(54) Title: FOOTWEAR SOLE STRUCTURE INCLUDING A SPRING PLATE

(57) Abstract: An article of footwear may include an upper, an outsole, and a spring plate. The spring plate may be located above at least a portion of the outsole and may extend through at least medial forefoot and medial midfoot regions. The spring plate may have an unloaded shape in which a front portion of the spring plate in a forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion. The spring plate may comprise an open central region defined by a surrounding band and may be nondestructively removable from and replaceable into the upper. The article may further include at least one inner sole member shaped to rest securely within a void defined at least in part by the upper. The at least one inner sole member may be compressible in at least first and fifth metatarsophalangeal joint regions.

FIG. 3
FOOTWEAR SOLE STRUCTURE INCLUDING A SPRING PLATE

CROSS-REFERENCE TO RELATED APPLICATION

[01] This application claims priority to U.S. provisional patent application no. 62/1 56,644, titled "Footwear Sole Structure Including a Spring Plate" and filed May 4, 2015. Application no. 62/1 56,644, in its entirety, is incorporated by reference herein.

BACKGROUND

[02] Conventional articles of footwear generally include an upper and a sole structure. The upper provides a covering for the foot and securely positions the foot relative to the sole structure. The sole structure is secured to a lower portion of the upper and is configured so as to be positioned between the foot and the ground when a wearer is standing, walking or running.

[03] As a result of ground contact during walking and running, the metatarsophalangeal joints in a person's foot undergo an extension controlled by the joint flexor muscle-tendon units. Associated with this controlled extension is mechanical energy expenditure at the joint. In conventional footwear, little to none of this mechanical energy is recovered to contribute back to ongoing movement. Reducing this energy expenditure and/or improving the energy recovery can potentially improve locomotion efficiency and elicit a new sensation to a person who is walking or running. There have been previous efforts to include features in sole structures to help improve energy recovery at the metatarsophalangeal joint. However, known attempts in this regard have not addressed certain problems and/or have otherwise left substantial room for improvement.
SUMMARY

[04] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the invention.

[05] In some embodiments, an article of footwear may include an upper, an outsole, an inner sole member, and a spring plate. The inner sole member may be shaped to rest securely within a void defined at least in part by the upper. A portion of the void above a top surface of the inner sole member may be sized to accommodate a wearer foot. The inner sole member may be compressible in at least first and fifth metatarsophalangeal joint regions. The spring plate may be positioned between at least a portion of the inner sole member and at least a portion of the outsole. The spring plate may extend through at least medial forefoot and medial midfoot regions and may have an unloaded shape in which a front portion of the spring plate in the forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion.

[06] In some embodiments, an article of footwear may include an upper, an outsole, and a spring plate. The spring plate may be positioned above at least a portion of the outsole. The spring plate may extend through at least medial forefoot and medial midfoot regions and may have an unloaded shape in which a front portion of the spring plate in the forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion. The spring plate may comprise an open region defined by a surrounding band.

[07] In some embodiments, an article of footwear may include an upper, an outsole, and a spring plate positioned above at least a portion of the outsole. The spring plate may extend through at least medial forefoot and medial midfoot regions and may have an unloaded shape in which a front portion of the spring plate in the forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion.
located rearward of the front portion. The spring plate may be nondestructively removable from and replaceable into the upper.

[08] Additional embodiments are described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[09] Some embodiments are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to similar elements.

[10] FIG. 1A is a diagram showing bones in a human right foot from a top (dorsal) view.

[11] FIG. 1B is a diagram showing bones of a human right foot from a medial side view.

[12] FIG. 2 is a medial side view of a shoe according to some embodiments.

[13] FIG. 3 is a partially schematic cross-sectional diagram showing the internal components of the shoe of FIG. 2, together with a wearer foot.

[14] FIG. 4A is a medial side view of the spring plate from the shoe of FIG. 2.

[15] FIGS. 4B through 4F are respective top, front, lateral side, bottom, and rear views of the spring plate from the shoe of FIG. 2.

[16] FIGS. 4G and 4H are respective front medial perspective and rear medial perspective views of the spring plate from the shoe of FIG. 2.

[17] FIG. 5 is a partially schematic medial side view of a spring plate similar to FIG. 4A.

[18] FIG. 6 is a lateral side view of a shoe according to some additional embodiments.

- 3 -
[19] FIG. 7 is a bottom view of the shoe of FIG. 6.

[20] FIG. 8 is an exploded, partially schematic lateral side view of the shoe of FIG. 6.

[21] FIG. 9 is another bottom view of the shoe of FIG. 6.

[22] FIGS. 10A through 10C are bottom views of a shoe according to some further embodiments.

DETAILED DESCRIPTION

[23] In at least some embodiments, an article of footwear may include an upper, an outsole, and a spring plate. The spring plate may be located above at least a portion of the outsole and may extend through at least medial forefoot and medial midfoot regions. The spring plate may have an unloaded shape in which a front portion of the spring plate in a forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion. The spring plate may comprise an open central region defined by a surrounding band and may be nondestructively removable from and replaceable into the upper.

[24] In at least some embodiments, an article of footwear may include an upper, an outsole, and a spring plate. The article may further include at least one inner sole member shaped to rest securely within a void defined at least in part by the upper. A portion of the void above a top surface of the at least one inner sole member may be sized to accommodate a wearer foot, and the at least one inner sole member may be compressible in at least first and fifth metatarsophalangeal joint regions.

[25] Additional embodiments are described herein.

[26] To assist and clarify subsequent description of various embodiments, various terms are defined herein. Unless context indicates otherwise, the following definitions apply throughout this specification (including the example embodiments included in the list of example embodiments attached hereto). "Shoe" and "article of
footwear” are used interchangeably to refer to an article intended for wear on a human foot. A shoe may or may not enclose the entire foot of a wearer. For example, a shoe could include a sandal or other article that exposes large portions of a wearing foot. The “interior” of a shoe refers to space that is occupied by a wearer's foot when the shoe is worn. An interior side, surface, face, or other aspect of a shoe component refers to a side, surface, face, or other aspect of that component that is (or will be) oriented toward the shoe interior in a completed shoe. An exterior side, surface, face, or other aspect of a component refers to a side, surface, face or other aspect of that component that is (or will be) oriented away from the shoe interior in the completed shoe. In some cases, the interior side, surface, face, or other aspect of a component may have other elements between that interior side, surface, face or other aspect and the interior in the completed shoe. Similarly, an exterior side, surface, face or other aspect of a component may have other elements between that exterior side, surface, face or other aspect and the space external to the completed shoe.

[27] Shoe elements can be described based on regions and/or anatomical structures of a human foot wearing that shoe, and by assuming that the interior of the shoe generally conforms to and is otherwise properly sized for the wearing foot. FIG. 1A shows outlines of bones in a human right foot 1 from a dorsal, or top, view. Those bones are the first distal phalanx 2, the first proximal phalanx 3, the first metatarsal 4, the second distal phalanx 5, the second middle phalanx 6, the second proximal phalanx 7, the second metatarsal 8, the third distal phalanx 9, the third middle phalanx 10, the third proximal phalanx 11, the third metatarsal 12, the fourth distal phalanx 13, the fourth middle phalanx 14, the fourth proximal phalanx 15, the fourth metatarsal 16, the fifth distal phalanx 17, the fifth middle phalanx 18, the fifth proximal phalanx 19, the fifth metatarsal 20, the medial cuneiform 21, the intermediate cuneiform 22, the lateral cuneiform 23, the navicular 24, the cuboid 25, the talus 26, and the calcaneus 27. FIG. 1B is a medial side view of bones in foot 1. Also shown in FIG. 1B are portions of the two lower leg bones: the tibia 28 and the fibula 29. These lower leg bones are movably attached to the talus 26. The exact
shape and size of the bones in a foot will vary from individual to individual, and FIGS. 1A and 1B are merely intended as convenient general references.

[28] A forefoot region of a foot includes the heads and bodies of the metatarsals 4, 8, 12, 16, and 20, as well as the phalanges 2, 3, 5-7, 9-1 1, 13-15, and 17-19. A forefoot element of a shoe is an element having one or more portions located under, over, to the lateral and/or medial side of, and/or in front of a wearer's forefoot (or portion thereof) when the shoe is worn. A midfoot region of a foot includes the cuboid 25, navicular 24, and cuneiforms 21-23, as well as the bases of the metatarsals 4, 8, 12, 16, and 20. A midfoot element of a shoe is an element having one or more portions located under, over, and/or to the lateral and/or medial side of a wearer's midfoot (or portion thereof) when the shoe is worn. A hindfoot (or heel) region of a foot includes the talus 26 and calcaneus 27. A hindfoot (or heel) element of a shoe is an element having one or more portions located under, to the lateral and/or medial side of, and/or behind a wearer's hindfoot (or portion thereof) when the shoe is worn. The forefoot region may overlap with the midfoot region, as may the midfoot and hindfoot regions.

[29] Unless indicated otherwise, a longitudinal axis refers to a horizontal heel-toe axis along the center of the foot that is roughly parallel to a line along the second metatarsal and second phalanges. A transverse axis refers to a horizontal axis across the foot that is generally perpendicular to a longitudinal axis. A longitudinal direction is generally parallel to a longitudinal axis. A transverse direction is generally parallel to a transverse axis.

[30] The metatarsophalangeal joints of a human foot are the joints between the metatarsal heads and the proximal phalanges. A first metatarsophalangeal joint 31 connects the first proximal phalanx 3 and the head of first metatarsal 4. A second metatarsophalangeal joint 32 connects the second proximal phalanx 7 and the head of second metatarsal 8. A third metatarsophalangeal joint 33 connects the third proximal phalanx 11 and the head of third metatarsal 12. A fourth metatarsophalangeal joint 34 connects the fourth proximal phalanx 15 and the head
of fourth metatarsal 16. A fifth metatarsophalangeal joint 35 connects the fifth proximal phalanx 19 and the head of fifth metatarsal 20.

[31] The metatarsophalangeal joints allow the toes to flex, i.e., to curl downward towards the bottom of the foot. The metatarsophalangeal joints also allow the toes to extend, i.e., bend upward toward the top of the foot. This is indicated in FIG. 1B, a medial side view of bones in foot 1. Phalanx 3 of the foot 1 big toe rotates upward about the head of first metatarsal 4 during extension, and rotates downward about the head of first metatarsal 4 during flexion. The other toes rotate about their corresponding metatarsal heads at the other metatarsophalangeal joints 32-35.

[32] As is generally known in the art, the second half of the stance phase is the portion of the gait cycle during which the leg moves from a flat footed position to a lifted heel position, and continues through pushing off with the toes. Throughout the second half of the stance phase, the metatarsophalangeal joints undergo extension as the foot rolls from heel to toe. To counteract the extension moment caused by the external ground reaction force during this foot roll, foot and lower leg muscles apply force to create a flexion moment about the metatarsophalangeal joints. As a result, negative joint mechanical work is performed as those muscle-tendon units apply force to control extension. Only a small portion of this energy is recovered at the very end of the foot contact with the ground. In effect, the metatarsophalangeal joints and their associated muscles act as energy absorbers that return very little of the joint mechanical energy expended during the gait cycle.

[33] In at least some embodiments, an article of footwear includes a downwardly bent spring plate that stores a large amount of energy and returns energy during the second half of the stance phase. This helps to change the metatarsophalangeal joints from energy absorbers to spring-like joints. As weight is increasingly shifted to the forefoot as the foot rolls forward, potential energy from body mass is stored in the spring plate as the spring plate changes from a bent to a more flat configuration. As the foot continues to roll forward and the heel lifts off the ground, the metatarsophalangeal joints begin to extend and additional energy is stored as the
spring plate bends further upward. By the time that the runner nears the toe-off portion of the gait cycle, substantial energy has been stored in the spring plate. This energy is released back to the runner as the runner toes off at the end of the second half of the stance phase.

[34] FIG. 2 is a medial side view of a shoe 100 according to at least some embodiments. The lateral side of shoe 100 has a similar configuration and appearance, but is configured to correspond to a lateral side of a wearer foot. Shoe 100 is configured for wear on a right foot and is part of a pair that includes a shoe (not shown) that is a mirror image of shoe 100 and is configured for wear on a left foot.

[35] Shoe 100 includes an upper 101 configured to surround and retain the foot of a shoe 100 wearer. In the embodiment of shoe 100, upper 101 may comprise a textile panel 102 that has been knit as a single element. In other embodiments, an upper may include multiple panels and/or be formed from other materials and/or using other manufacturing techniques. Although not visible in FIG. 2, a lasting element (e.g., a Strobel) is stitched, bonded or otherwise attached to the lower edge of panel 102 and generally extends the entire length and width of upper 101. An interior face of the lasting element and an interior face of panel 102 form a void of shoe 100 that receives a wearer foot and other components described below.

[36] Panel 102 of upper 101 incorporates tensile elements 103. Tensile elements 103 are shown with broken lines to indicate that they may be incorporated into or otherwise contained within the textile material of panel 102. Tensile elements 103 may be substantially inextensible. With lace 104, tensile elements 103 help to hold the sole structure elements of shoe 100 in contact with the wearer’s foot. In particular, lower ends of elements 103 may be connected to the lasting element at the boundary between that lasting element and the lower edge of panel 102. Upper ends of elements 103 may terminate in loops 105 that form eyes for lace 104. Lace 104 may be cinched to tightly secure that lasting element, together with sole and upper components attached thereto, to the wearer foot. In some embodiments,
upper 100 may lack a tongue or an opening between eyelets 105 on medial and lateral sides, although in other embodiments a conventional tongue and tongue opening may be present. Upper 101 may optionally include a bootie and/or other type of liner.

[37] Upper 101 includes an ankle collar 110 that completely surrounds a wearer foot at or above ankle level. An opening 111 in ankle collar 110 allows a wearer to insert a foot into the interior of shoe 100. Ankle collar 110 may include eyes or loops (not shown) through which lace 104 passes. In this manner, cinching of lace 104 also secures ankle collar 110 about the wearer ankle. As explained in more detail below, securing of ankle collar 110 in this manner helps to hold hindfoot portions of the shoe 100 sole structure against the wearer heel.

[38] In some embodiments, upper 101 may be an upper as described in U.S. patent application publication no. 2014/0137433, titled "Footwear Upper Incorporating A Knitted Component With Collar And Throat Portions" and incorporated by reference herein. In shoes according to other embodiments, however, an upper may take other forms.

[39] The sole structure of shoe 100 includes an outsole 114, as well as internal elements described below in connection with FIG. 3. Outsole 114 is highly flexible and may be formed from synthetic rubber having a hardness and other properties similar to those of synthetic rubber compounds conventionally used for footwear outsoles. Outsole 114 may also include lugs or other external elements to increase traction. As indicated above, upper 101 includes a lasting element that is attached to the lower edge of panel 102. An exterior face of that lasting element is bonded directly to outsole 114.

[40] In some embodiments, outsole 114 may be an outsole such as is described in U.S. patent application publication no. 2014/0150297, titled "Article of Footwear" and incorporated by reference herein. In shoes according to other embodiments, however, an outsole may take other forms.
FIG. 3 is a partially schematic cross-sectional diagram showing internal components of shoe 100, as well as a wearer foot 1. In FIG. 3, upper 101 is shown in large broken lines and lasting element 120 is shown in smaller broken lines. The void 121 of shoe 100 formed by upper 101 and lasting element 120 is sized to accommodate foot 1, which shoe 100 is sized to fit, as well as other components of the shoe 100 sole structure. Those additional sole structure components include inner sole member 122 and spring plate 123. FIG. 3 includes small gaps between inner sole member 122 and spring plate 123, between spring plate 123 and lasting element 120, and between lasting element 120 and outsole 114. These gaps are only included for purposes of explanation so as to clearly indicate different features. In an actual shoe such as shoe 100, the bottom surface of inner sole member 122 may be in direct contact with the top surface of spring plate 123, the bottom surface of spring plate 123 may be in direct contact with the top surface of lasting element 120, and the bottom surface of lasting element 120 may be in direct contact with the top surface of outsole 114.

Inner sole member 122 is configured to cushion and support wearer foot 1. To provide support, a top surface of inner sole member 122 may be generally contoured to conform to the plantar surface of foot 1. Such contouring may include, e.g., a raised medial midfoot portion to provide arch support. Inner sole member 122 is compressible in at least metatarsophalangeal joint regions so as to cushion foot 1 during flattening of spring plate 123. To provide cushioning, some or all of inner sole member 122 may be formed from one or more closed cell polymer foams and/or other type(s) compressible materials. Inner sole member 122 has a peripheral shape that generally corresponds to that of a wearer foot, and is sized to snugly fit within upper 101. In particular, and when shoe 100 is assembled, the sides of inner sole member 122 are in contact with the inner surface of upper 101 (or of a liner of upper 101, if a separate bootie or other liner is included).

In at least some embodiments, inner sole member 122 is a removable foam midsole formed from ethylene vinyl acetate (EVA) and/or other polymer foam.
material. In some embodiments, inner sole member 122 may be formed from foam materials such as those used in the LUNAR family of footwear products available from NIKE, Inc. of Beaverton, Oregon. Additional examples of foam materials that can be used for inner sole member 122 include materials described in U.S. Patent 7,941,938, which patent is incorporated by reference herein, TPU (thermoplastic polyurethane) foams, and PU (polyurethane) foams. In some embodiments, inner sole member 123 is a removable foam midsole such as that described in U.S. patent application publication no. 2014/0150297. In shoes according to other embodiments, however, an inner sole member may take other forms.

[44] Inner sole member 122 is flexible and allows foot 1 to move naturally. In particular, inner sole member 122 allows the toes of foot 1 to flex and extend without imposing significant resistance. One or more transverse sipes 124 may extend across inner sole member 122 from the medial to the lateral side so as to allow unrestricted toe extension. Additional sipes, not shown, may also extend in transverse and longitudinal directions.

[45] Spring plate 123 is situated between inner sole member 122 and lasting element 120. In the embodiment of shoe 1 and in at least some other embodiments, spring plate 123 is also removable and replaceable. FIG. 3 shows spring plate 123 in an unloaded condition. In particular, the weight of the wearer has not been placed on foot 1, and no flattening of spring plate 123 has occurred. In the embodiment of shoe 100, spring plate 123 extends the full length of shoe 100 and has an unloaded shape in which forefoot portions of spring plate 123 are downwardly bent. As also seen in FIG. 3, the contour of spring plate 123 is generally flat in locations forward of the downward bend and in locations rearward of the downward bend.

[46] FIGS. 4A through 4H show spring plate 123 removed from shoe 100 and in an unloaded condition. FIG. 4A is a medial side view of spring plate 123. FIG. 4B is a top view of spring plate 123. FIG. 4C is a front view of spring plate 123. FIG. 4D is a lateral side view of spring plate 123. FIG. 4E is a bottom view of spring plate 123. FIG. 4F is a rear view of spring plate 123. FIG. 4G is a rear perspective view of
spring plate 123 from the medial side. FIG. 4H is a front perspective view of spring plate 123 from the medial side.

[47] Spring plate 123 has a continuous band 131 that defines an open center region 132. In some embodiments, and as discussed more fully below, band 131 may be formed from an epoxy and carbon fiber composite material. A peripheral edge of band 131 has a shape generally corresponding to that of the lower part of void 121 and to the bottom surface of inner sole member 122. The peripheral edge of band 131 is sized so as to contact upper 101 (and/or a bootie or other liner, if present) and/or lasting element 120, and so as not to significantly shift in longitudinal or transverse directions when shoe 100 is assembled. Spring plate 123 extends from a rear-most end 133 to a forward-most end 134. Band 131 has a top surface 135 and a bottom surface 136. When shoe 100 is assembled, top surface 135 contacts the bottom surface of inner sole member 122 and bottom surface 136 contacts the top surface of lasting element 120.

[48] In the embodiment of spring plate 123, and for a male size 10 shoe, spring plate 123 has an overall width W of approximately 98 millimeters and an overall length L of approximately 275 millimeters. In that embodiment, width w of band 131 varies from approximately 20 millimeters in hindfoot regions, to approximately 23 millimeters in forward midfoot and rear forefoot regions, to approximately 30 millimeters at front-most end 134. These values are only examples, however, and spring plates according to other embodiments may have overall lengths, overall widths, and/or band widths of different values. Band 131 has a thickness t that is generally constant over all of band 131. As explained in more detail below, values for thickness t may vary based on a target wearer body mass and on materials used for spring plate 131.

[49] As indicated above, a portion 139 of spring plate 123 in the forefoot region bends downward in when spring plate 123 is in an unloaded condition. The downward bend begins at an apex location 137 on the medial side and at an apex location 138 on the lateral side and has an unloaded bend angle a. In the
embodiment of spring plate 123, a has a value of about 20°. As used herein, "about" means ± 5%, with "about 20°" meaning 20° ± 1° (or between 19° and 21°). This value is only an example, however, and spring plates according to other embodiments may have bend angles of different values. In some embodiments, an unloaded bend angle may be about 10°, about 11°, about 12°, about 13°, about 14°, about 15°, about 16°, about 17°, about 18°, about 19°, about 21°, about 22°, about 23°, about 24°, or about 25°.

A bend need not be constant. For example, portion 139 could be curved, with a bend angle measured at a curve tangent increasing toward front-most end 134. In such an embodiment, the bend angle may increase from very small values near the apex locations to larger values near the front-most end.

In at least some embodiments, spring plate 123 is fabricated so as to have a desired stiffness for a particular range of wearer body mass. In embodiments of spring plate 123 having approximate dimensions as indicated above, and in which band 131 is fabricated from an epoxy and carbon fiber composite, the number of carbon fiber layups forming band 131 may be as shown in Table 1.

<table>
<thead>
<tr>
<th>Wearer Body Mass Target Range (kg)</th>
<th>Carbon Fiber Layup Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>40-70</td>
<td>9</td>
</tr>
<tr>
<td>70-100</td>
<td>11-13</td>
</tr>
<tr>
<td>100-130</td>
<td>15-17</td>
</tr>
</tbody>
</table>

As seen in Table 1, a spring plate 123 for use in shoe 100 by heavier wearers will have more layers. Accordingly, a thickness t for such a spring plate 123 may be greater than a thickness t of a spring plate 123 intended for use in shoe 100 by less heavy wearers. In some embodiments, a carbon fiber material used in layup layers of a fabricated spring plate 123 may be a fabric having 3K carbon warp yarn, 3K carbon weave yarn, a dry fabric weight of 204 GSM / 6 oz., 2x2 twill weave style, a
nominal construction warp count of 13/in., and a nominal construction weave count of 13/in.

[53] In some embodiments, a spring plate may have an angular stiffness about the metatarsophalangeal joint axis in the range of between 5 to 100 N·m/rad (Newton-meters per radian). These values may correspond to bending moments about that axis that are required to deflect a spring plate by 25°, which is the approximate angular displacement that an athlete may achieve when running in a shoe that includes a spring plate. This is illustrated in FIG. 5, a partially schematic medial side view of spring plate 123 similar to FIG. 4A. In FIG. 5, the metatarsophalangeal joint axis is aligned with apexes 137 and 138. In some embodiments, apex 137 and/or apex 138 may be slightly in front of or behind the metatarsophalangeal joint axis.

[54] In some embodiments, shoe 100 and spring plate 123 may be sold or otherwise provided separately. In this manner, a wearer can choose a spring plate corresponding to his or her body mass. As indicated above, spring plate 123 and inner sole member 122 may be removable. Accordingly, a purchaser of shoe 100 could easily remove inner sole member 122, remove a first spring plate 123, insert a second spring plate 123 having a desired stiffness, and then reinsert inner sole member 122.

[55] In other embodiments, a spring plate may be formed from other materials. Examples of such other materials include other types of composites, e.g., epoxy-glass composites, polyester-carbon composites, and polyester-glass composites. Additional examples of such other materials include other polymers (with or without added reinforcing material), metals, and combinations thereof.

[56] The apex of the bend in spring plate 123 may be approximately aligned with the metatarsophalangeal joints of the foot of a shoe 100 wearer. Apex location 137 at which the downward bend begins on the medial side may approximately correspond to the portion of first metatarsal 4 just behind the head. Apex location 138 at which the downward bend begins on the lateral side may approximately
correspond to the portion of fifth metatarsal 20 just behind the head. In some embodiments, however, an apex location may be directly under a metatarsophalangeal joint or slightly in front of a metatarsophalangeal joint. In some embodiments, one apex may be under or slightly behind one metatarsophalangeal joint, with another apex under or slightly in front of another metatarsophalangeal joint.

[57] In some embodiments, upper 101 and outsole 114 are configured so as to provide minimal resistance to toe and forefoot bending in either the flexion or extension directions. Outsole 114, for example, may be relatively thin in the forefoot regions and/or may comprise multiple transverse grooves similar to sipes 124 in inner sole member 122. Upper 101 may also be relatively thin and/or may include pleats, elastic regions, or other elements incorporated into forefoot and midfoot regions to permit bending of upper 101. In some embodiments, the combined bending resistance of the upper and other sole structure elements is such that spring plate 123 can deform the assembled shoe, when not worn, to conform to the downward bend of spring plate 123.

[58] When spring plate 123 is flattened as a shoe 100 wearer rolls his or her foot 1 from the heel to the toe, the rear end of spring plate 123 will push downward on the hindfoot region of lasting element 120. If unrestrained, this would tend to pull the hindfoot region of the shoe 100 sole structure away from the wearer’s heel. In some embodiments, hindfoot regions of upper 101 between ankle collar 110 and lasting element 120 may be relatively inelastic so as to provide appropriate restraint. When ankle collar 120 is secured in place (e.g., by lace 104) and the wearer deforms spring plate 123, the hindfoot portions of upper 101 will be placed in tension between ankle collar 110 and lasting element 120. If those portions of upper 101 are relatively inelastic, the hindfoot portions of the shoe 100 sole structure are maintained in place relative to the wearer’s heel. In other embodiments, other configurations may be used to hold a shoe sole structure against a wearer heel.
during spring plate deformation. As but one example, hindfoot region straps may be added to a shoe.

[59] FIG. 6 is a lateral side view of a shoe 200 according some additional embodiments. The medial side of shoe 200 has a similar configuration and appearance, but is configured to correspond to a lateral side of a wearer foot. Shoe 200 is configured for wear on a right foot and is part of a pair that includes a shoe (not shown) that is a mirror image of shoe 200 and is configured for wear on a left foot.

[60] Shoe 200 includes an upper 201 configured to surround and retain the foot of a shoe 200 wearer. In the embodiment of shoe 200, upper 201 may be of conventional construction and include a tongue 206 that spans a tongue opening 207 located in an instep region. A lace 204, only certain segments of which are shown in FIG. 6, may be used to cinch upper 201 about a wearer foot in a conventional manner. A lasting element (e.g., a Strobel) may be stitched, bonded or otherwise attached to the lower edge of upper 201 and generally extends the entire length and width of upper 201. An interior face of the lasting element and an interior face of upper 201 form a void of shoe 200 that receives a wearer foot inserted through ankle opening 211.

[61] The sole structure of shoe 200 includes a midsole 252, a spring plate 223, a front outsole 214, and a rear outsole 215. Midsole 252 and spring plate 223 are external relative to upper 201. As explained in detail below in connection with FIG. 8, the sole structure of shoe 200 also includes an insole located within the void of upper 201. Midsole 252 may be formed from one or more compressible foam materials and may have a top surface that is contoured, at least in part, to conform to a plantar region of a wearer foot. Foam materials that may be used for midsole 252 include any of the foams that may be used to form inner sole member 122 of shoe 100.
FIG. 7 is a bottom view of shoe 200 and shows additional details of outsoles 214 and 215. Front outsole 214 is approximately U shaped and comprises a strip that extends around the outer edge of spring plate 223 from a lateral midfoot region to a medial midfoot region. An interior edge 261 of outsole 214 defines an open region 262 exposing a portion of the bottom surface 236 of spring plate 223. The lateral side of outsole 214 extends further rearward than the medial side of outsole 214. A rounded end of the outsole 214 lateral side is spaced apart from a rounded end of the outsole 214 medial side to define a gap therebetween. A bottom surface of front outsole 214 includes multiple pointed traction elements 256, as well as four receptacles 260 configured to receive track spikes 258. Track spikes are omitted from the rear lateral and rear medial receptacles 260 in FIGS. 6-8 for purposes of illustration. Front outsole 214 may be molded from, e.g., hard rubber or other conventional outsole materials, with receptacles 260 embedded at the time of molding.

FIG. 8 is an exploded, partially schematic lateral side view of shoe 200. In FIG. 8, an outline of upper 201 is shown with a first type of broken line and a lasting element 220 is shown with a second type of broken line having smaller segments. Other components of shoe 200 are shown in lateral side view.

As indicated above, and as shown schematically in FIG. 8, lasting element 220 is joined to a bottom edge of upper 201 to define a void of shoe 200. Located within that void is an inner sole element in the form of insole 222. Insole 222 may be molded from one or more compressible foam materials (e.g., foamed EVA, foamed PU, blown rubber). In some embodiments, a top surface 241 of insole 222 may include a fabric layer. Insole 222 may be molded to have a curvature corresponding...
to the curvature of the undeformed top surface of midsole 252. A bottom surface 242 of insole 222 may rest against a top, interior face 243 of lasting element 220.

[66] A bottom surface 244 of lasting element 220 may be bonded to a top surface 245 of midsole 252. As indicated above, midsole 252 may be formed from one or more compressible foam materials. In some embodiments, midsole 252 may be molded so that it has undeformed contours similar to those indicated in FIG. 8. In particular, a bottom surface 246 of midsole 252 may have a contour corresponding to the contour of the top surface 235 of an undeformed spring plate 223. A top surface of midsole 252 may have a similar contour, but with additional surface features to provide arch support, heel elevation, etc.

[67] Bottom surface 246 of midsole 252 may be bonded to top surface 235 of spring plate 223. The bonding may be over all, or over a sub-portion, of bottom surface 246 in contact with top surface 235. Unlike spring plate 123, spring plate 223 lacks an open region. However, spring plate 223 may otherwise be similar to spring plate 123 with regard to thickness and other dimensions, unloaded forefoot region bend angle α, apex locations, etc. Spring plate 223 may be formed from any of the materials described above in connection with spring plate 123, may have lay-up details and components similar to those described in connection with spring plate 123, and/or may have angular stiffness characteristics similar to those described in connection with FIG. 5. In the embodiment of shoe 200, spring plate 223 has a slight upward bend in the heel region. In other embodiments, however, a spring plate otherwise similar to spring plate 223 in a shoe otherwise similar to that of shoe 200 may be substantially flat in the heel region (similar to spring plate 123).

[68] Top surface 248 of front outsole 214 may be bonded to a portion of spring plate 223 bottom surface 236 in the forefoot and midfoot regions. The bonding may be over all, or over a sub-portion, of top surface 248 in contact with bottom surface 236. Top surface 249 of rear outsole 215 may be bonded to a portion of spring plate 223 bottom surface 236 in the midfoot and heel regions. The bonding may be over all, or over a sub-portion, of top surface 249 in contact with bottom surface 236. A
portion of peripheral outer edge 271 rear outsole 215 may be substantially coextensive with a portion of peripheral outer edge 272 of spring plate 223. A portion of peripheral outer edge 273 front outsole 214 may be substantially coextensive with a portion of peripheral outer edge 272 of spring plate 223. In some embodiments, edges may be considered "substantially coextensive" if any offset between those edges is less than 7 millimeters, less than 6 millimeters, less than 5 millimeters, less than 4 millimeters, less than 3 millimeters, less than 2 millimeters, less than 1 millimeter, or less than 0.5 less than 6 millimeter. In some embodiments, an outsole (or multiple separate outsole elements) may cover all of a spring plate bottom surface. In some such embodiments, some or all of a peripheral edge of the spring plate may be substantially coextensive with some or all of the peripheral edge(s) of the one or more outsole elements covering the spring plate bottom surface.

[69] FIG. 9 is another bottom view of shoe 200, but with front outsole 214 and rear outsole 215 omitted. As indicated above, and as seen in seen in FIG. 9, spring plate 223 lacks an open region. In particular, top surface 236 extends uninterrupted from medial to lateral edges and from front end to rear end. Bottom surface 235 similarly extends uninterrupted from medial to lateral edges and from front end to rear end. In the embodiment of shoe 200, spring plate 223 covers the entire bottom surface 246 of midsole 252. In other embodiments, a spring plate may cover less than all of a midsole bottom surface.

[70] In some embodiments, for example, a spring plate in a shoe otherwise similar to shoe 200 may include an open region similar to open region 132 of spring plate 123, or may include one or more open regions having other configurations. Such open regions could be included to, e.g., reduce weight and/or as a way of adjusting spring force in the spring plate. Such open regions could also be used to help position a spring plate relative to a midsole and/or to help position one or more outsoles relative to the spring plate. For example, FIG. 10A shows a bottom view of a shoe 300 that, except as described below, is similar to shoe 200. A spring plate
and outsoles are omitted from FIG. 10A. As seen in FIG. 10A, bottom surface 346 of midsole 352 includes a shelf 399 and a central island 398 that extends downward (outward from shelf 399 in FIG. 10A). FIG. 10B is another bottom view of shoe 300 after a spring plate 323 has been bonded to midsole 352. Spring plate 323 includes an open region 332 similar to open region 132 of spring plate 123. Open region 332 has a shape corresponding to the shape of island 398. Island 398 extends through open region 332, and bottom surface 336 of spring plate 323 is flush with the portion of the midsole 352 bottom surface 346 included in island 398. A top surface of spring plate 323, not shown, is bonded to the portion of the midsole 353 bottom surface 346 located in shelf 399. FIG. 10C is a further bottom view of shoe 300 after bonding of outsole 314 and 315 to portions of the spring plate 323 bottom surface 336 and to portions of the outsole 353 bottom surface 346 exposed through opening 332. Outsoles 314 and 315 may be similar to outsoles 214 and 215, or may have other configurations.

[71] Other embodiments include numerous additional variations on the components and combinations described above. Without limitation, such variations may include one or more of the following.

[72] In some additional embodiments, a shoe may have a sole structure similar to that of shoes 200 or 300, but may have an upper similar to that of shoe 100.

[73] As indicated above, an inner sole member such as insole 222 may be molded to have a curvature such as is shown in FIG. 8. In some embodiments, an inner sole member such as inner sole member 122 could be molded so as to have an unloaded shape, similar to that shown in FIG. 3, in which a forefoot region has a downward bend corresponding to a downward bend of a spring plate that will be used with the inner sole member.

[74] A spring plate may have a variable thickness t. For example, a thickness t may be decreased in regions around a bend apex so as to
facilitate desired bendability, and increased in regions where no less (or no) bendability is desired.

Parameters other than or in addition to number of layup layers may be varied so as to achieve desired spring plate stiffness. For example, a width of a band such as band 131 could be increased in a bend apex region to increase stiffness, and vice versa.

Spring plate stiffness could be tuned so as to make the stiffness at one of the medial or lateral side bend apexes greater than the stiffness at the other of the medial or lateral side bend apexes. Such tuning could be used, e.g., to help correct excessive pronation or other undesirable characteristics of a wearer's gait.

An inner sole member could comprise more than one component. For example, an inner sole member could comprise an inner midsole and an separate sock liner. As another example, an inner sole member could comprise a first inner midsole that rests within a front portion of a shoe interior and a second inner midsole that rests within a rear portion of the shoe interior, with the first and second midsole overlapping in a middle portion of the shoe interior.

In the embodiment of shoe 100, no portion of inner sole member 122 is below spring plate 123. In other embodiments, one or more inner sole members or portions thereof might be located under a spring plate.

In some embodiments, a spring plate might be incorporated into an inner sole member, into an outsole, or into a midsole or other portion of a sole structure located below a lasting element. A portion of a spring plate may be exposed and form a portion of a ground contacting surface of a sole structure.

In some embodiments, an article of footwear may include more than one spring plate. For example, a spring plate similar to spring plate 123 may
split into two separate spring plates (e.g., a medial side spring plate and a lateral side spring plate). As another example, spring plates may overlap one another. Some or all of overlapping spring plates may not extend around an entire periphery of the sole structure.

A spring plate may have different bend angles on medial and lateral sides. As but one example, a bend angle on a medial side of a spring plate could be greater than a bend angle on a lateral side of a spring plate.

A bend angle may be sharper (i.e., with a smaller bend radius) or more gentle (i.e., with a larger bend radius) than is shown in FIGS. 3, 4A, 4D, 4G, 4H, and 8.

In some embodiments, a spring plate that is nondestructively removable from and replaceable into the void of an upper, similar to spring plate 123, may lack an open center region and may instead have top and bottom surfaces that extend uninterrupted from medial to lateral edges and from front end to rear end, similar to spring plate 223.

The foregoing description of embodiments has been presented for purposes of illustration and description. The foregoing description is not intended to be exhaustive or to limit embodiments of the present invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of various embodiments. The embodiments discussed herein were chosen and described in order to explain the principles and the nature of various embodiments and their practical application to enable one skilled in the art to utilize the present invention in various embodiments and with various modifications as are suited to the particular use contemplated. Any and all combinations, subcombinations and permutations of features from herein-described embodiments are the within the scope of the invention. In the claims, a reference to a potential or intended wearer or a user of a component does not
require actual wearing or using of the component or the presence of the wearer or user as part of the example embodiment.

[85] For the avoidance of doubt, the present application includes, without limitation, the subject-matter described in the following numbered paragraphs (referred to as "para." or "paras."): 

1. An article of footwear comprising an upper; an outsole; at least one inner sole member shaped to rest securely within a void defined at least in part by the upper; and a spring plate positioned between at least a portion of the at least one inner sole member and at least a portion of the outsole, the spring plate extending through at least medial forefoot and medial midfoot regions and having an unloaded shape in which a front portion of the spring plate in the forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion.

2. The article of footwear of para. 1, wherein a portion of the void above a top surface of the at least one inner sole member is sized to accommodate a wearer foot.

3. The article of footwear of para. 1 or para. 2, wherein the at least one inner sole member is compressible in at least first and fifth metatarsophalangeal joint regions.

4. The article of footwear of any of paras. 1 through 3, wherein the spring plate comprises an open region defined by a surrounding band.

5. The article of footwear of para. 4, wherein the surrounding band is continuous around an entire periphery of the spring plate.
6. The article of footwear of any of paras. 1 through 5, wherein the front portion of the spring plate is substantially flat and the rear portion of the spring plate is substantially flat.

7. The article of footwear of any of paras. 1 through 6, wherein the spring plate extends substantially an entire length and width of the article within the upper.

8. The article of footwear of any of paras. 1 through 7, wherein the at least one inner sole member has an unloaded shape in which a front portion of the at least one inner sole member in the forefoot region is downwardly bent relative to a rear portion of the at least one inner sole member located rearward of the front portion of the at least one inner sole member.

9. The article of footwear of any of paras. 1 through 8, wherein a peripheral edge of the spring plate has a shape that is generally the same as a shape of a peripheral edge of the at least one inner sole member.

10. The article of footwear of any of paras. 1 through 9, further comprising a midsole, wherein a surface of the spring plate is at least partially bonded to a surface of the midsole.

11. The article of footwear of any of paras. 1 through 10, wherein a surface of the spring plate is at least partially bonded to a surface of the outsole.

12. The article of footwear of para. 11, wherein at least a portion of a peripheral edge of the outsole is substantially coextensive with at least a portion of a peripheral edge of the spring plate.

13. The article of footwear of any of paras. 1 through 9, wherein the spring plate is nondestructively removable from and replaceable into the upper.
14. The article of footwear of any of paras. 1 through or 13, wherein the at least one inner sole member is nondestructively removable from and replaceable into the upper.

15. The article of footwear of any of paras. 1 through 14, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle between about 10 degrees and about 25 degrees.

16. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 20 degrees.

17. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 19 degrees.

18. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 18 degrees.

19. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 17 degrees.

20. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 16 degrees.
21. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 15 degrees.

22. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 10 degrees.

23. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 21 degrees.

24. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 22 degrees.

25. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 23 degrees.

26. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 24 degrees.

27. The article of footwear of any of paras. 1 through 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 25 degrees.

28. An article of footwear comprising an upper; an outsole; and a spring plate positioned above at least a portion of the outsole, the spring plate extending through at least medial forefoot and medial midfoot regions and
having an unloaded shape in which a front portion of the spring plate in the
forefoot region is downwardly bent relative to a rear portion of the spring plate
located rearward of the front portion, the spring plate comprising an open
region defined by a surrounding band.

29. The article of footwear of para. 28, wherein the surrounding band is
continuous around an entire periphery of the spring plate.

30. The article of footwear of para. 28 or para. 29, wherein the front portion
of the spring plate is substantially flat and the rear portion of the spring plate is
substantially flat.

31. The article of footwear of any of paras. 28 through 30, wherein the
spring plate extends substantially an entire length and width of the article
within the upper.

32. The article of footwear of any of paras. 28 through 31, further
comprising at least one inner sole member shaped to rest securely within a
void defined at least in part by the upper.

33. The article of footwear of para. 32, wherein a portion of the void above
a top surface of the at least one inner sole member is sized to accommodate
a wearer foot.

34. The article of footwear of para. 32 or para. 33, wherein the at least one
inner sole member is compressible in at least first and fifth
metatarsophalangeal joint regions.

35. The article of footwear of any of paras. 28 through 34, further
comprising a midsole, wherein a surface of the spring plate is at least partially
bonded to a surface of the midsole.
36. The article of footwear of any of paras. 28 through 35, wherein a surface of the spring plate is at least partially bonded to a surface of the outsole.

37. The article of footwear of para. 36, wherein at least a portion of a peripheral edge of the outsole is substantially coextensive with at least a portion of a peripheral edge of the spring plate.

38. The article of footwear of any of paras. 28 through 34, wherein the spring plate is nondestructively removable from and replaceable into the upper.

39. The article of footwear of any of paras. 28 through 38, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle between about 10 degrees and about 25 degrees.

40. The article of footwear of any of paras. 28 through 39, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 20 degrees.

41. An article of footwear comprising an upper; an outsole; and a spring plate positioned above at least a portion of the outsole, the spring plate extending through at least medial forefoot and medial midfoot regions and having an unloaded shape in which a front portion of the spring plate in the forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion, the spring plate being nondestructively removable from and replaceable into the upper.

42. The article of footwear of para. 41, wherein the spring plate comprises an open region defined by a surrounding band.
43. The article of footwear of para. 41 or para. 42, wherein the surrounding band is continuous around an entire periphery of the spring plate.

44. The article of footwear of any of paras. 41 through 43, wherein the front portion of the spring plate is substantially flat and the rear portion of the spring plate is substantially flat.

45. The article of footwear of any of paras. 41 through 44, wherein the spring plate extends substantially an entire length and width of the article within the upper.

46. The article of footwear of any of paras. 41 through 45, further comprising at least one inner sole member shaped to rest securely within the void.

47. The article of footwear of para. 46, wherein a portion of the void above a top surface of the at least one inner sole member is sized to accommodate a wearer foot.

48. The article of footwear of any of paras. 41 through 48, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle between about 10 degrees and about 25 degrees.

50. An article of footwear comprising an upper; a midsole engaged with the upper, a spring plate engaged with a bottom of the midsole, and an outsole engaged with a bottom of the spring plate.
51. The article of footwear of para. 50, further comprising a midsole, wherein a surface of the spring plate is at least partially bonded to a surface of the midsole.

52. The article of footwear of para. 50 or para. 51, wherein a surface of the spring plate is at least partially bonded to a surface of the outsole.

53. The article of footwear of para. 52, wherein at least a portion of a peripheral edge of the outsole is substantially coextensive with at least a portion of a peripheral edge of the spring plate.

54. The article of footwear of any of paras. 50 through 53, wherein a portion of the spring plate is exposed on a bottom of the article.

55. The article of footwear of any of paras. 50 through 54, wherein the midsole is external relative to the upper.

56. The article of footwear of any of paras. 50 through 55, wherein the article comprises multiple separate outsoles engaged with the bottom of the spring plate.

57. The article of footwear of any of paras. 50 through 56, wherein the spring plate lacks an open region.

58. The article of footwear of any of paras. 50 through 57, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle between about 10 degrees and about 25 degrees.
CLAIMS:

1. An article of footwear comprising:
   an upper;
   an outsole;
   at least one inner sole member shaped to rest securely within a void defined at least in part by the upper, wherein a portion of the void above a top surface of the at least one inner sole member is sized to accommodate a wearer foot, and wherein the at least one inner sole member is compressible in at least first and fifth metatarsophalangeal joint regions; and
   a spring plate positioned between at least a portion of the at least one inner sole member and at least a portion of the outsole, the spring plate extending through at least medial forefoot and medial midfoot regions and having an unloaded shape in which a front portion of the spring plate in the forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion.

2. The article of footwear of claim 1, wherein the spring plate comprises an open region defined by a surrounding band.

3. The article of footwear of claim 2, wherein the surrounding band is continuous around an entire periphery of the spring plate.

4. The article of footwear according to claim 1, wherein the front portion of the spring plate is substantially flat and the rear portion of the spring plate is substantially flat.

5. The article of footwear of claim 4, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle of about 20 degrees.

6. The article of footwear of claim 1, wherein the spring plate extends substantially an entire length and width of the article within the upper.
7. The article of footwear of claim 1, wherein the spring plate and the at least one inner sole member are each nondestructively removable from and replaceable into the upper.

8. The article of footwear of claim 1, wherein the spring plate is nondestructively removable from and replaceable into the upper.

9. The article of footwear of claim 1, wherein the at least one inner sole member has an unloaded shape in which a front portion of the at least one inner sole member in the forefoot region is downwardly bent relative to a rear portion of the at least one inner sole member located rearward of the front portion of the at least one inner sole member.

10. The article of footwear of claim 1, wherein a peripheral edge of the spring plate has a shape that is generally the same as a shape of a peripheral edge of the at least one inner sole member.

11. The article of footwear of claim 1, wherein the spring plate is positioned between a midsole and the outsole.

12. The article of footwear of claim 11, wherein the midsole is external to the upper, wherein the spring plate is attached to a bottom side of the midsole and a top side of the outsole, and wherein a portion of the spring plate is exposed on a bottom side of the article.

13. An article of footwear comprising;
   an upper;
   an outsole; and
   a spring plate positioned above at least a portion of the outsole, the spring plate extending through at least medial forefoot and medial midfoot regions and
having an unloaded shape in which a front portion of the spring plate in the forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion, the spring plate comprising an open region defined by a surrounding band.

14. The article of footwear of claim 13, wherein the surrounding band is continuous around an entire periphery of the spring plate.

15. The article of footwear of claim 13, wherein the front portion of the spring plate is substantially flat and the rear portion of the spring plate is substantially flat.

16. The article of footwear of claim 15, wherein the front portion of the spring plate is downwardly bent relative to the rear portion of the spring plate at an angle between about 10 degrees and about 25 degrees.

17. The article of footwear of claim 13, wherein the spring plate extends substantially an entire length and width of the article within the upper.

18. The article of footwear of claim 13, wherein the spring plate is nondestructively removable from and replaceable into the upper.

19. The article of footwear of claims 13, further comprising at least one inner sole member shaped to rest securely within a void defined at least in part by the upper, wherein a portion of the void above a top surface of the at least one inner sole member is sized to accommodate a wearer foot, and wherein the at least one inner sole member is compressible in at least first and fifth metatarsophalangeal joint regions.

20. An article of footwear comprising;
   an upper;
   an outsole; and
a spring plate positioned above at least a portion of the outsole, the spring plate extending through at least medial forefoot and medial midfoot regions and having an unloaded shape in which a front portion of the spring plate in the forefoot region is downwardly bent relative to a rear portion of the spring plate located rearward of the front portion, the spring plate being nondestructively removable from and replaceable into the upper.

21. The article of footwear of claim 20, wherein the spring plate comprises an open region defined by a surrounding band.

22. The article of footwear of claim 21, wherein the surrounding band is continuous around an entire periphery of the spring plate.

23. The article of footwear of claim 20, wherein the spring plate extends substantially an entire length and width of the article within the upper.

24. The article of footwear of claim 20, further comprising at least one inner sole member shaped to rest securely within the void, wherein a portion of the void above a top surface of the at least one inner sole member is sized to accommodate a wearer foot, and wherein the at least one inner sole member is compressible in at least first and fifth metatarsophalangeal joint regions.
INTERNATIONAL SEARCH REPORT

PCT/US2016/030759

A. CLASSIFICATION OF SUBJECT MATTER

INV. A43B5/00 A43B13/02 A43B13/12 A43B13/14 A43B13/18

ADD.

According to International Patent Classification (IPC) and to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A43B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>paragraphs [0021], [0024], [0025]: figures</td>
<td>20</td>
</tr>
<tr>
<td>X</td>
<td>US 7 062 865 Bl (NORDT LLIAM E [US]) 20 June 2006 (2006-06-20)</td>
<td>1, 2, 5-10, 20-24</td>
</tr>
<tr>
<td>Y</td>
<td>col umn 4, lines 21-30, 53-64; figures</td>
<td>13-19</td>
</tr>
<tr>
<td>X</td>
<td>EP 1 857 005 Al (OTTE M CHRISTOPHE [LU]) 21 November 2007 (2007-11-21)</td>
<td>1, 4-6, 9-12</td>
</tr>
<tr>
<td>A</td>
<td>figures</td>
<td>20</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search: 1 July 2016

Date of mailing of the international search report: 12/07/2016

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax. (+31-70) 340-3016

Authorized officer

Vesin, Stephane
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 5 142 797 A (COLE III CHARLES D [US]) 1 September 1992 (1992-09-01) column 4, line 6 - column 5, line 15; figure 4</td>
<td>1,4-6,9, 10, 13, 20</td>
</tr>
<tr>
<td>A</td>
<td>DE 27 36 974 A1 (WOESSNER HUGO) 1 March 1979 (1979-03-01) figure 2</td>
<td>1,4-6,9, 10, 13, 20</td>
</tr>
</tbody>
</table>

Form PCT/ISA/210 (continuation of second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EP 1381292 A1</td>
<td>21-01-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2002152642 A1</td>
<td>24-10-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 02085146 A1</td>
<td>31-10-2002</td>
</tr>
<tr>
<td>US 7062865 B1</td>
<td>20-06-2006</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 5142797 A1</td>
<td>01-09-1992</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>DE 2736974 A1</td>
<td>01-03-1979</td>
<td>DE 2736974 A1</td>
<td>01-03-1979</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 4199878 A</td>
<td>29-04-1980</td>
</tr>
<tr>
<td>US 2003221337 A1</td>
<td>04-12-2003</td>
<td>CZ 20031521 A3</td>
<td>14-01-2004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2840163 A1</td>
<td>05-12-2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2003221337 A1</td>
<td>04-12-2003</td>
</tr>
<tr>
<td>US 2014059895 A1</td>
<td>06-01-2014</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>