to the depth), with lengths *(e.g.,* a largest dimension) and widths *(e.g.,* a largest dimension taken perpendicular to the length) that range between about 10 mm and about 30 mm, although other configurations are possible.

[0115] With continued reference to FIG. 24, the portions of the midsole 612 that are exposed along the bottom surface 616 can also include sole elements 618. Specifically, the midsole 612 further includes a fifth group of recesses 692 *(e.g.,* a bottom medial group) and a sixth group of recesses 694 *(e.g.,* a bottom lateral group) disposed in and along the exposed portions of the midsole 612. The fifth group of recess 692 includes two sub-groups, namely, a medial or first portion 692a that is disposed closer to the medial side 628 than a central or second portion 674b. The recesses of the first portion 692a are similar to the first portion 592a of the midsole 512 discussed above. The recesses of the second portion 692b sized and shaped similarly to the recesses of a second portion 684b of the third group of recesses 684 (e.g., the teardrop-shaped recess) and are arranged generally in a line along the longitudinal axis 630. The sixth group of recesses 694 are similar to the sixth group of recesses 494.

[0116] Similar to above, sole elements can be arranged to impart a sole structure with zones of differing traction, flexibility, and stability. For example, still referring to FIG. 24, the sole structure 604 can define a first zone 695 disposed generally within the heel region 624 to provide enhanced cushioning and traction, and more specifically, a second zone 696 disposed generally within the midfoot region 622 and the forefoot region 620 to provide enhanced stability, and a third zone 697 disposed generally within the forefoot region 620 provide for more efficient transfer of energy to the ground during toe-off and enhanced traction, a fourth zone 698 along the lateral side 626 of the forefoot region 620 to provide enhanced

flexibility, and a fifth zone 699 along the medial side 628 of the forefoot region 620 to provide enhance traction and stability. Within the fourth zone 698, the increase size of the recesses 684 can reduce weight while increasing flexibility and stability.

[0117] Any of the embodiments described herein may be modified to include any of the structures or methodologies disclosed in connection with different embodiments. For example, certain features and combinations of features that are presented with respect to particular embodiments in the discussion above can be utilized in other embodiments and in other combinations, as appropriate. Similarly, materials or construction techniques, other than those disclosed above, may be substituted or added in some embodiments according to known approaches. Further, the present disclosure is not limited to articles of footwear of the type specifically shown. Still further, aspects of the articles of footwear of any of the embodiments disclosed herein may be modified to work with any type of footwear, apparel, or other athletic equipment.

[0118] As noted previously, it will be appreciated by those skilled in the art that while the disclosure has been described above in connection with particular embodiments and examples, the disclosure is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto.

INDUSTRIAL APPLICABILITY

[0119] Numerous modifications to the present invention will be apparent to those skilled in the art in view of the foregoing description. Accordingly, this description is to be construed as illustrative only and is presented for the purpose of enabling those skilled in the art to make and use the invention. The exclusive rights to all modifications which come within the scope of the appended claims are reserved.

Claims

1. An article of footwear comprising:

an upper; and

a sole structure coupled with the upper, the sole structure extending through each of a forefoot region, a midfoot region, and a heel region, from a heel end to a toe end, and between a lateral side and a medial side, the sole structure including:

a midsole coupled to the upper, the midsole including a first plurality of protrusions disposed along each of the lateral side and the medial side, and a first plurality of recesses disposed along each of the lateral side, the medial side, and a bottom surface of the midsole; and

an outsole coupled with the midsole, opposite the upper, the outsole including a second plurality of protrusions disposed along a medial half of the forefoot region, a second plurality of recesses disposed along the medial half of the forefoot region, and a third plurality of recesses extending through each of the midfoot region and the heel region.

2. The article of footwear of claim 1, wherein the first plurality of protrusions are configured as elongate protrusions that extend in a heel-to-toe direction.

3. The article of footwear of claim 1, wherein the first plurality of recesses are arranged to form a plurality of curvilinear rows that extend in a heel to toe direction.

4. The article of footwear of claim 3, wherein the recesses of the first plurality of recesses are shaped to define a gradient that transitions from a first shape at a heel end to a second shape at the toe end.

5. The article of footwear of claim 1, wherein at least one of the second plurality of recesses extends through the outsole and into the midsole.

6. The article of footwear of claim 1, wherein the protrusions of the second plurality of protrusions are shaped to define a gradient that transitions from a first shape at the toe end, to a second shape at the heel end.

7. The article of footwear of claim 6, wherein the gradient further includes a third shape between the first shape and the second shape.

8. The article of footwear of claim 7, wherein the first shape is a first teardrop shape that is oriented with a pointed end oriented closer to the toe end than is a rounded end,

wherein the second shape is a second teardrop shape that is oriented with a pointed end oriented closer to the heel end than is a rounded end; and

wherein the third shape is a rounded triangular shape with a pointed end oriented closer to the toe end than is a flat end.

9. The article of footwear of claim 1, wherein the second plurality of protrusions and the second plurality of recesses are arranged to form a first plurality transverse arcuate rows.

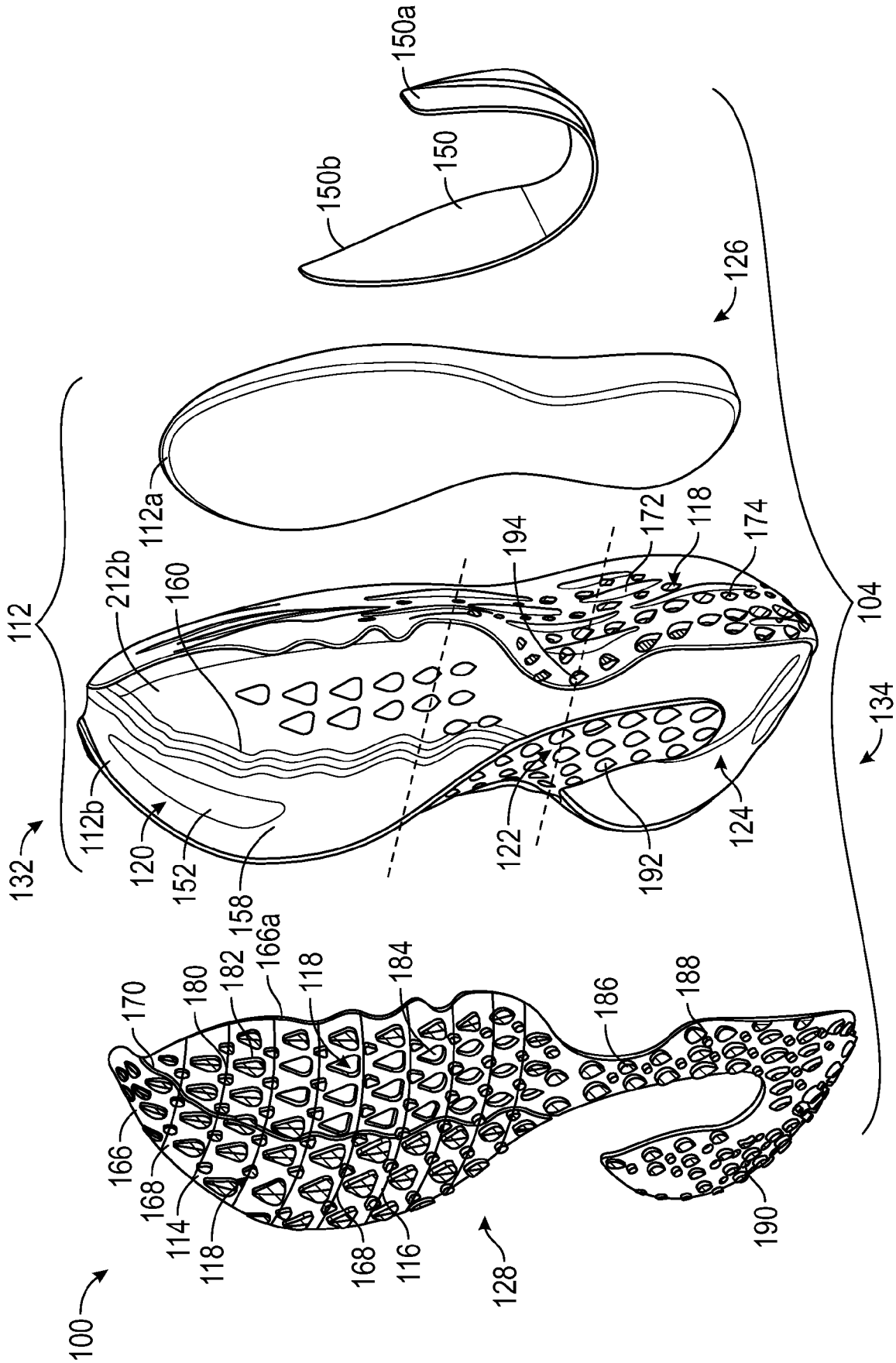
10. The article of footwear of claim 9, wherein the outsole includes a third plurality of protrusions that are arranged to form a second plurality transverse arcuate rows that alternate with the first plurality transverse arcuate rows.

11. The article of footwear of claim 10, wherein the protrusions of the third plurality of protrusions are shaped to define:

a first gradient that transitions from a first shape at the toe end to a second shape proximate a widest potion of the sole structure; and
a second gradient that transitions from a third shape proximate the widest portion of the sole structure to a fourth shape at about the midfoot region.

12. The article of footwear of claim 11, wherein the first shape is a first rounded shape, the second shape is a first rounded triangular shape with a pointed end oriented toward the toe end, the third shape is a second rounded triangular shape with a pointed end oriented toward the heel end, and the fourth shape is a second rounded shape.

13. The sole structure of claim 1, wherein the midsole includes a first layer and a second layer, and wherein at least one of the third plurality of recesses extends through the outsole and the second layer of the midsole to expose the first layer of the midsole.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132
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118
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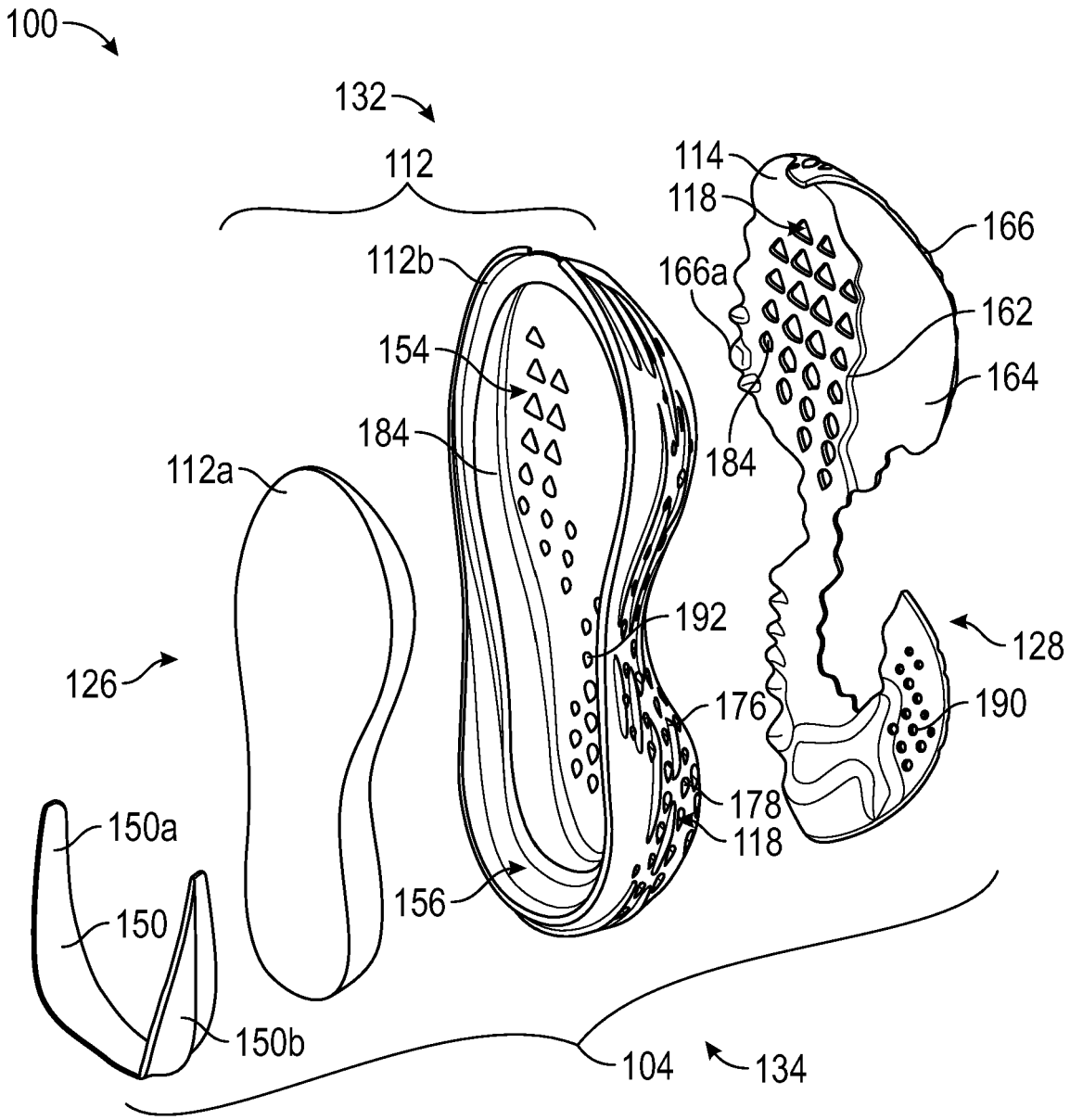
100

FIG. 1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112b
166a
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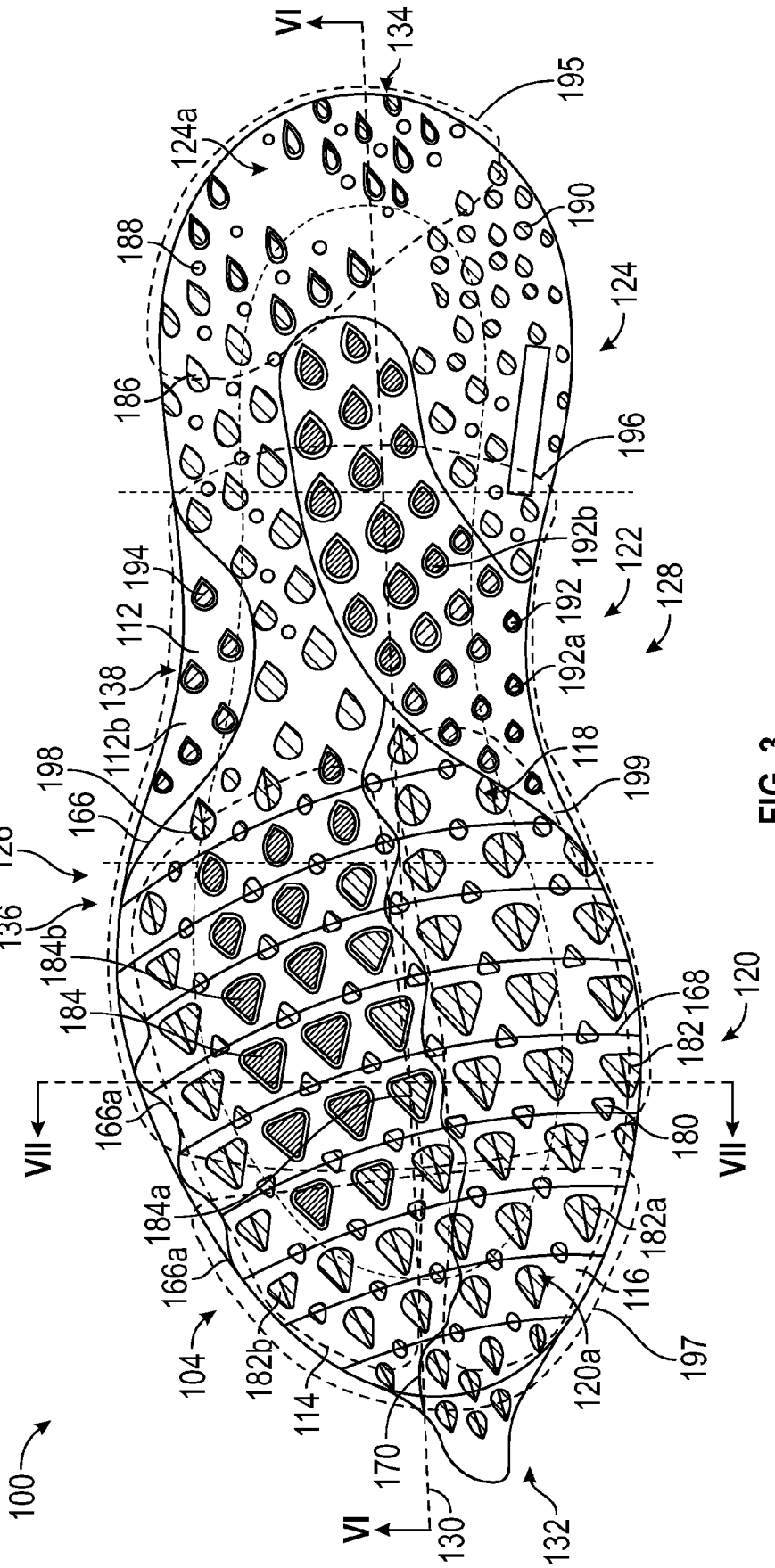
134

FIG. 2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199
166
126
136
184b
184
168
120
182
VII
166a
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182b
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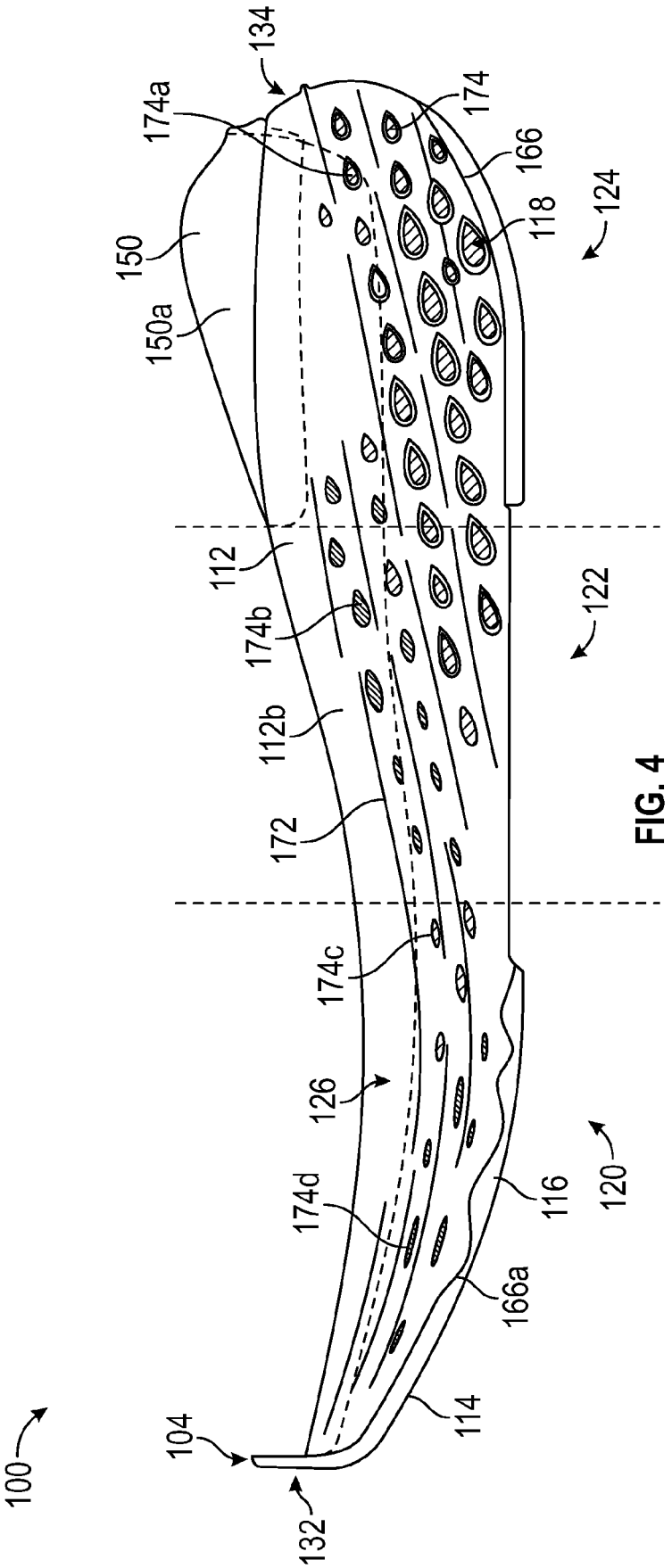
VI
130
132

FIG. 3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104
132
100

FIG. 4

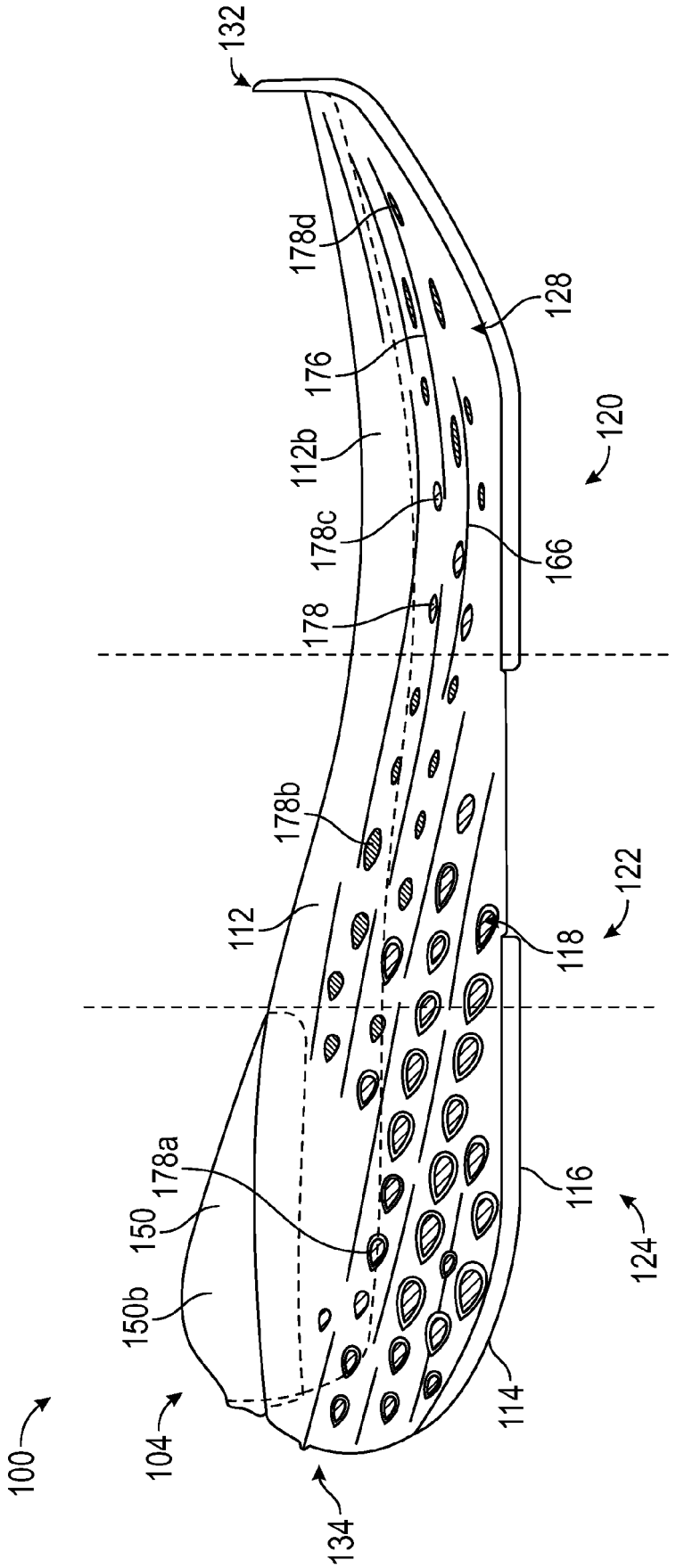
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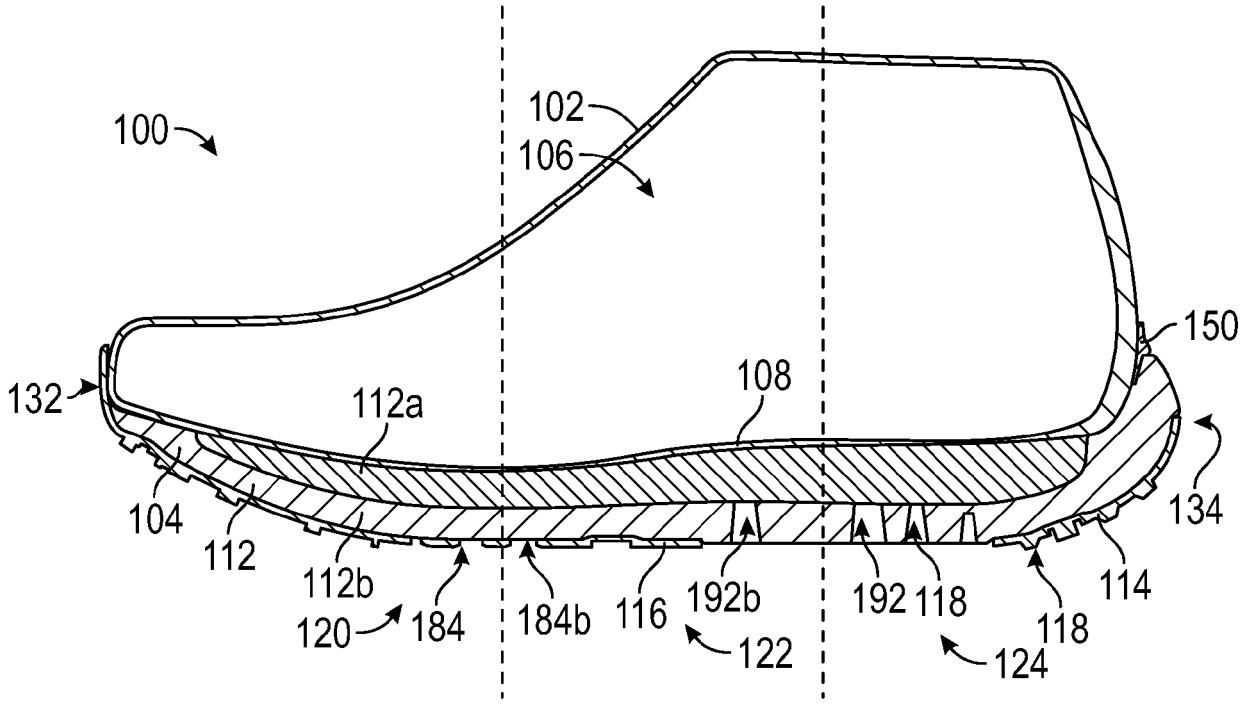
FIG. 5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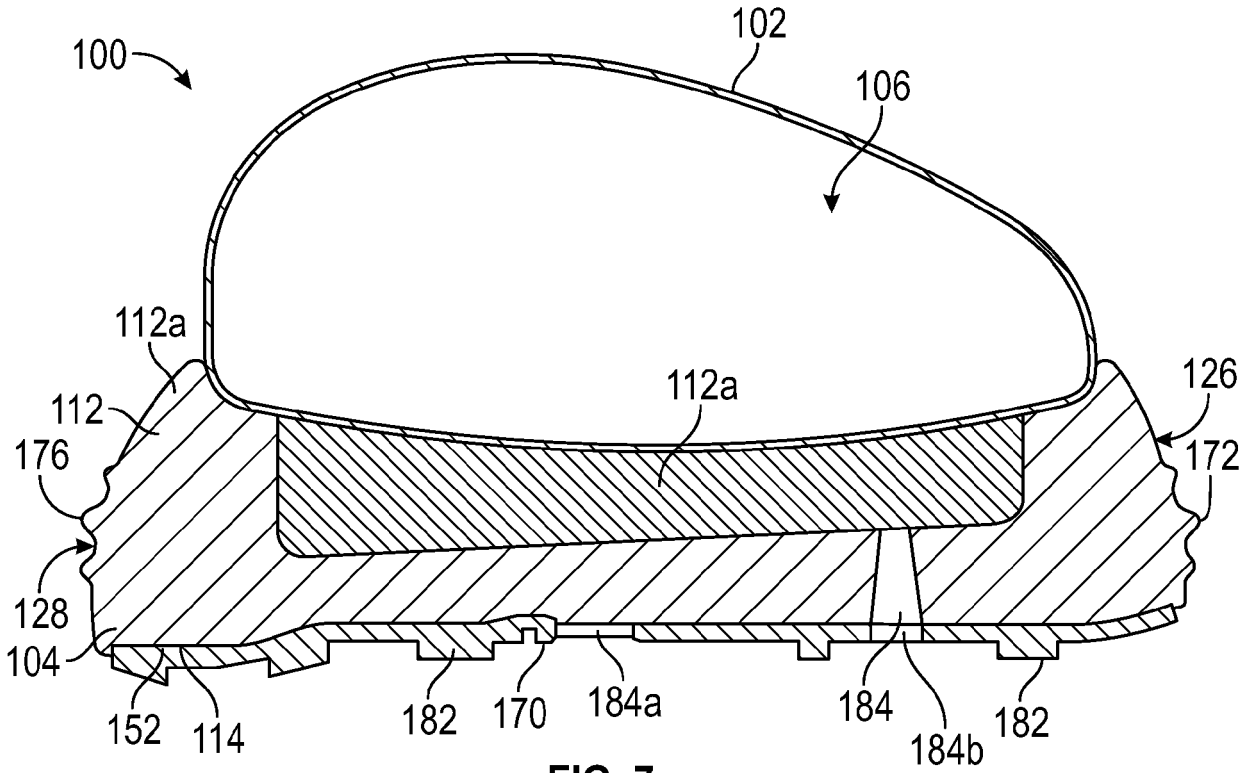
134

FIG. 6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184b
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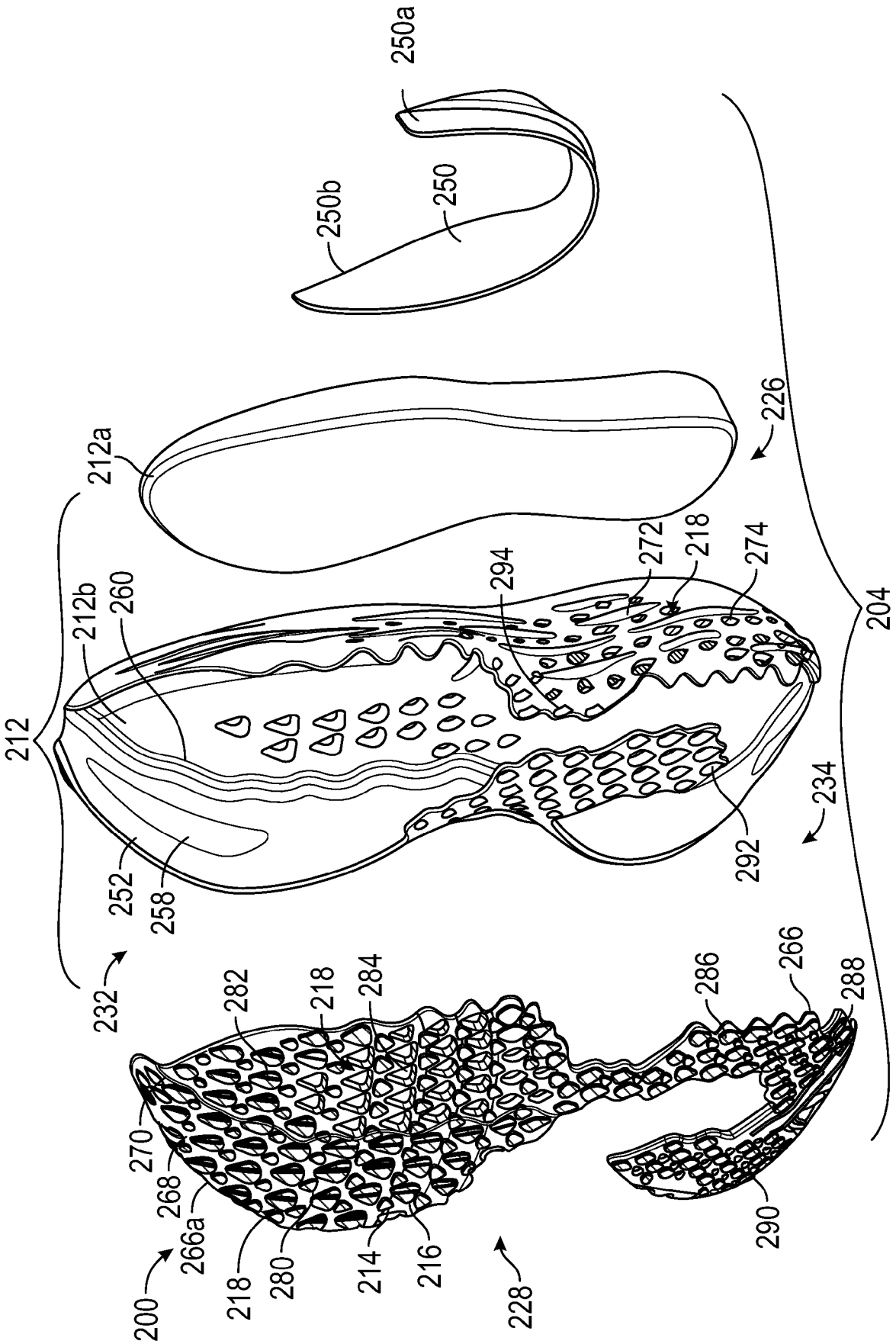
FIG. 7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212
212b
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294
272
218
274
204
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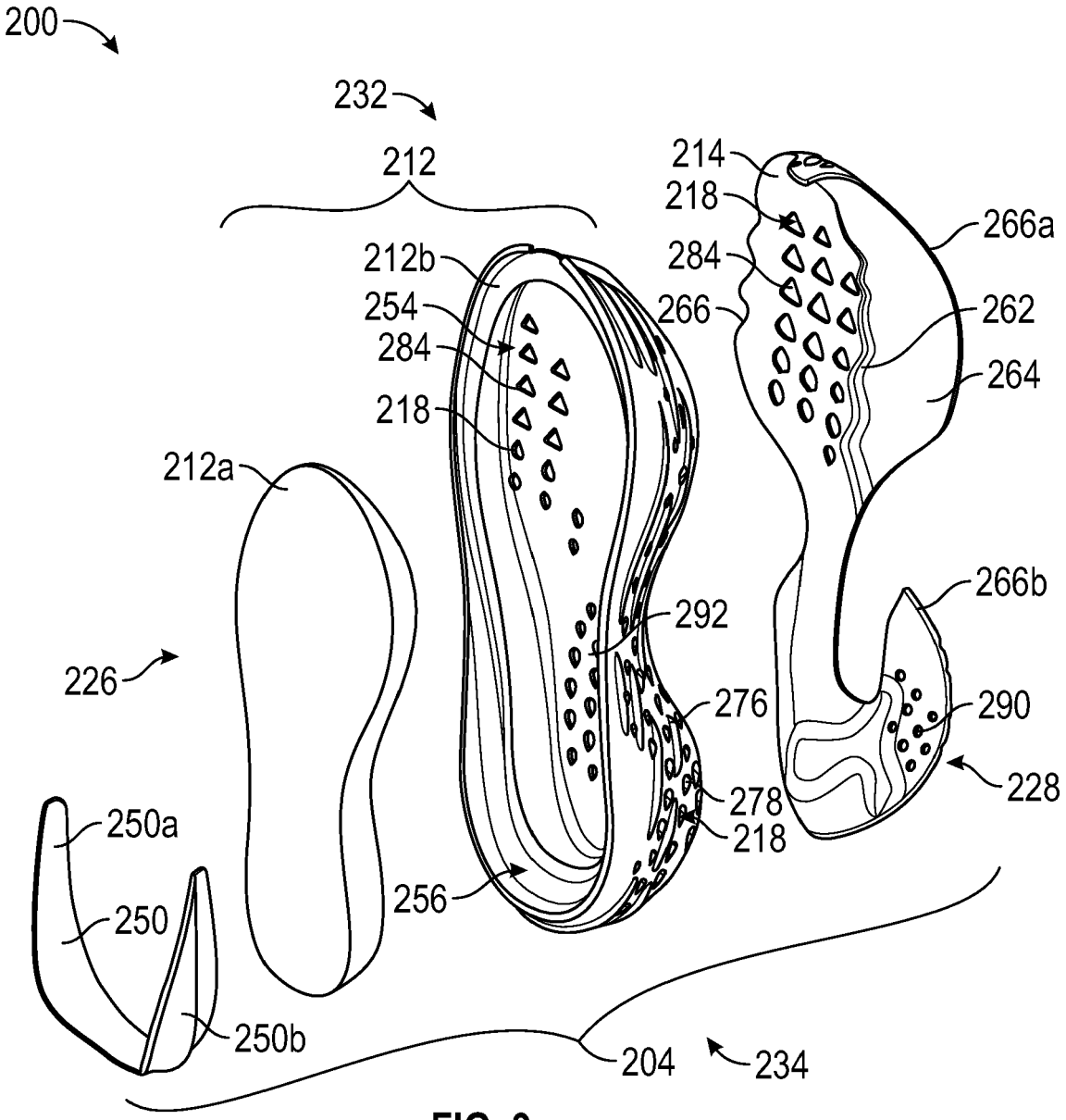
286
266
288
270
268
266a
218
280
214
216
228
200
290

FIG. 8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266
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256
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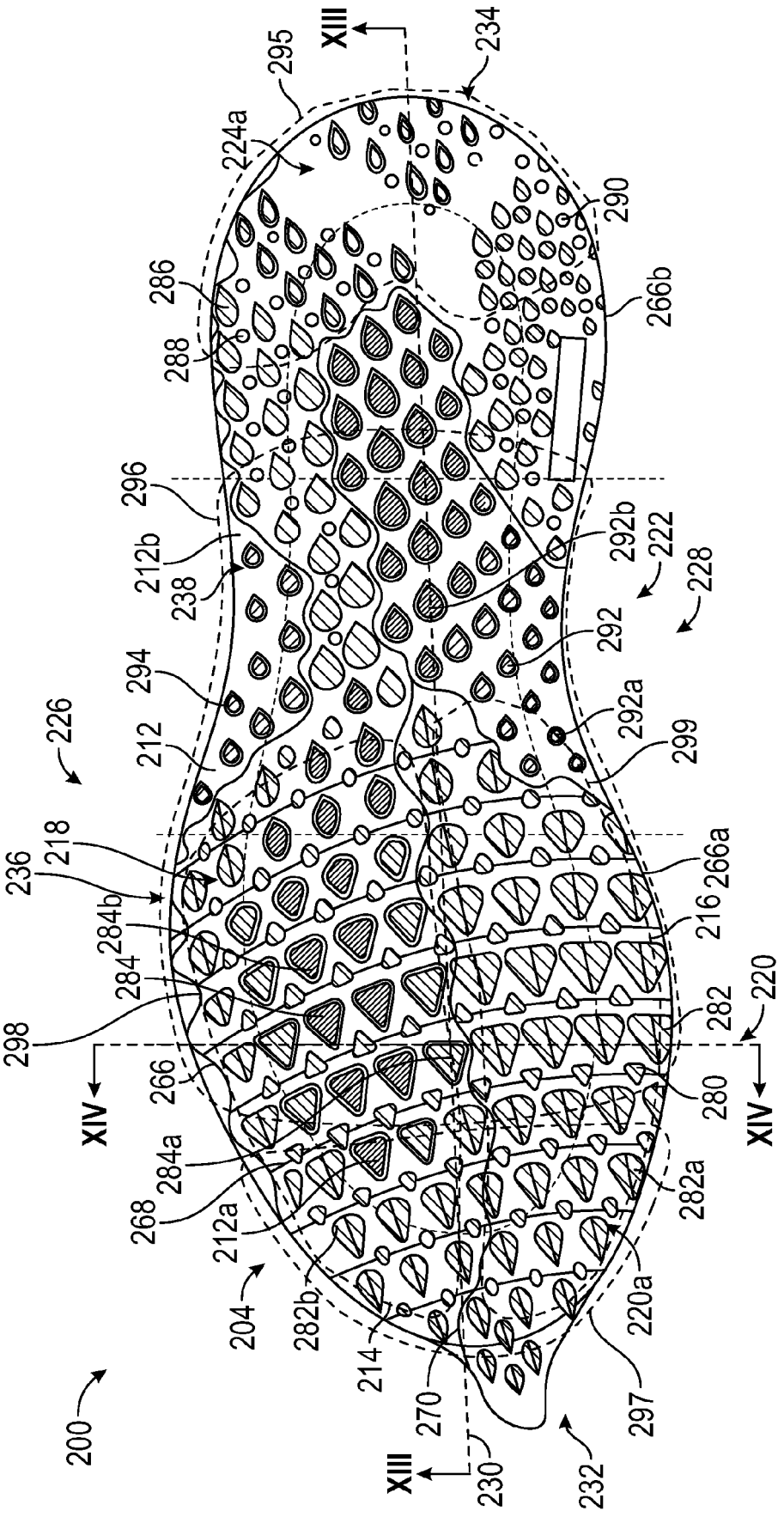
250b
204
234

FIG. 9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XIV
XIV
XIII
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212b
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226
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282
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292b
294
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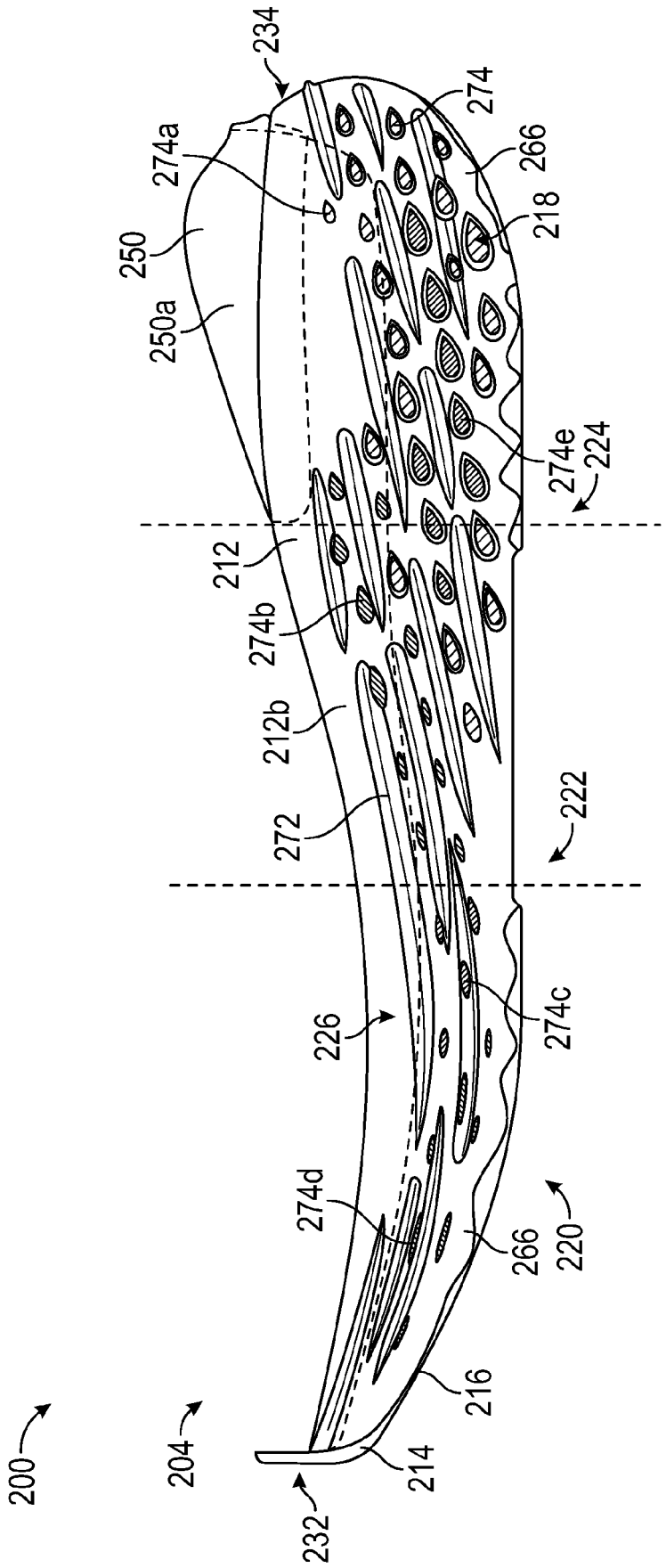
296
297
298
299

FIG. 10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232
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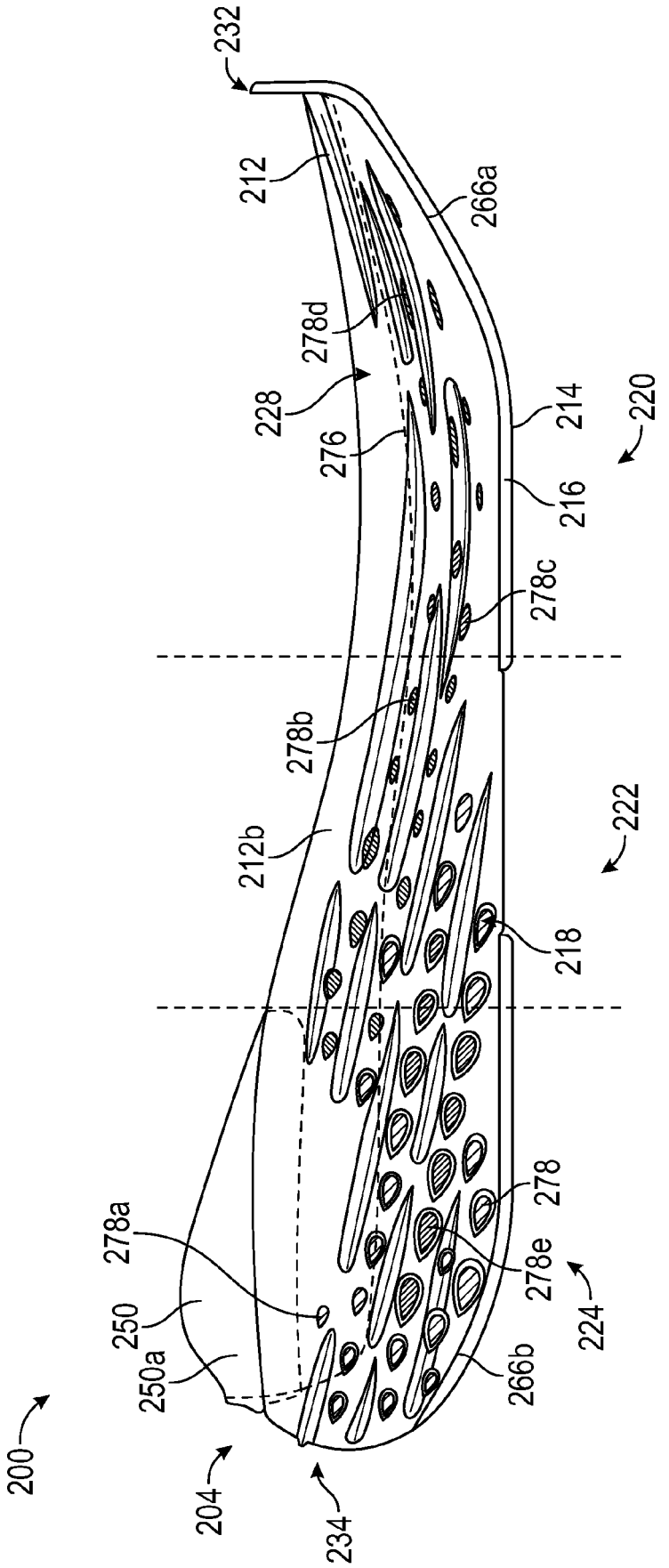
200

FIG. 11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276
214
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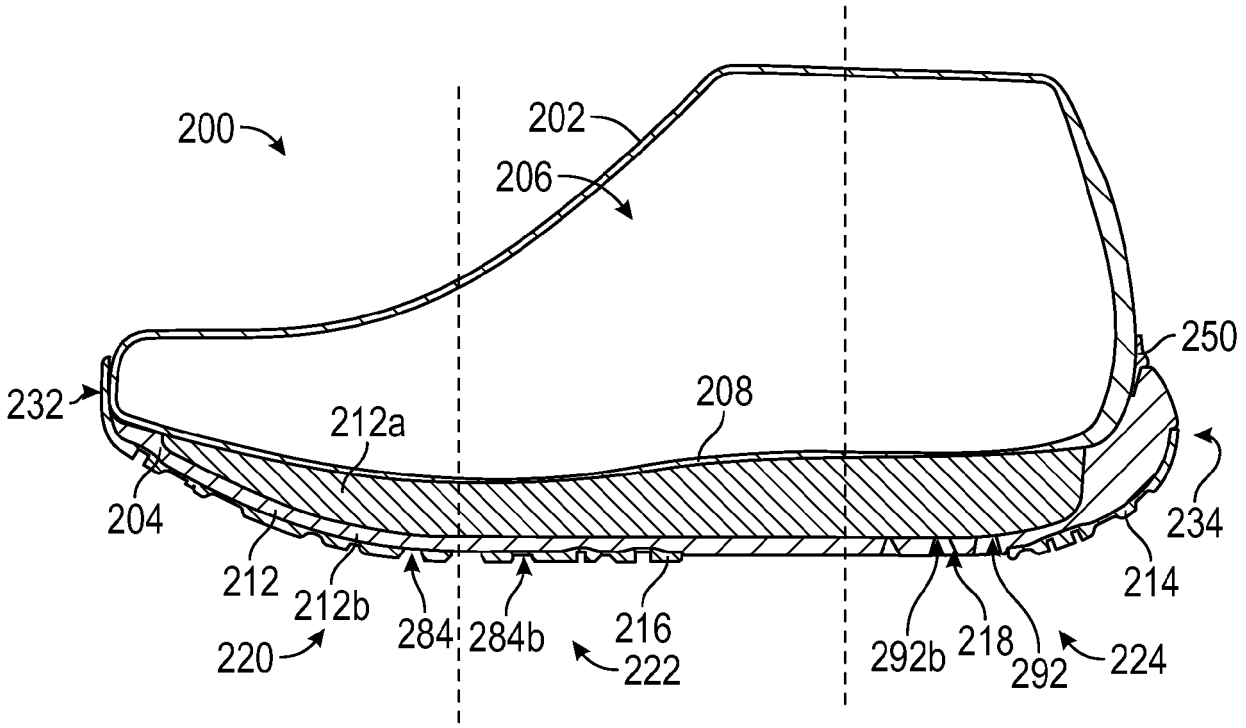
278a
250
250a
278
278e
224
266b
200
204
234

FIG. 12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212b
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218
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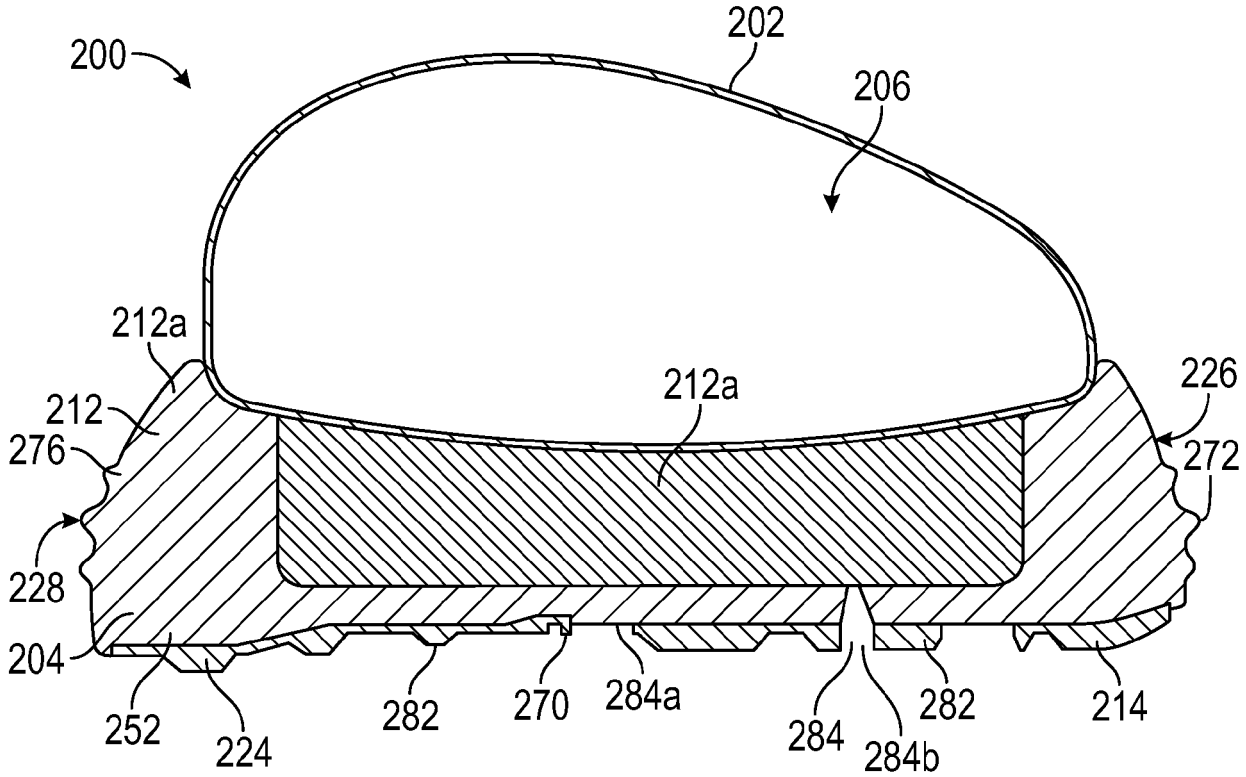
FIG. 13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284b
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214

FIG. 14

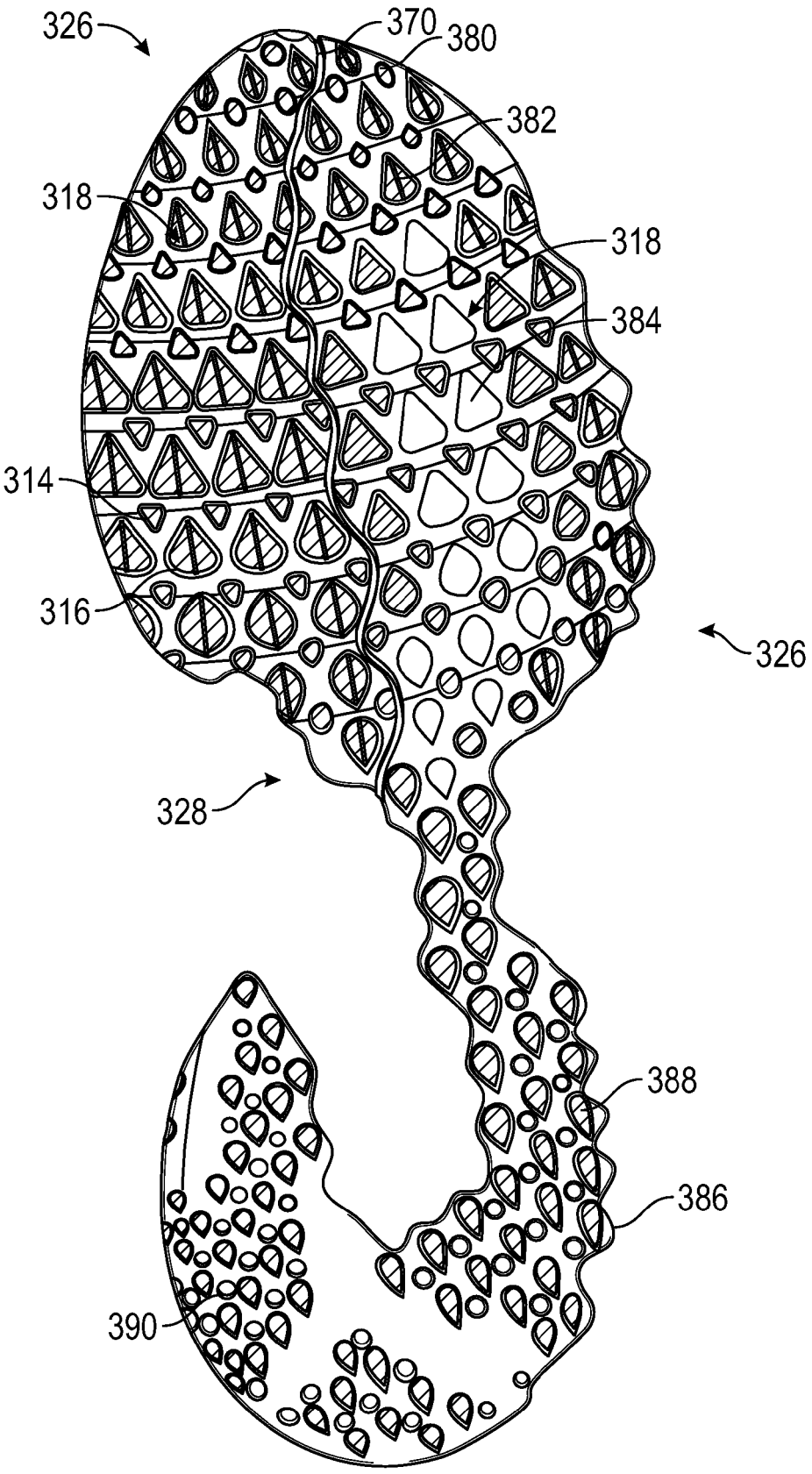
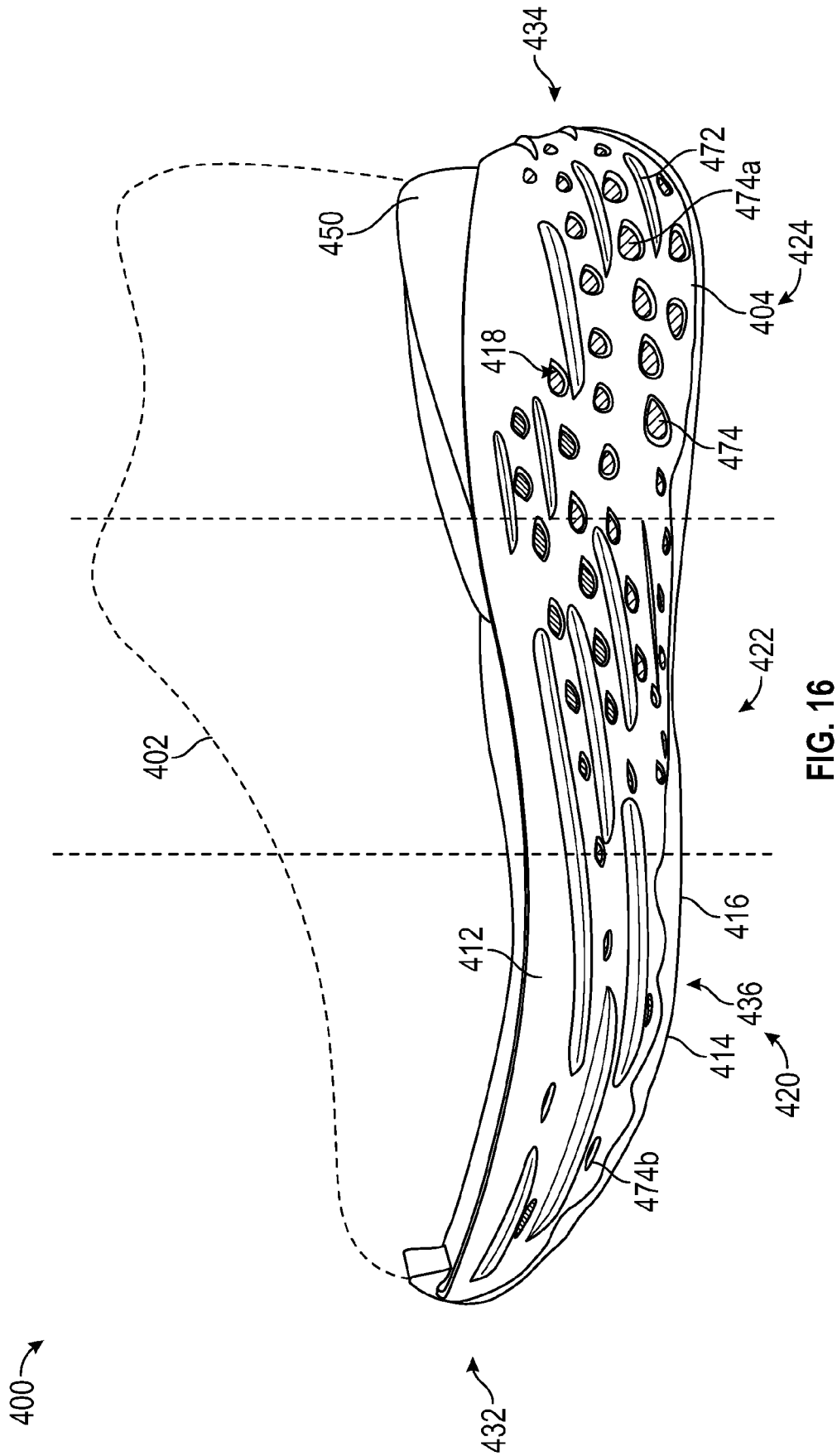


FIG. 15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404
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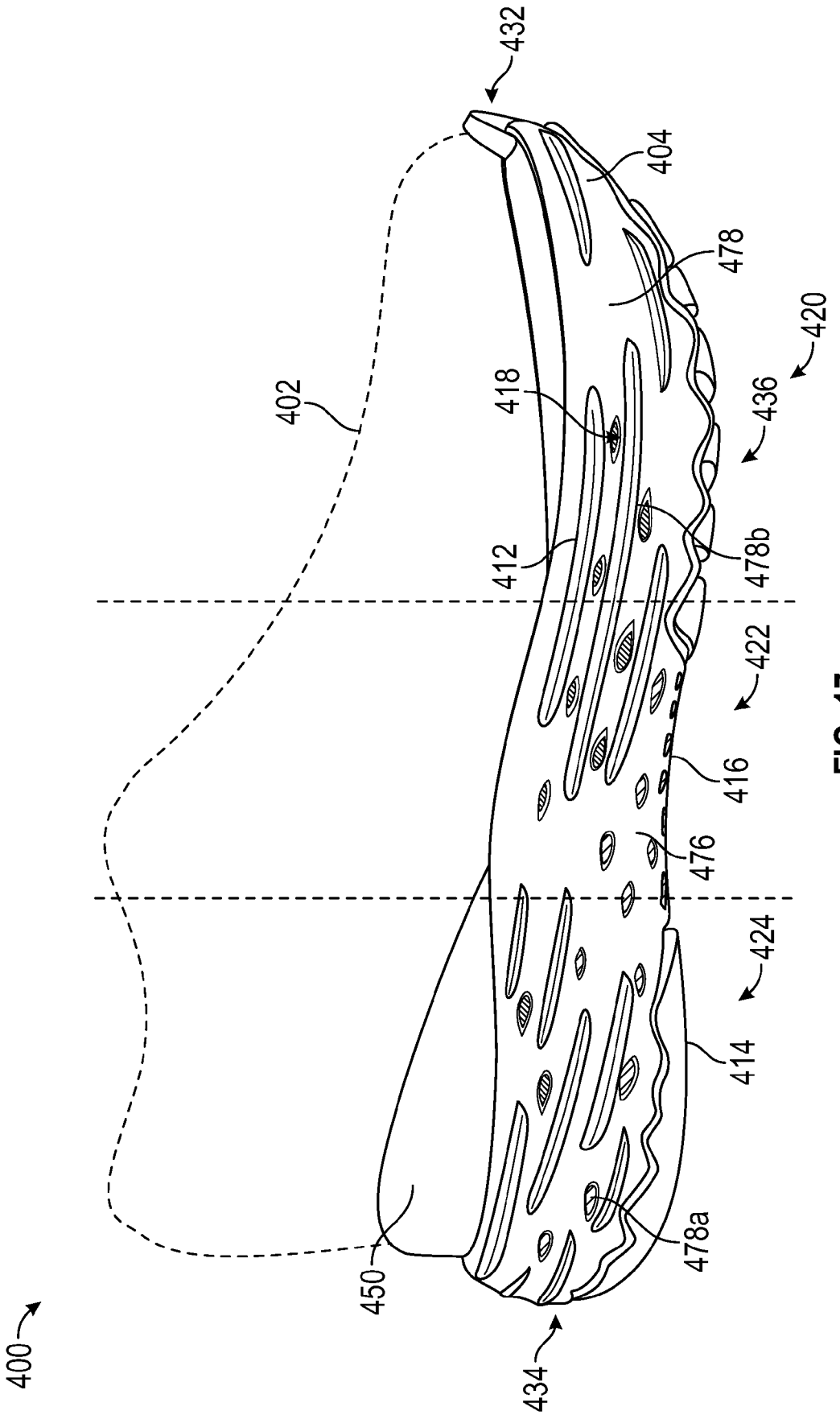
474
422
402
416
412
436
414
420
474b
400
432

FIG. 16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436
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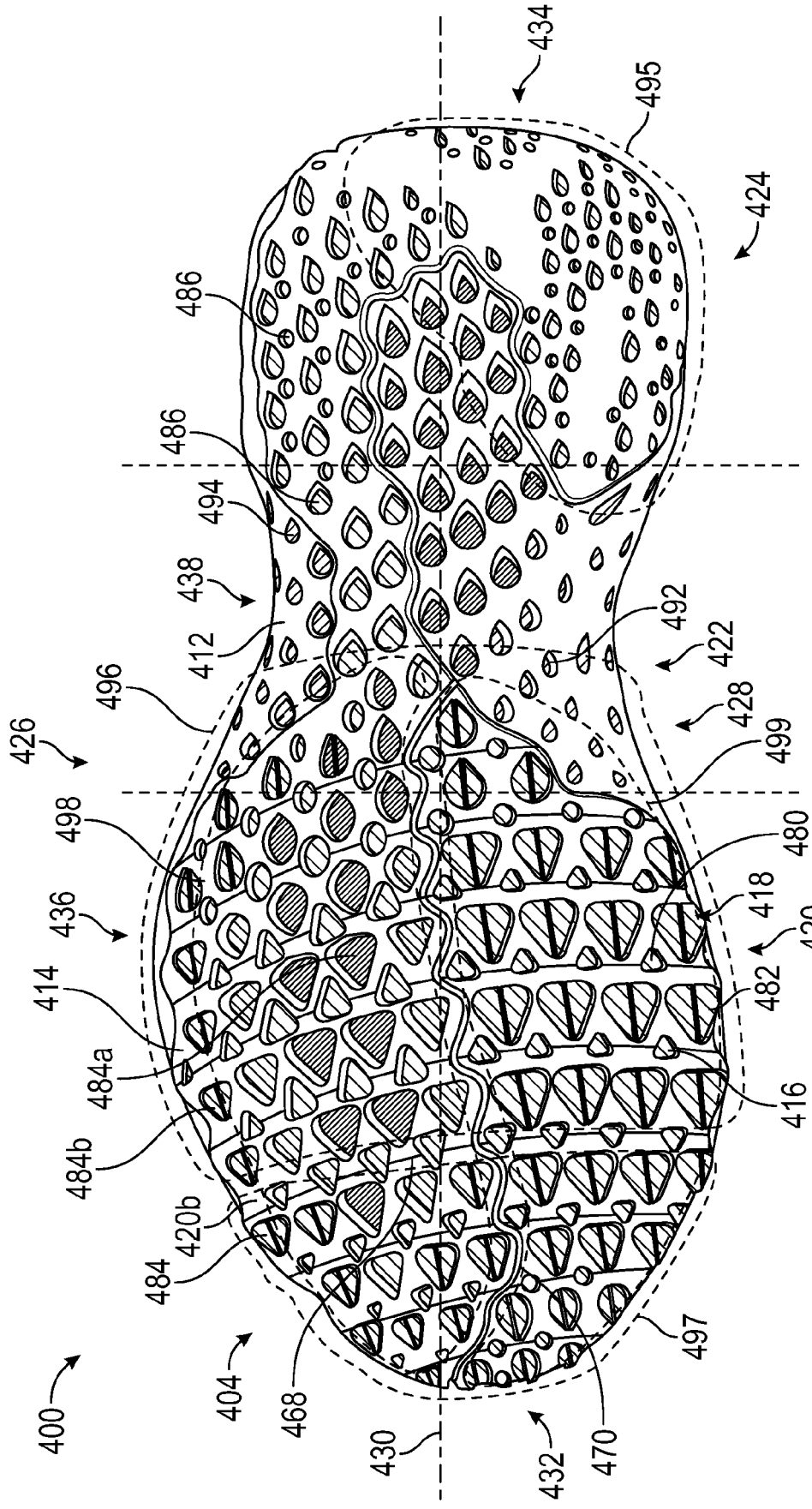
478a
478b

FIG. 17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484a
416
484b
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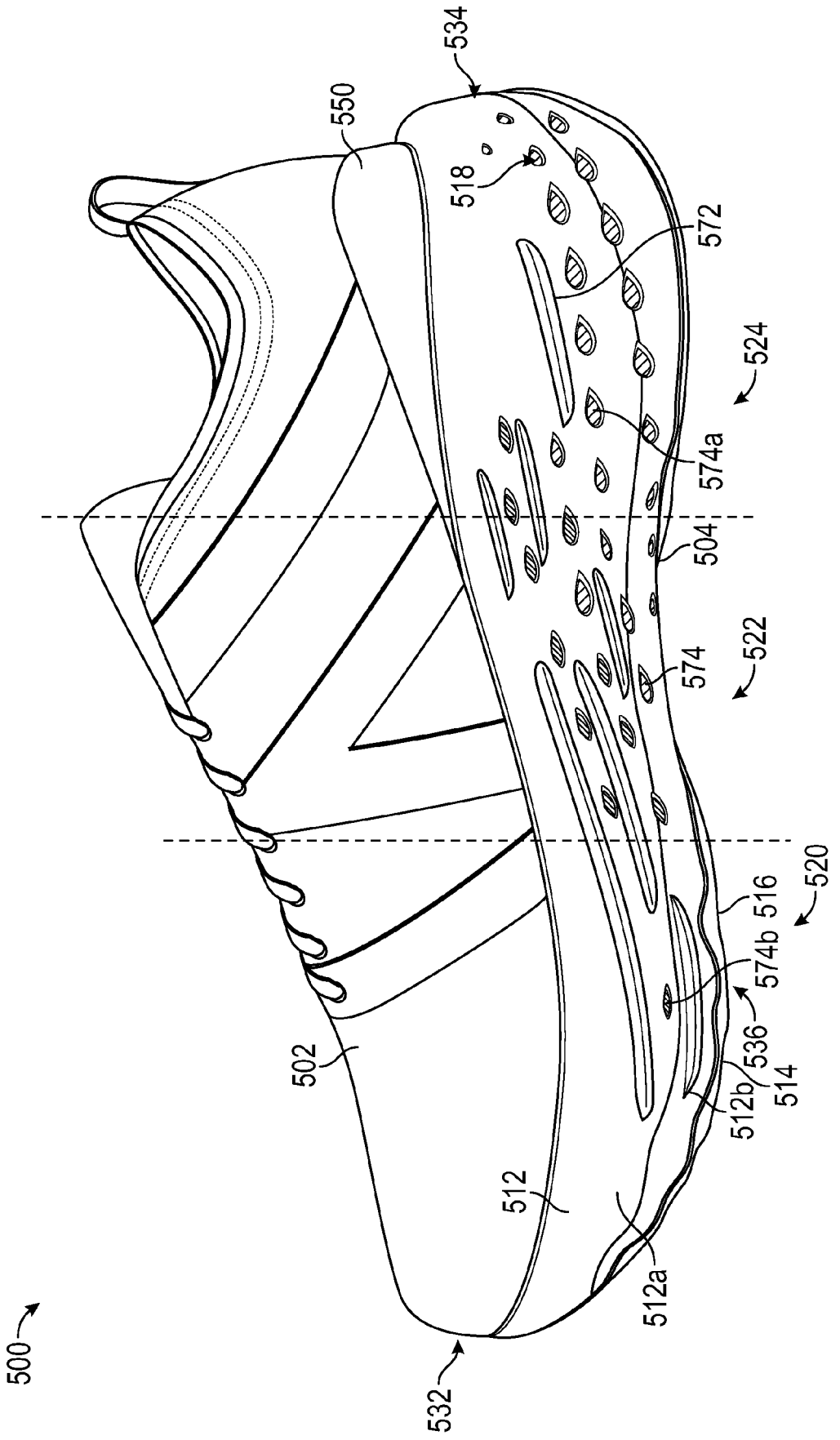
484
497
404
468
400
430
432
470

FIG. 18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574b
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502
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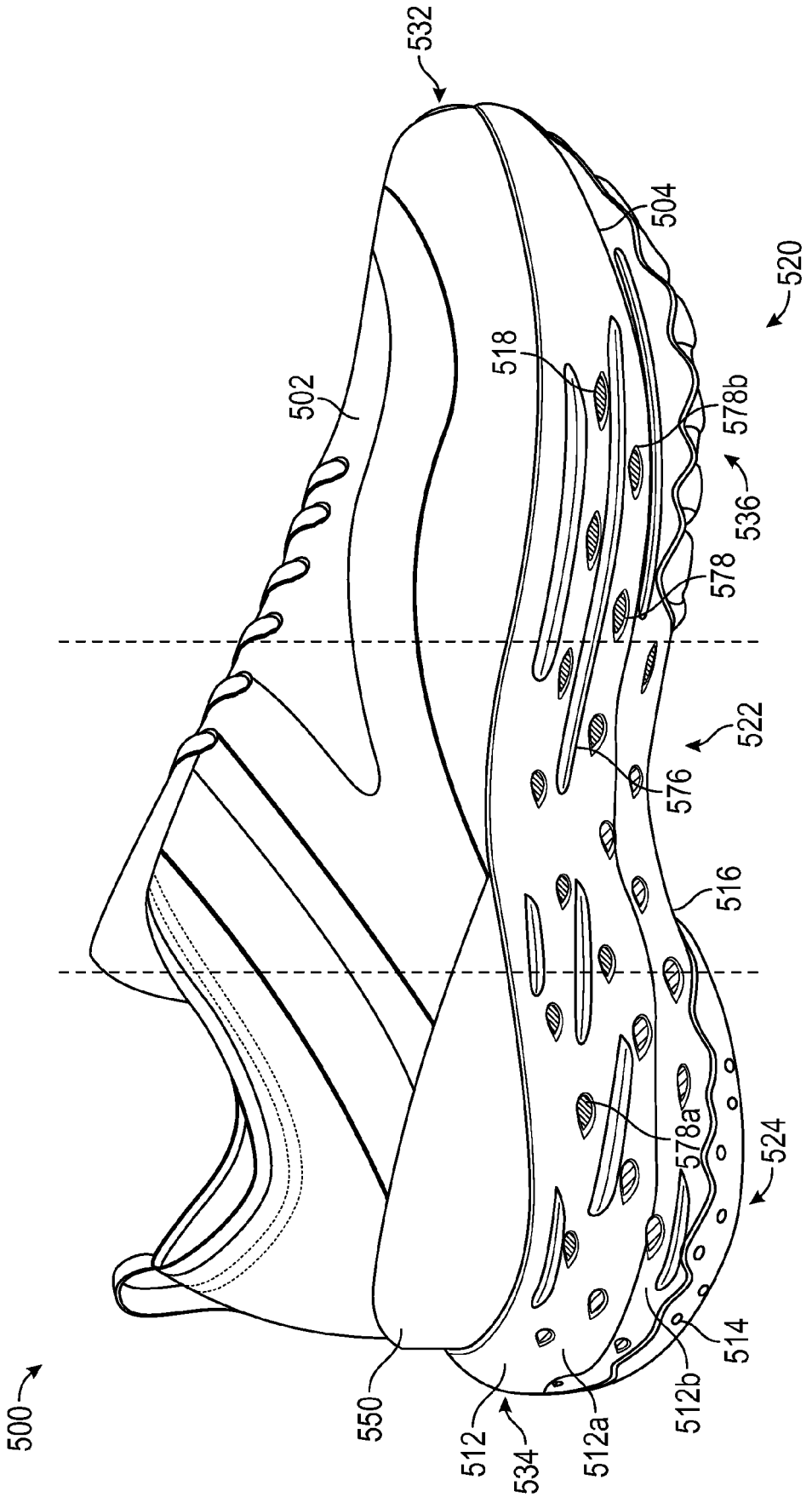
512a
532
500

FIG. 19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578b
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522
576
516
578a
524
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512b
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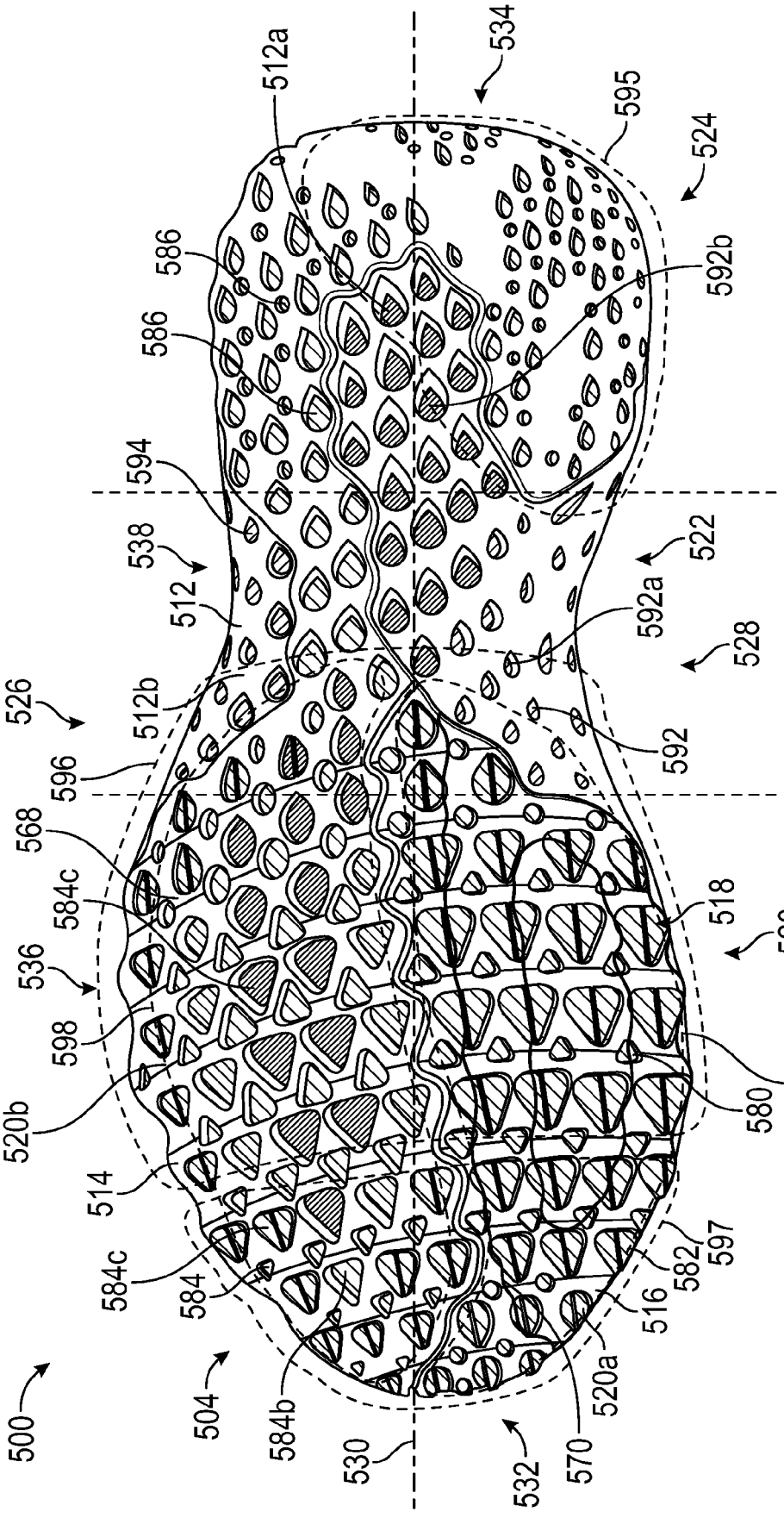
534
512
550
500

FIG. 20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504
512
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526
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538
568
570
580
582
584
584b
584c
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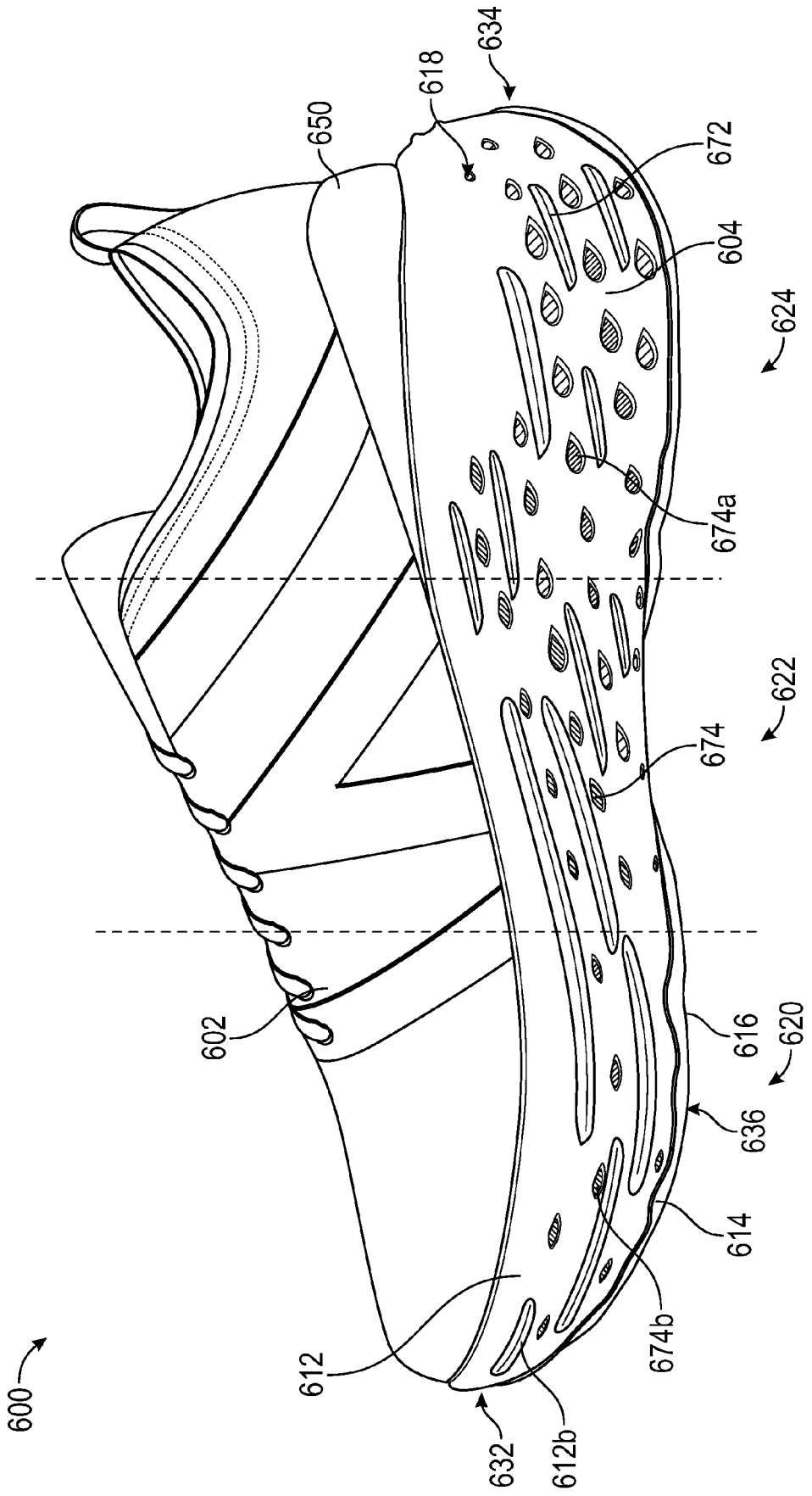
FIG. 21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602
612
612b
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634
618
650
672
604
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674a
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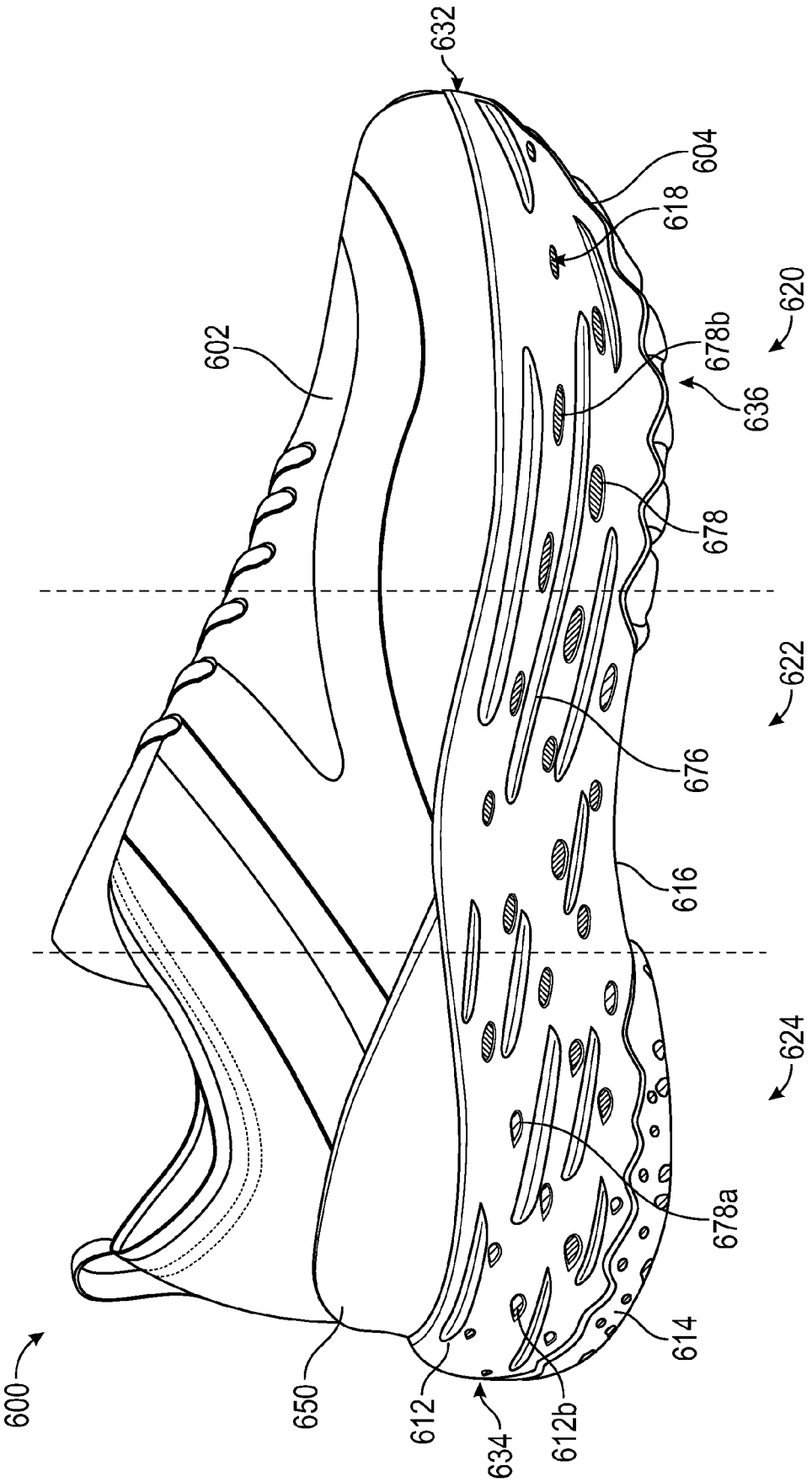
674
616
620
636
614
674b

FIG. 22


632
604
618
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678b
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676
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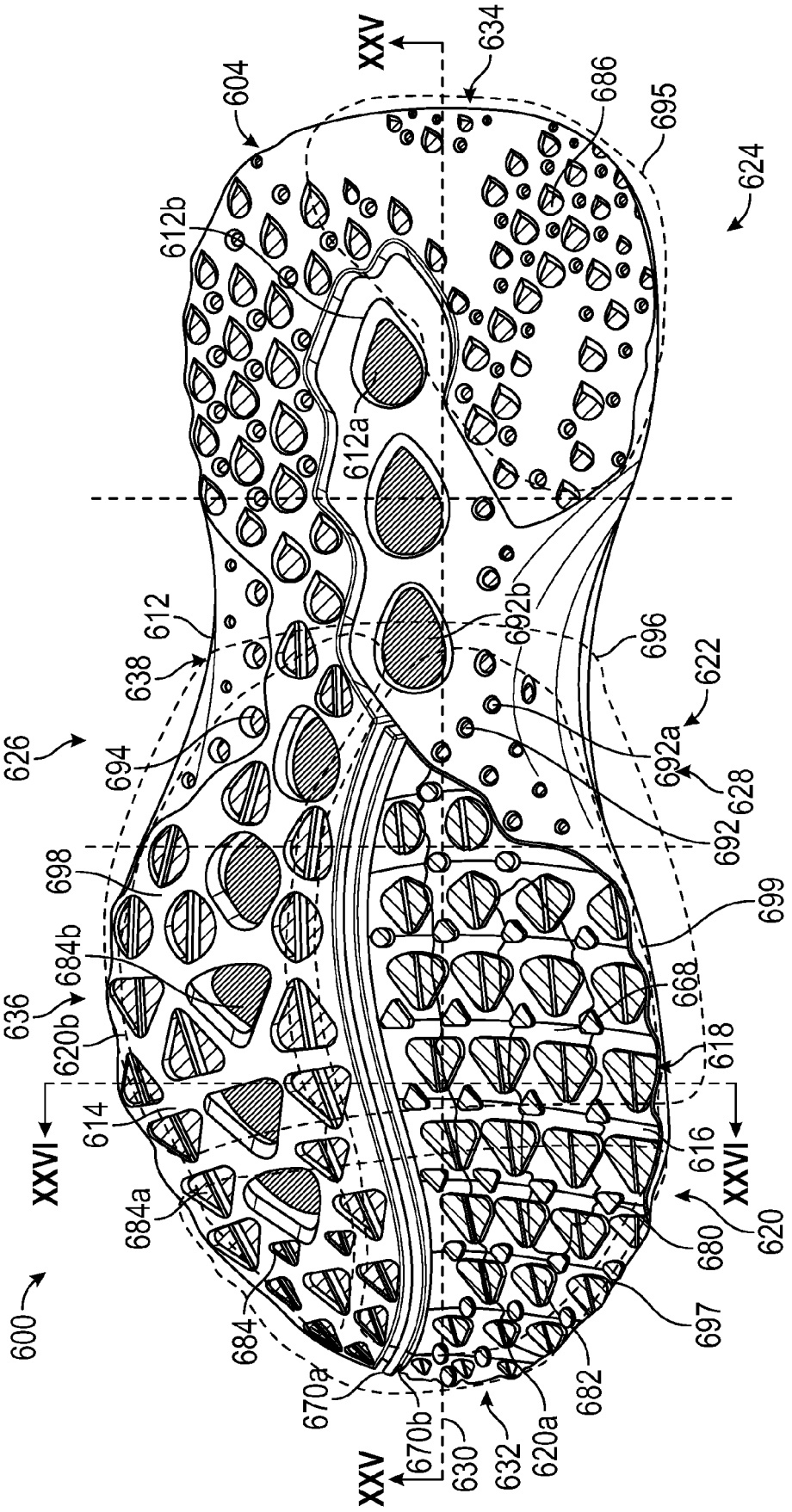
678a
614
600
650
612
634
612b

FIG. 23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684b
668
636
620b
618
614
616
XXVI
XXVI
684a
620
680
600
697
684
682
670a
670b
630
632
620a
XXV

FIG. 24

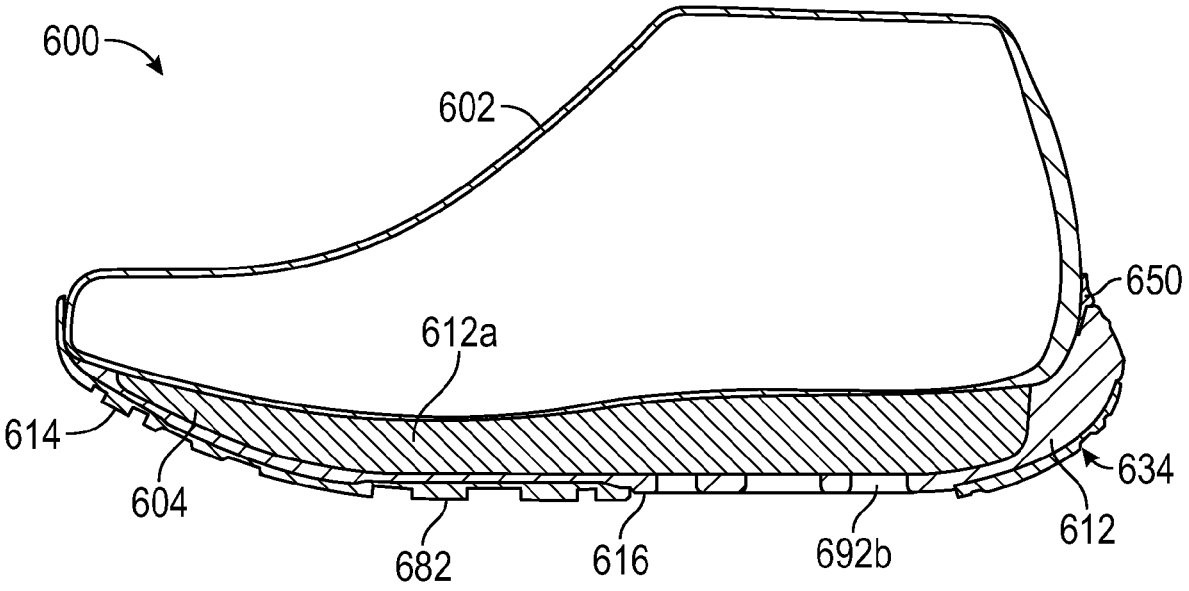
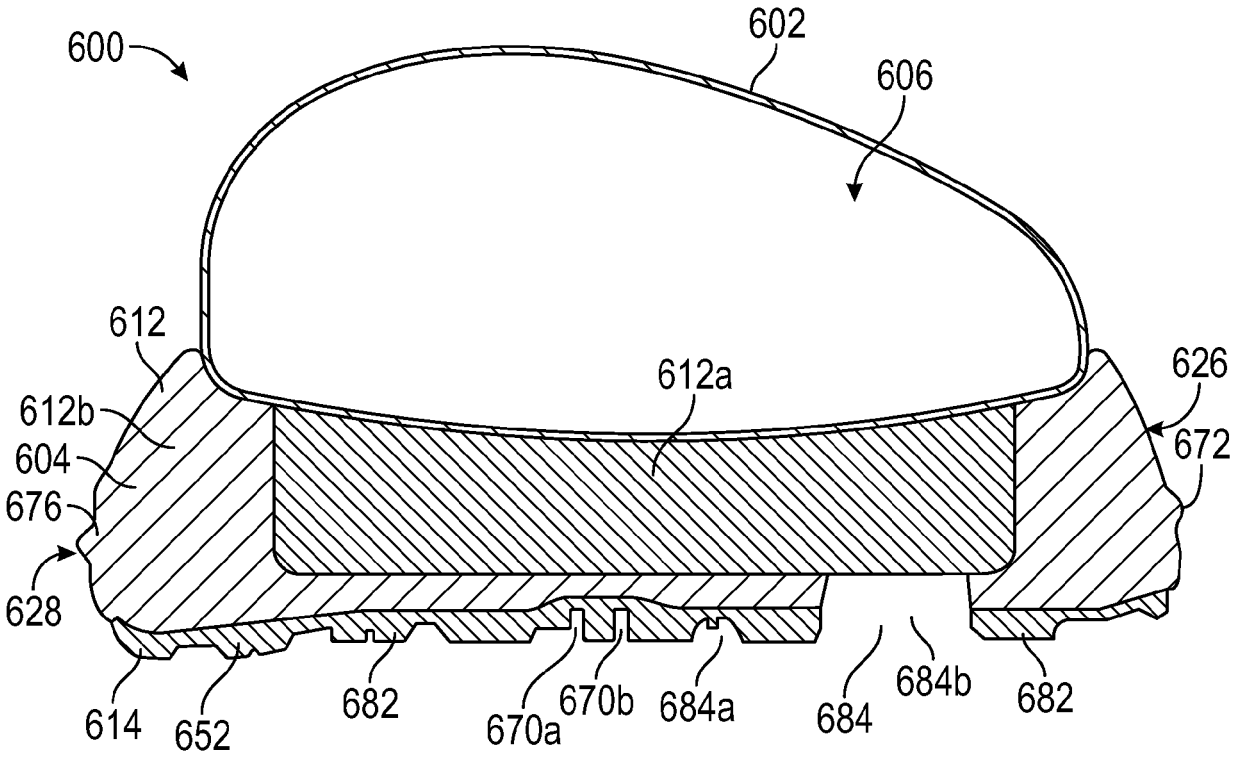

600
602
650
612a
614
604
634
612
682
616
692b

FIG. 25


600
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612a
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612b
672
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676
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670a
670b
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684
684b
682

FIG. 26

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 April 2023	Gkionaki, Angeliki

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