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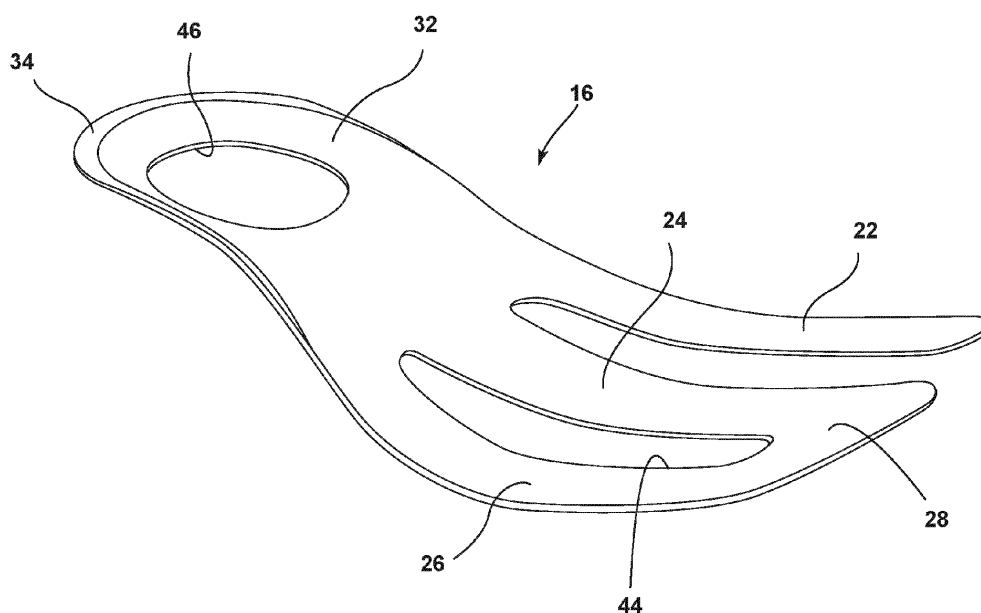
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(54) **ARTICLE OF FOOTWEAR WITH SOLE PLATE**

(57) A sole assembly for an article of footwear. The sole assembly includes a top midsole layer, a bottom midsole layer and a plate disposed between the top midsole layer and the bottom midsole layer. The plate includes a forefoot portion with lateral, medial and central longitudinal extensions, and a heel portion with a heel

cup and a heel flange extending outwardly from the heel cup. The central and lateral longitudinal extensions are joined by a bridge. The top midsole layer is seated within the heel cup and does not cover the upper surface of the heel flange. The bottom midsole layer underlies and supports the heel flange.



**FIG. 6**

## Description

### BACKGROUND OF THE INVENTION

**[0001]** The present invention relates to footwear, and more particularly to footwear incorporating a sole assembly have a plate.

**[0002]** A typical article of footwear includes an upper joined to a sole or sole assembly. The sole underlies the wearer's foot and provides a ground-engaging surface that protects the wearer's foot. In addition to protecting the wearer's foot, soles are often designed to provide the desired support, cushioning and energy return. To achieve these objectives, footwear is available with a wide variety of different soles or sole assemblies. In many articles of footwear, the sole assembly incorporates a plate that is substantially more rigid than the cushioning materials incorporated into the sole assembly. The plate is designed to bend under load during an initial portion of the wearer's stride to store energy and then to return to its original shape as the load is reduced during a later portion of the wearer's stride, for example, during toe off.

**[0003]** The properties of a sole assembly are complex and depend greatly on a variety of factors, most notably the design and configuration of the plate and the cushioning materials with which the plate is combined. As a result, a wide range of plated sole assemblies have been developed for a variety of different applications, such as hiking, walking, running and leisure activities. For example, the rigidity of the plate, the position of the plate within the sole assembly, the shape of the plate, the material from which the plate is manufactured, the cushioning properties of the cushioning materials (e.g. midsole), the position of the cushioning material relative to the plate and the wearer's foot are all factors that contribute to the overall properties of the sole assembly. More rigid plates can be used to provide enhanced support when desired, but they can increase weight and make the sole assembly less comfortable and overly stiff for a range of applications. By changing the size, shape and configuration of the plate, the support and energy return properties provided by the plate can be localized or otherwise controlled to contribute to the overall characteristics of the sole assembly. Similarly, the cushioning materials can be designed to accommodate the plate and to give the sole assembly the cushioning, comfort and energy return characteristics desired. Too little cushioning material may not provide adequate cushioning and may reduce the comfort level of the sole assembly. On the other hand, too much cushioning material may make the sole assembly excessively thick and may reduce the effectiveness of the plate by absorbing too much of the energy returned by the plate.

**[0004]** As can be seen, a variety of properties can be deliberately adjusted to tune a plated sole assembly for the intended application. Despite this general understanding within the footwear industry, ideal plated sole assemblies have not been developed for many different

footwear applications. As a result, there remains a need for a plated sole assembly that provides an optimized combination of support, cushioning and energy return for use in an article of footwear intended for use in the field of running and other athletic activities.

### SUMMARY OF THE INVENTION

**[0005]** An article of footwear includes a sole assembly have a plate disposed between top and bottom midsole layers. The plate includes a heel portion, an arch portion and a forefoot portion. The forefoot portion includes a medial extension that extends generally longitudinally along the medial edge of the forefoot region, a central extension that extends longitudinally through the approximate center of the forefoot region and a lateral extension that extends longitudinally along the lateral edge of the forefoot region. The central and lateral longitudinal extensions are joined to one another at their forward ends.

**[0006]** In one embodiment, the heel portion of the plate includes a peripheral region that is curved upwardly to provide a somewhat concave seat for the heel of the wearer's foot. In one embodiment, the arch portion also includes a peripheral region that extends upwardly in concert with the peripheral region of the heel portion, whereby the arch region and heel region cooperatively define a heel cradle that begins in the arch portion and extends to the rearmost end of the plate. The heel cradle receives the heel portion of the top midsole layer and, when worn, receives the heel of the wearer's foot. The complex curvature of the plate in the heel region also enhances the rigidity of the plate in the heel region where the force of heel strike is primarily focused.

**[0007]** In one embodiment, an opening is defined through the approximate center of the heel region of the plate. The opening may be generally oval being extended in the longitudinal direction. The heel opening allows communication between the upper midsole layer and the bottom midsole layer in the approximate center of the heel region, thereby providing enhanced centering and cushioning of the wearer's foot while also reducing the weight of the plate.

**[0008]** In one embodiment, the medial extension is curved and extends along the medial peripheral edge of the sole beginning at the forward end of the arch region and extending forwardly to at least a point under the great toe. The medial extension may be offset inwardly from an extend parallel to the medial edge of the sole assembly.

**[0009]** In one embodiment, the lateral extension is curved and extends along the lateral peripheral edge of the sole beginning at the forward end of the arch region and extending forwardly to at least a point under the small toes. The lateral extension may be offset inwardly from and extend parallel to the lateral edge of the sole assembly.

**[0010]** In one embodiment, the central longitudinal extension is generally straight beginning at the forward end

of the arch region and extending forwardly to a point between the end of the medial longitudinal extension and the lateral longitudinal extension.

**[0011]** In another embodiment, the plate includes a lateral bridge extending somewhat laterally between the forward ends of the central extension and the lateral extension. The bridge may have approximately the same width as the central extension and the lateral extension. In one embodiment, the central extension, lateral extension and lateral bridge cooperatively define a closed opening in the forefoot region.

**[0012]** In still another embodiment, the heel region of the upper midsole layer is disposed in the heel cradle. The upper midsole layer may be supported upon the plate with its peripheral edge remaining separate from the lower midsole layer. In one embodiment, the peripheral edges of the upper midsole layer and the lower midsole layer are separated through the heel portion or separated through both the arch portion and the heel portion.

**[0013]** In one embodiment, the peripheral edge of the plate flares outwardly to define a heel flange extending around at least a portion of the heel region of the plate. The heel flange may extend along a plane. The heel flange may include an upwardly facing surface that is exposed around at least a portion of the heel portion. In one embodiment, the upper midsole layer terminates short of the heel flange on the lateral side, the medial side and the rear end of the sole assembly. In such embodiments, the upper midsole layer may be adhesively joined to the upper surface of the plate, excluding the upper face of the flange.

**[0014]** In one embodiment, the lower midsole layer is wider than the upper midsole layer in at least a portion of the heel region. In one embodiment, the lower midsole layer extends beneath the heel flange of the plate and is in direct contact therewith. As a result, the portions of the lower midsole layer beneath the heel flange provide additional cushioning and support for the wearer's foot, especially during heel strike.

**[0015]** In yet another embodiment, an outsole is disposed on the undersurface of the bottom midsole layer. If included, the outsole may cover all of the undersurface or it may cover one or more portions of the undersurface. The outsole may be formed by a single continuous section of outsole material or it may be formed by a plurality of separate segments of outsole material that cooperate to cover different portions of the undersurface. In some embodiments, the outsole (whether continuous or in separate parts) is secured to the undersurface of the bottom midsole layer by adhesive

In one embodiment, the peripheral edges of the bottom surface of plate are exposed in the arch region. For example, the bottom midsole layer may include medial and lateral recesses that expose portions of the bottom surface of the plate. In some application, the size and shape of the recesses may be selected to tune the cushioning, support and energy return characteristics of the plate, particularly in the arch region.

**[0016]** In yet another embodiment, the upper, top midsole layer, plate and bottom midsole layer may have a stepped arrangement in the heel portion that is configured to provide the sole with the desired cushioning, support and energy return characteristics. In one embodiment, the top midsole layer extends outwardly beyond the lateral, medial and rear extents of the upper in the heel region. In one embodiment, the plate extends outwardly beyond the lateral, medial and rear extents of the top midsole layer. In one embodiment, the bottom midsole layer extends outwardly beyond the lateral, medial and rear extents of the top midsole layer and/or the plate in the heel region. The stepped arrangement provides the sole assembly with broad support for the heel on the lateral side, the medial side and the rear while reducing the breadth of the top midsole layer to enhance the cushioning feel above the plate.

**[0017]** The current embodiments relate to a sole construction having a unique arrangement of a top midsole layer, a plate and a bottom midsole layer that provide optimal support, cushioning and energy return through the gait cycle from heel strike to toe off. Among other things, the plate provides the forefoot with substantial longitudinal support while still allowing a desirable amount of lateral flexibility. The use of a separate medial extension and joined central and lateral extensions gives the great toe enhanced, independent flexibility while helping to maintain a greater level of lateral support for the remaining toes. The heel cradle helps to center and support the wearer's foot, as well as to provide optimized energy return following heel strike. The incorporation of a stepped configuration broadens the ground engaging surface to provide enhanced support and cushioning. The heel flange extends outwardly over the broadened bottom midsole layer, thereby receiving support and cushioning from the additional cushioning material disposed thereunder.

**[0018]** These and other objects, advantages, and features of the invention will be more fully understood and appreciated by reference to the description of the current embodiment and the drawings.

**[0019]** Before the embodiments of the invention are explained in detail, it is to be understood that the invention is not limited to the details of operation or to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention may be implemented in various other embodiments and of being practiced or being carried out in alternative ways not expressly disclosed herein. Also, it is to be understood that the phraseology and terminology used herein are for the purpose of description and should not be regarded as limiting. The use of "including" and "comprising" and variations thereof is meant to encompass the items listed thereafter and equivalents thereof as well as additional items and equivalents thereof. Further, enumeration may be used in the description of various embodiments. Unless otherwise expressly stated, the use of enumeration should not be

construed as limiting the invention to any specific order or number of components. Nor should the use of enumeration be construed as excluding from the scope of the invention any additional steps or components that might be combined with or into the enumerated steps or components.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### [0020]

Fig. 1 is a perspective view of an article of footwear incorporating a sole in accordance with an embodiment of the present invention.

Fig. 2 is a left side view of the sole assembly.

Fig. 3 is a right side view of the sole assembly.

Fig. 4 is an exploded view of the sole assembly.

Fig. 5 is a top perspective view of the sole assembly.

Fig. 6 is a top perspective view of the plate.

Fig. 7 is a top perspective view of the bottom midsole layer.

Fig. 8 is a section view of the sole taken along line 8-8 of Fig. 2.

Fig. 9 is a section view of the sole taken along line 9-9 of Fig. 2.

Fig. 10 is a section view of the sole taken along line 10-10 of Fig. 2.

Fig. 11 is a section view of the sole taken along line 11-11 of Fig. 2.

Fig. 12 is a top plan view of the plate and bottom midsole layer with the top midsole layer removed; and

Fig. 13 is a bottom plan view of the plate and the top midsole layer with the bottom midsole layer removed.

#### DETAILED DESCRIPTION OF THE CURRENT EMBODIMENTS

[0021] An article of footwear in accordance with a current embodiment of the present invention is shown in Fig. 1 and generally designated 10. The article of footwear 10 includes a sole assembly 12 that incorporates a top midsole layer 14, a plate 16 and a bottom midsole layer 18. The sole assembly 106 may also include an outsole 50 that is joined to the bottom surface of the bottom midsole layer 18. The top midsole layer 14, the plate 16 and the bottom midsole layer 18 are configured to provide enhanced support, cushioning and energy return. In this embodiment, the plate 16 includes a forefoot portion 20 with a medial extension 22, a central extension 24 and a lateral extension 26. The central extension 24 and the lateral extension 26 of this embodiment are joined to one another by a bridge 28 at their forward ends. The plate 16 also includes a heel portion 30 that includes a heel cup 32 and a peripheral heel flange 34. In this embodiment, the top midsole layer 14 is secured within the heel cup 32 and does not extend over the heel flange 34, while

the bottom midsole layer 18 is broader than the top midsole layer 14 and extends beneath and supports the heel flange 34.

[0022] Although a current embodiment is illustrated in the context of a running shoe, the sole assembly thereof can be incorporated into any type or style of footwear, including performance shoes, trail shoes and boots, work boots, all-terrain shoes, hiking shoes, athletic shoes, running shoes, sneakers, conventional tennis shoes, walking shoes, multisport footwear, casual shoes, dress shoes or any other type of footwear or footwear components. It also should be noted that directional terms, such as "vertical," "horizontal," "top," "bottom," "upper," "lower," "inner," "inwardly," "outer" and "outwardly," are used to assist in describing the invention based on the orientation of the embodiments shown in the illustrations. Further, the terms "medial," "lateral" and "longitudinal" are used in the manner commonly used in connection with footwear. For example, when used in referring to a side of the shoe, the term "medial" refers to the inward side (that is, the side facing the other shoe) and "lateral" refers to the outward side. When used in referring to a direction, the term "longitudinal direction" refers to a direction generally extending along the length of the shoe between toe and heel, and the term "lateral direction" refers to a direction generally extending across the width of the shoe between the medial and lateral sides of the shoe.

[0023] The use of directional terms should not be interpreted to limit the invention to any specific orientation. Further, as used herein, the term "arch region" (or arch or midfoot) refers generally to the portion of the footwear or sole assembly corresponding to the arch or midfoot of the wearer's foot; the term "forefoot region" (or forefoot) refers generally to the portion of the footwear forward of the arch region corresponding to the forefoot (for example, including the ball and the toes) of a wearer's foot; and the term "heel region" (or heel) refers generally to that portion of the footwear rearward of the arch region corresponding to the heel of the wearer's foot. The forefoot region 100, arch region or mid-foot region 102, and heel region 104 generally are identified in FIG. 1; however, delineation of these regions may vary depending upon the configuration of the sole assembly and/or footwear.

[0024] The footwear 10 can include a textile upper 106 joined with the sole assembly 12. The upper 106 can be formed from a variety of material elements joined together to cover at least a portion of the wearer's foot. The material elements can be selected based on the intended uses of the article of footwear 10, and can include synthetic textiles, mesh textiles, polymers or leather, for example. The upper 106 can be constructed to improve the rigidity of the sole assembly 12. For example, the upper can be constructed from leather, plastic, canvas or other materials. The upper 106 can include one or more closure elements, including, for example, shoelaces. The upper 106 additionally includes an upper opening for receiving the wearer's foot. The upper 106 may be affixed to sole

assembly 12 using essentially any form of attachment. For example, the bottom of the upper 106 may be closed by a Strobel board (not shown) in a conventional manner, and the bottom edge of the sidewall of the upper 106 and the bottom surface of the Strobel board may be secured to the sole assembly 106 by an adhesive. The joining of the sole assembly 12 and the upper 106 can be accomplished using adhesives, cement, injection molding, pour molding or any other technique used to join an upper and sole assembly.

**[0025]** An insole, inner sole or footbed (not shown) can be positioned within the void defined by the upper 106. The insole can be constructed from a sheet of material, such as foam, EVA, PU, latex, gel or other materials, and by virtue of its compressibility, provide cushioning, and may also conform to the foot in order to provide comfort, support, and stability. The insole (not shown) need not be constructed from a sheet material, but may instead be formed by other techniques, such as injection molding, compression molding or additive manufacturing.

**[0026]** The sole assembly 12 will now be described in further detail with reference to Figs. 2-12. Fig. 2, 3 and 5 show the sole assembly 12 separated from the upper 106. As mentioned above, the sole assembly 12 of the illustrated embodiment includes a top midsole layer 14, a plate 16, a bottom midsole layer 18 and an outsole 50 (as perhaps best shown in the exploded view of Fig. 4). The plate 16 is disposed between the top midsole layer 14 and the bottom midsole layer 18.

**[0027]** The top midsole layer 14 is configured to generally extend the full length and width of the sole assembly 12 to provide a platform to receive and support (directly or indirectly) the wearer's foot. In the illustrated embodiment, the upper surface 40 of the top midsole layer 14 is curved to provide a three-dimensional recess configured to receive the bottom of the upper 106 and to provide a comfortable seat for the wearer's foot. The curvature may be selected to correspond anatomically with the shape of the bottom surface of the wearer's foot. In this embodiment the peripheral margin 42 of the top midsole layer 14 is raised above the bottom extent of the upper 106. This allows the top midsole layer 14 to extend up around the bottom of the upper 106 to facilitate a durable and aesthetically pleasing connection. The raised peripheral margin 42 helps to center and retain the wearer's foot on the sole assembly 12. The thickness of the top midsole layer 14 may vary to provide the desired support, cushioning and energy return profile. For example, in the illustrated embodiment, the top midsole layer 14 is thinner in the heel region 104 and gradually thickens through the arch region 102 into the forefoot region 100 with its maximum thickness in the approximate center of the forefoot region 100 so that the top midsole layer 14 provides the greatest degree of cushioning below the metatarsal heads of the wearer's foot (see Fig. 11).

**[0028]** In the illustrated embodiment, the sole assembly 12 is configured to provide a support platform that is broader than the extents of the upper 106. As shown in

Figs. 1, 5, 10 and 11, the top midsole layer 14 extends outwardly beyond the periphery of the upper 106 in the heel region 104 on the lateral side, the medial side and the rear of the footwear 10. Additionally, the bottom midsole layer 18 extends beyond the periphery the top midsole layer 14 in the heel region on the lateral side, the medial side and the rear of the footwear 10.

**[0029]** As noted above, the plate 16 is disposed between the top midsole layer 14 and the bottom midsole layer 18 and is configured to provide the sole assembly 12 with the desired support, cushioning and energy return characteristics. Referring now to Fig. 6, the plate 16 generally includes a forefoot portion 20 extending through the forefoot region 100 of the sole assembly 12, an arch portion 36 extending through the arch region 102 of the sole assembly 12 and a heel portion 30 extending through the heel region 104 of the sole assembly. As shown, the plate 16 may begin close to the rearmost extend of the sole assembly 12 and continue forwardly into the forefoot region 100 terminating somewhat short of the forwardmost end of the sole assembly 12. The plate 14 includes a plurality of longitudinal extensions running through the forefoot region 100. The forefoot portion 20 of the plate 14 of the illustrated embodiment includes a medial extension 22 that extends generally longitudinally along the medial edge of the sole assembly 12 through the forefoot region 100, a central extension 24 that extends longitudinally through the approximate center of the forefoot region 100 and a lateral extension 26 that extends longitudinally along the lateral edge of the sole assembly 12 in the forefoot region 100. In this embodiment, the central and lateral longitudinal extensions are joined to one another at their forward ends by bridge 28.

**[0030]** In the illustrated embodiment, the medial longitudinal extension 22 is curved and extends along the medial peripheral edge of the sole assembly 12 beginning at the forward end of the arch region and extending forwardly at least to a point underlying a portion of the distal phalanx of the great toe (see Figs. 8, 12 and 13). The medial longitudinal extension 22 may in one embodiment extend to a point below the phalanges, the proximal phalanx or below the distal phalanx of the great toe. The configuration of the medial longitudinal extension 22 may vary from application to application. For example, the length, width, curvature and thickness of the medial longitudinal extension 22, as well as the offset from the medial edge of the sole assembly 12, may vary.

**[0031]** The lateral longitudinal extension 26 of the illustrated embodiment is also curved in a manner similar to the medial longitudinal extension 22. As shown in Figs. 8, 12 and 13, the lateral longitudinal extension 26 extends along the lateral peripheral edge of the sole assembly 12 beginning at the forward end of the arch region 102 and extending forwardly at least to a point underlying a portion of the middle phalanx of the 4<sup>th</sup> and/or 5<sup>th</sup> toes. The lateral longitudinal extension 26 may in one embodiment extend to a point below the phalanges, the proximal phalanges, the intermediate phalanges or the distal phalanges of the

4<sup>th</sup> and/or 5<sup>th</sup> toes. The configuration of the lateral longitudinal extension 26 may vary from application to application. For example, the length, width, curvature and thickness of the lateral longitudinal extension 26, as well as the offset from the lateral edge of the sole assembly 12, may vary.

**[0032]** The central longitudinal extension 24 of the illustrated embodiment is generally straight beginning at the forward end of the arch region 102 and extending forwardly at least to a point underlying a portion of the middle phalanx of the 2<sup>nd</sup> and/or 3<sup>rd</sup> toes (see Figs. 8, 12 and 13). In this embodiment, a lateral bridge 28 extends between the forward ends of the central extension 24 and the lateral extension 26. The central longitudinal extension 24 may in one embodiment extend to a point below the phalanges, the proximal phalanges, the intermediate phalanges or the distal phalanges of the 2<sup>nd</sup> and/or 3<sup>rd</sup> toes. The central longitudinal extension 24 may vary from application to application. For example, the length, width, curvature and thickness of the central longitudinal extension 24 may vary.

**[0033]** As discussed above, the illustrated plate 16 includes a bridge 28 that joins the central longitudinal extension 24 and the lateral longitudinal extension 26 to provide enhanced stability and support for the 2<sup>nd</sup>-5<sup>th</sup> toes. The bridge 28 may in one embodiment extend beneath the phalanges, the proximal phalanges, the intermediate phalanges or the distal phalanges of the 2<sup>nd</sup>-5<sup>th</sup> toes. As shown, the central longitudinal extension 24, the lateral longitudinal extension 26 and the lateral bridge 28 cooperatively define a closed opening 44 in the forefoot region 100. The central and lateral longitudinal extensions may be varied to alter the size, shape and/or configuration of the closed opening 44.

**[0034]** Referring now to Figs. 6 and 9-11, the heel portion 30 of the illustrated plate 16 is shaped to provide a heel cup 32. More specifically, the heel portion includes a gradual upwardly opening curve that helps to seat and center the wearer's foot on the sole assembly 12. In this embodiment, the arch portion 36 is also curved upwardly in concert with the peripheral region of the heel portion 30, such that the heel portion 30 and the arch portion 36 cooperatively define an extended heel cup 32 that begins at the back of the heel and extends well into the arch region 102. The extents of the heel cup 32 may vary from application to application.

**[0035]** Referring now to Figs. 6, 10 and 11, an opening 46 is defined through the approximate center of the heel portion 30. The opening 46 may be generally oval being extended in the longitudinal direction. The heel opening 46 allows communication between the top midsole layer 14 and the bottom midsole layer 18 in the approximate center of the heel region 104, thereby providing enhanced centering and cushioning of the wearer's foot while also reducing the weight of the plate 16. The size, shape and configuration of the heel opening 46 may vary from application to application to tune the support, cushioning and energy return characteristics of the sole as-

sembly 12. In some applications, the heel opening 46 may be eliminated.

**[0036]** In the illustrated embodiment, the peripheral edge of the plate 16 flares outwardly in the heel region 104 to define a heel flange 34 extending around at least a portion of the heel region 30 of the plate 16. As perhaps best shown in Figs. 6, 10 and 11, the heel flange 34 of the illustrated embodiment extends along a plane and is generally crescent-shaped, but it may in alternative embodiments be nonplanar and have different shapes. In the illustrated embodiment, the heel portion of the top midsole layer 14 terminates short of the heel flange 34, thereby leaving the top surface of the heel flange 34 exposed. More specifically, as shown in Figs. 5, 10 and 11, the illustrated heel flange 34 includes an upwardly facing surface that is exposed around at least a portion of the heel region 30 and a downwardly facing surface that is in direct contact with the bottom midsole layer 18 as discussed in more detail below.

**[0037]** In this embodiment, the top midsole layer 14 is adhesively joined to the upper face of the plate 16, excluding the upper face of the heel flange 34 (which, as noted above, is exposed and not covered by the top midsole layer 16). The top midsole layer 14 may also be adhesively joined to the upper face of the bottom midsole layer 14 in those regions in which the bottom surface of the top midsole layer 14 and the surface of the bottom midsole layer 18 come into contact, such as through the heel opening 46, around the periphery of the forefoot region and through the spaces between the longitudinal extensions 22, 24 and 26. The top midsole layer 14 and/or the bottom midsole layer 18 may be recessed to accommodate the plate 16. For example, the bottom surface of the top midsole layer 14 may define a recess 70 that corresponds with the plate 16. In this embodiment, the recess 70 is essentially coextensive with the plate 16 and is essentially the same thickness as the plate 16 so that the bottom surface of the plate 16 is essentially flush with the bottom surface of the top midsole layer 14 surrounding the recess 70. In alternative applications, the plate 16 may be recessed into the bottom midsole layer 18 or into both the top midsole layer 14 and the bottom midsole layer 18. In alternative applications, the recess may be eliminated in its entirety.

**[0038]** In the illustrated embodiment, the bottom midsole layer 18 provides the sole assembly 12 with a cushioning, support and energy return layer disposed generally below the plate 16. Referring now to Figs. 5 and 8-11, the bottom midsole layer 18 is positioned immediately below the plate 16. The bottom midsole layer 18 of the illustrated embodiment is wider than the top midsole layer 14 in at least a portion of the heel region. As shown, the illustrated bottom midsole layer 18 extends beneath and in direct contact with the heel flange 34 of the plate 16. As a result, the portions of the bottom midsole layer 18 beneath the heel flange 34 provide additional cushioning, support and energy return that is generally communicated through the plate 16.

**[0039]** As noted above, the sole assembly 12 of the illustrated embodiment includes a stepped arrangement in the heel region 104. More specifically, the upper 106, top midsole layer 14, plate 16 and bottom midsole layer 18 of Fig. 1 are arranged in a stepped configuration with each component being somewhat wider than the component disposed above. The stepped heel configuration helps to provide the sole with the desired cushioning, support and energy return characteristics. Referring now to Fig. 1, the top midsole layer 14 extends outwardly beyond the lateral, medial and rear extremes of the upper 100 in the heel region 104. Similarly, the plate 16 of this embodiment extends outwardly beyond the lateral, medial and rear extremes of the top midsole layer 14 in the heel region 104. Further, the bottom midsole layer 18 of this embodiment extends outwardly beyond the lateral, medial and rear extremes of the top midsole layer 14 and/or the plate 16 in the heel region 104. The degree of offset between the various layers of the sole assembly 12 may vary from application to application to provide the desired cushioning, support and energy return characteristics.

**[0040]** In the illustrated embodiment, the peripheral edges of the bottom surface of plate 16 are exposed on both lateral and medial sides in the arch region 102. For example, the bottom midsole layer 18 may include medial and lateral recesses 48 that expose portions of the bottom surface of the plate 18. The size, shape and configuration of the recesses 48 may be selected to tune the cushioning, support and energy return characteristics of the plate 16, particularly in the arch region 102. More specifically, the characteristics of the recesses 48 may be varied to tune the amount of cushioning material that is engaged with and supports the plate in the arch region 102.

**[0041]** In the illustrated embodiment, the bottom midsole layer 18 may define a forefoot opening 60 disposed that extends through the bottom midsole layer 18 from the bottom surface to the top surface. The forefoot opening 60 may be aligned with and extend along at least a portion of the central longitudinal extension 24. The forefoot opening 60 may reduce the support provided to the central longitudinal extension 24 by the bottom midsole layer 18, thereby giving the central longitudinal extension 24 additional flexibility along its length. The size, shape and configuration of the forefoot opening 60 may vary from application to application as desired to tune the characteristics of the sole assembly 12.

**[0042]** Similarly, the bottom midsole layer 18 may define an arch opening 62 that extends through the bottom midsole layer 18 in the arch region 102. The arch opening 62 of the illustrated embodiment is generally triangular in shape and extends entirely through the bottom midsole layer 18 from bottom surface to top surface, such that the plate 16 is visible through the arch opening 62. In some applications, the arch opening 62 helps to control the amount of support and cushioning in the arch region 102 and also provides a degree of decoupling between

the forefoot and heel portions of the bottom midsole layer 18. The size, shape and configuration of the arch opening 62 may vary from application to application as desired to tune the characteristics of the sole assembly 12.

**[0043]** In the illustrated embodiment, the bottom midsole layer 18 also defines a heel recess 64 that extends into the bottom of the bottom midsole layer 18 in the heel region 104. The size, shape, depth and configuration of the heel recess 64 may vary from application to application to tune the properties of the bottom midsole layer 18 in the heel region 104.

**[0044]** In this embodiment, the bottom midsole layer 18 is adhesively joined to the bottom surface of the plate 16 and the bottom surface of the top midsole layer 14. However, the bottom midsole layer 18 may be joined to the sole assembly 12 using other methods. For example, the plate 16 may be placed in a mold and the top midsole layer 14 and/or bottom midsole layer 18 may be molded in place on the plate 16 as an integral part of the molding process.

**[0045]** As noted above, an outsole 50 is disposed on the undersurface of the bottom midsole layer 18 in the illustrated sole assembly 12. When included, the outsole 50 may cover all of the undersurface of the bottom midsole layer 18 or it may cover one or more different portions of the undersurface of bottom the midsole layer 18. The outsole may be formed by a single continuous section of outsole material or it may be formed by a plurality of separate segments of outsole material that cooperate to cover all or different portions of the undersurface. Referring now to Figs. 2, 3, 8, 10 and 11, the outsole 50 include a forefoot segment 52 and a heel segment 54. The illustrated forefoot segment 52 defines a central opening 56 that is aligned with the forefoot opening 60 in the bottom midsole layer 18, such that the central longitudinal extension 24 is visible from the bottom of the sole assembly 12.

**[0046]** In the illustrated embodiment, the outsole 50 (whether continuous or in separate parts) is secured to the undersurface of the bottom midsole layer 18 by adhesive. However, the outsole 50 may be joined to the undersurface using other methods. For example, the outsole 50 may be positioned in the mold when the bottom midsole layer 18 is formed and therefore become joined as an integral part of the molding process.

**[0047]** The top midsole layer 14 and the bottom midsole layer 18 may be manufactured from essentially any desirable cushioning material. For example, the two midsole layers may be manufactured from ethyl vinyl acetate (EVA), polyurethane (PU), expanded thermoplastic polyurethane (eTPU) foam, polyether block amide (PEBA/PEBAX) foam, other bead and non-bead foams, a gel or other cushioning materials. In the illustrated embodiment, the top midsole layer 14 and the bottom midsole layer 18 are manufactured from eTPU or PEBA bead foams. While the top midsole layer 14 and the bottom midsole layer 18 are manufactured from the same material in the illustrated embodiment, the two midsole lay-

ers may be manufactured from different materials or from the same material, but with different cushion properties (such as different durometers).

**[0048]** The plate 16 may be manufactured from essentially any material and will typically be manufactured from a material that is more rigid than the material used to manufacture the midsole layers 14 and 18. In the illustrated embodiment, the plate 16 is manufactured from nylon. For example, the plate 16 may be molded from nylon stock or formed from a sheet of nylon. Although the plate 16 of the illustrated embodiment is manufactured from a single layer of material, the plate 16 may in alternative embodiments be constructed from multiple layers. For example, the plate 16 can be constructed from a composite material, such as layers of carbon fabric that are each weaved from carbon strands. It also will be appreciated that the plate can be constructed from other polymer materials, such as polymers, metals, composites and combinations thereof.

**[0049]** The outsole 50 can be manufactured from one or more materials, for example, natural or synthetic rubber, thermoplastic polyurethane elastomers (TPU), nylon, polymer blends, wear resistant polymers, elastomers and/or other materials. Other materials, such as fiber-reinforced polymers can be used, which can include epoxy, polyethylene or thermosetting plastic reinforced with carbon, glass and/or aramid fibers for enhanced protection. The outsole 50 can include multiple lugs and/or treads that extend downward or that are defined by recesses into the bottom surface of the outsole, or alternatively can be relatively featureless, forming a smooth surface. Where present, the lugs and treads can be arranged as desired, and alternatively in a repeating pattern. The lugs and treads can include one or more geometric shapes.

**[0050]** Although the different elements and assemblies of the embodiments are described herein as having certain functional characteristics, each element and/or its relation to other elements can be depicted or oriented in a variety of different aesthetic configurations, which support the ornamental and aesthetic aspects of the same. Simply because an apparatus, element or assembly of one or more of elements is described herein as having a function does not mean its orientation, layout or configuration is not purely aesthetic and ornamental in nature.

**[0051]** In addition, when a component, part or layer is referred to as being "joined with," "on," "engaged with," "adhered to," "secured to," or "coupled to" another component, part or layer, it may be directly joined with, on, engaged with, adhered to, secured to, or coupled to the other component, part or layer, or any number of intervening components, parts or layers may be present. In contrast, when an element is referred to as being "directly joined with," "directly on," "directly engaged with," "directly adhered to," "directly secured to," or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe

the relationship between components, layers and parts should be interpreted in a like manner, such as "adjacent" versus "directly adjacent" and similar words. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

**[0052]** The above description is that of current embodiments of the invention. Various alterations and changes can be made without departing from the spirit and broader aspects of the invention as defined in the appended claims, which are to be interpreted in accordance with the principles of patent law including the doctrine of equivalents. This disclosure is presented for illustrative purposes and should not be interpreted as an exhaustive description of all embodiments of the invention or to limit the scope of the claims to the specific elements illustrated or described in connection with these embodiments. For example, and without limitation, any individual element(s) of the described invention may be replaced by alternative elements that provide substantially similar functionality or otherwise provide adequate operation. This includes, for example, presently known alternative elements, such as those that might be currently known to one skilled in the art, and alternative elements that may be developed in the future, such as those that one skilled in the art might, upon development, recognize as an alternative. Further, the disclosed embodiments include a plurality of features that are described in concert and that might cooperatively provide a collection of benefits. The present invention is not limited to only those embodiments that include all of these features or that provide all of the stated benefits, except to the extent otherwise expressly set forth in the issued claims. Any reference to claim elements in the singular, for example, using the articles "a," "an," "the" or "said," is not to be construed as limiting the element to the singular. Any reference to claim elements as "at least one of X, Y and Z" is meant to include any one of X, Y or Z individually, any combination of X, Y and Z, for example, X, Y, Z; X, Y; X, Z; Y, Z, and/or any other possible combination together or alone of those elements, noting that the same is open ended and can include other elements.

**[0053]** The description extends to the following set of numbered statements:

S1. A sole assembly comprising:

a top midsole layer;  
a bottom midsole layer; and  
a plate disposed between the top midsole layer and the bottom midsole layer, the plate including a heel portion, an arch portion and a forefoot portion, the forefoot portion including a medial longitudinal extension extending forwardly from the arch portion and having a free end opposite the arch portion, a central longitudinal extension extending forwardly from the arch portion and having a free end opposite the arch portion and a lateral longitudinal extension extending for-

wardly from the arch portion and having a free end opposite the arch portion, the central longitudinal extension and the lateral longitudinal extension being joined to one another by a bridge, the bridge extending between the free end of the central longitudinal extension and the free end of the lateral longitudinal extension.

S2. The sole assembly of statement S1 wherein the plate includes a heel cup disposed at least in the heel portion, the heel cup being curved and opening upwardly.

S3. The sole assembly of statement S2 wherein the plate includes a heel flange extending outwardly from the heel cup at least in the heel portion.

S4. The sole assembly of statement S3 wherein the top midsole layer does not cover the heel flange.

S5. The sole assembly of statement S3 (or S4) wherein the bottom midsole layer underlies the heel flange.

S6. The sole assembly of statement S5 (or S3 or S4) wherein the sole assembly includes a heel region and wherein the top midsole layer and the bottom midsole layer are stepped with the bottom midsole layer extending beyond a medial extent, a lateral extent and a rear extent of the top midsole in the heel region.

S7. The sole assembly of statement S6 (or any of S3 to S5) wherein the heel flange is crescent shaped and generally planar.

S8. The sole assembly of statement S7 (or any of S1 to S6) wherein the bottom midsole layer defines lateral and medial recesses that expose portions of an undersurface of the plate in the arch region.

S9. The sole assembly of statement S8 (or any of S1 to S7) wherein the bottom midsole layer defines a forefoot opening underlying a portion of the central longitudinal extension, the forefoot opening extending through the bottom midsole layer to expose at least a portion of an undersurface of the central longitudinal extension.

S10. The sole assembly of statement S1 (or any of S2 to S9) wherein the medial longitudinal extension is offset inwardly from a medial edge of the sole assembly, the medial longitudinal extension being curved in correspondence with the medial edge; and

wherein the lateral longitudinal extension is offset inwardly from a lateral edge of the sole assembly, the lateral longitudinal extension being curved in correspondence with the lateral edge; and

wherein the central longitudinal extension is generally straight and is disposed between the medial lateral extension and the lateral longitudinal extension.

S11. An article of footwear comprising:

an upper having a heel portion, an arch portion and a forefoot portion; and  
a sole assembly connected to the upper, the sole assembly including;

a top midsole layer having a heel portion, an arch portion and a forefoot portion;  
a bottom midsole layer having a heel portion, an arch portion and a forefoot portion; and  
a plate disposed between the top midsole layer and the bottom midsole layer, the plate having a heel portion with a heel cup and a peripheral flange extending from at least a portion of the heel cup, the plate having an arch portion extending forwardly from the heel portion, the plate having a forefoot portion with a medial longitudinal extension extending forwardly from the arch portion, a central longitudinal extension extending forwardly from the arch portion and a lateral longitudinal extension extending forwardly from the arch portion and having a free end opposite the arch portion, the central longitudinal extension and the lateral longitudinal extension being joined to one another by a bridge, the bridge extending between the free end of the central longitudinal extension and the free end of the lateral longitudinal extension, the plate having a bridge extending between the central longitudinal extension and the lateral longitudinal extension.

S12. The footwear of statement S11 wherein the heel portion of the top midsole layer extends outwardly beyond the heel portion of the upper on a lateral side, a medial side a rear of the upper; wherein the heel portion of the bottom midsole layer extends outwardly beyond the heel portion of the top midsole layer on a lateral side, a medial side a rear of the upper.

S13. The footwear of statement S12 (or S11) wherein the heel portion of the top midsole layer is seated within the heel cup; and wherein the heel flange includes a top surface that is uncovered by the top midsole layer and a bottom surface that is engaged with the bottom midsole layer.

S14. The footwear of statement S13 (or S11 or S12) wherein the heel flange is crescent shaped and generally planar.

S15. The footwear of statement S14 (or any of S11 to S13) wherein the bottom midsole layer defines lateral and medial recesses that expose portions of an undersurface of the arch portion of the plate.

S16. The footwear of statement S15 (or any of S11 to S14) wherein the bottom midsole layer defines a

forefoot opening underlying a portion of the central longitudinal extension, the forefoot opening extending through the bottom midsole layer to expose at least a portion of an undersurface of the central longitudinal extension.

S17. The footwear of statement S16 (or any of S11 to S15) wherein the heel portion of the plate defines a central opening, the top midsole layer being in communication with the bottom midsole layer through the central opening.

S18. The footwear of statement S17 (or any of S11 to S16) wherein the medial longitudinal extension is offset inwardly from a medial edge of the sole assembly, the medial longitudinal extension being curved and extending generally parallel to the medial edge; and

wherein the lateral longitudinal extension is offset inwardly from a lateral edge of the sole assembly, the lateral longitudinal extension being curved and extending generally parallel to the lateral edge; and

wherein the central longitudinal extension is generally straight and is disposed between the medial lateral extension and the lateral longitudinal extension.

S19. The footwear of statement S18 wherein the medial longitudinal extension extends along the medial edge of the sole assembly in a location to support a great toe of a wearer's foot and the bridge extends laterally across the sole assembly in a location to support 2<sup>nd</sup> through 5<sup>th</sup> toes of a wearer's foot.

S20. The footwear of statement S19 (or any of S11 to S18) further comprising an outsole, the outsole having a forefoot segment and a heel segment, the forefoot segment defining a forefoot opening coinciding with the forefoot opening of the bottom midsole layer.

S21. An article of footwear comprising:

the sole assembly according to any of statements S1 to S10,  
optionally wherein the article of footwear additionally comprises an upper having a heel portion, an arch portion and a forefoot portion, and the sole assembly is connected to the upper.

S22. An article of footwear incorporating the sole assembly of statement S1 further comprising:

an upper having a heel portion, an arch portion and a forefoot portion; and  
wherein the sole assembly is connected to the upper, the sole assembly including;

the top midsole layer having a heel portion, an arch portion and a forefoot portion;

the bottom midsole layer having a heel portion, an arch portion and a forefoot portion; and

the heel portion of the plate having a heel cup and a peripheral flange extending from at least a portion of the heel cup, the arch portion of the plate.

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## 10 Claims

1. A sole assembly comprising:

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a top midsole layer;  
a bottom midsole layer; and  
a plate disposed between the top midsole layer and the bottom midsole layer, the plate including a heel portion, an arch portion and a forefoot portion, the forefoot portion including a medial longitudinal extension extending forwardly from the arch portion and having a free end opposite the arch portion, a central longitudinal extension extending forwardly from the arch portion and having a free end opposite the arch portion and a lateral longitudinal extension extending forwardly from the arch portion and having a free end opposite the arch portion, the central longitudinal extension and the lateral longitudinal extension being joined to one another by a bridge, the bridge extending between the free end of the central longitudinal extension and the free end of the lateral longitudinal extension.

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2. The sole assembly of claim 1 wherein the plate includes a heel cup disposed at least in the heel portion, the heel cup being curved and opening upwardly.

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3. The sole assembly of claim 2 wherein the plate includes a heel flange extending outwardly from the heel cup at least in the heel portion.

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4. The sole assembly of claim 3 wherein the top midsole layer does not cover the heel flange.

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5. The sole assembly of claim 3 or 4 wherein the bottom midsole layer underlies the heel flange.

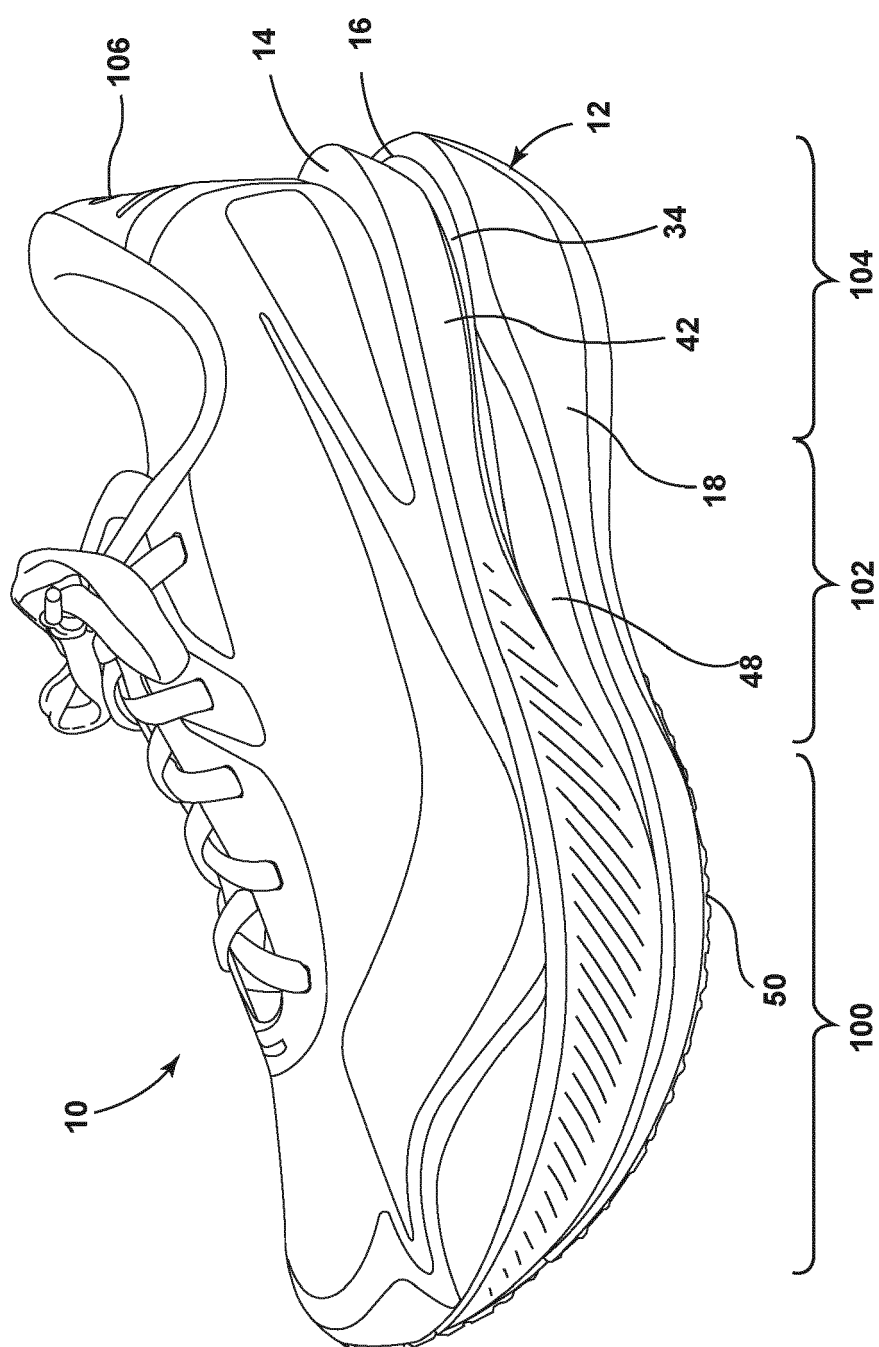
6. The sole assembly of any of claims 3 to 5 wherein the sole assembly includes a heel region and wherein the top midsole layer and the bottom midsole layer are stepped with the bottom midsole layer extending beyond a medial extent, a lateral extent and a rear extent of the top midsole in the heel region.

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7. The sole assembly of any of claims 3 to 6 wherein the heel flange is crescent shaped and generally planar.

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8. The sole assembly of any of the preceding claims wherein the bottom midsole layer defines lateral and medial recesses that expose portions of an undersurface of the plate in the arch region. 5
9. The sole assembly of any of the preceding claims wherein the bottom midsole layer defines a forefoot opening underlying a portion of the central longitudinal extension, the forefoot opening extending through the bottom midsole layer to expose at least a portion of an undersurface of the central longitudinal extension. 10
10. The sole assembly of any of the preceding claims wherein the medial longitudinal extension is offset inwardly from a medial edge of the sole assembly, the medial longitudinal extension being curved in correspondence with the medial edge; and 15
- wherein the lateral longitudinal extension is offset inwardly from a lateral edge of the sole assembly, the lateral longitudinal extension being curved in correspondence with the lateral edge; and 20
- wherein the central longitudinal extension is generally straight and is disposed between the medial lateral extension and the lateral longitudinal extension. 25
11. An article of footwear incorporating the sole assembly of any of the preceding claims further comprising: 30
- an upper having a heel portion, an arch portion and a forefoot portion; and
- wherein the sole assembly is connected to the upper, the sole assembly including; 35
- the top midsole layer having a heel portion, an arch portion and a forefoot portion;
- the bottom midsole layer having a heel portion, an arch portion and a forefoot portion; 40
- and
- the heel portion of the plate having a heel cup and a peripheral flange extending from at least a portion of the heel cup, optionally 45
- wherein the arch portion of the plate extends forwardly from the heel portion.
12. The footwear of claim 11 wherein the heel portion of the top midsole layer extends outwardly beyond the heel portion of the upper on a lateral side, a medial side a rear of the upper; 50
- wherein the heel portion of the bottom midsole layer extends outwardly beyond the heel portion of the top midsole layer on a lateral side, a medial side a rear of the upper. 55
13. The footwear of claim 11 or 12 wherein the heel portion of the top midsole layer is seated within the heel cup; and
- wherein the heel flange includes a top surface that is uncovered by the top midsole layer and a bottom surface that is engaged with the bottom midsole layer.
14. The footwear of claim 11, 12 or 13 wherein the heel flange is crescent shaped and generally planar.
15. The footwear of any of claims 11 to 14 wherein the bottom midsole layer defines lateral and medial recesses that expose portions of an undersurface of the arch portion of the plate.



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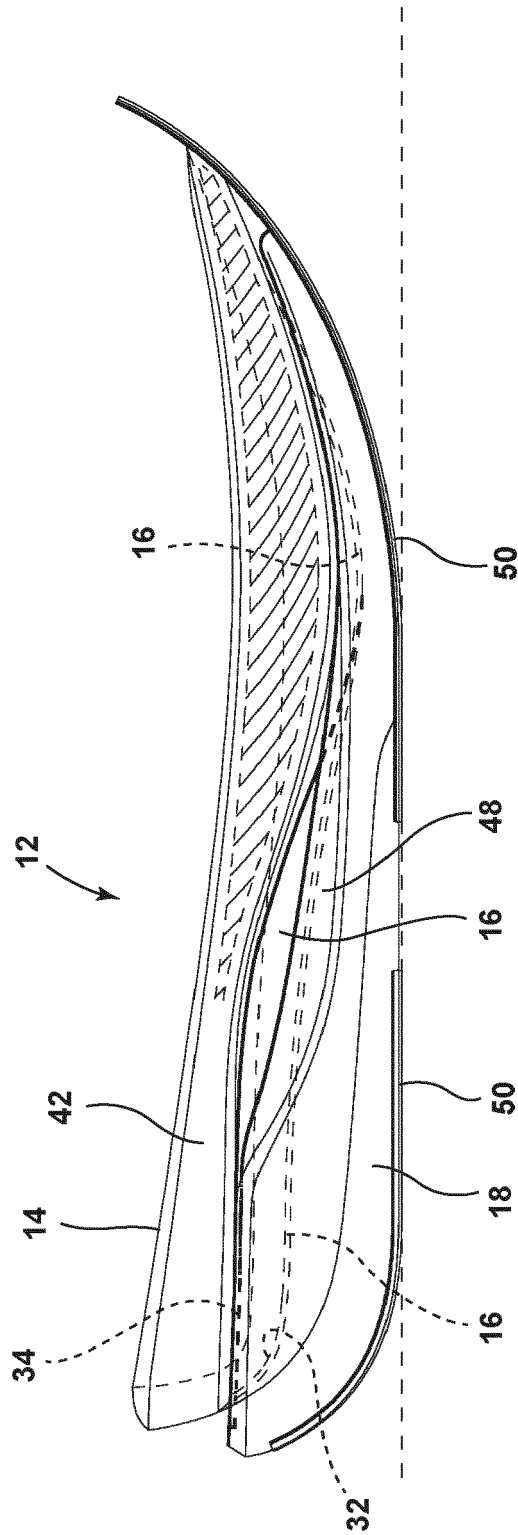


FIG. 2

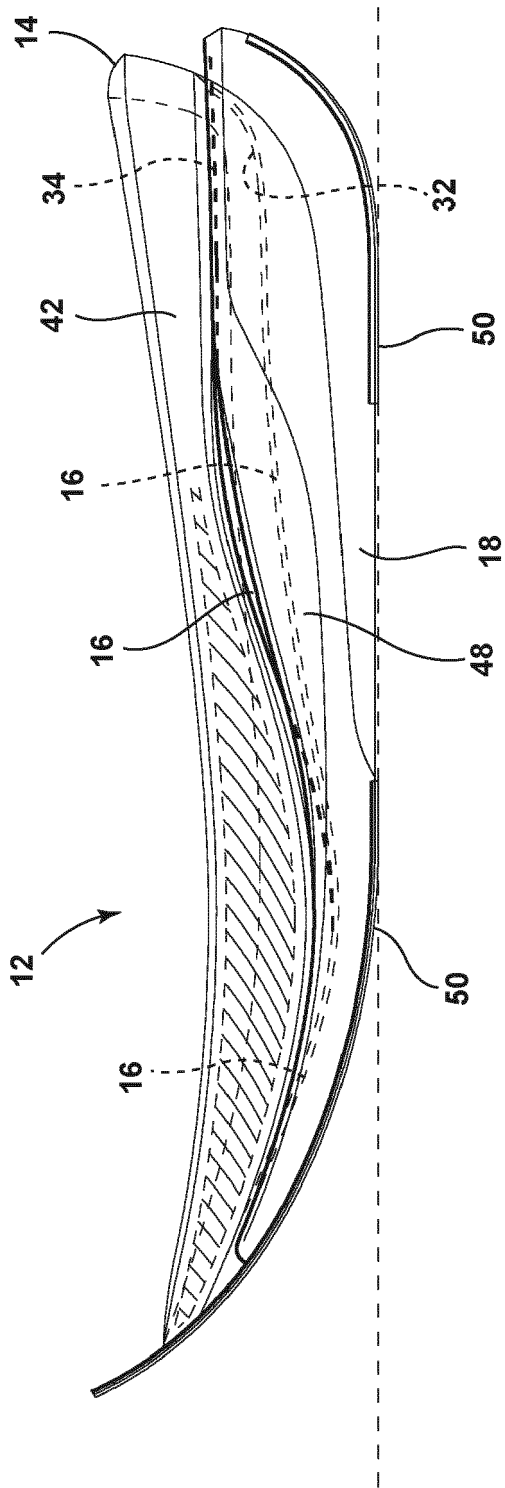


FIG. 3

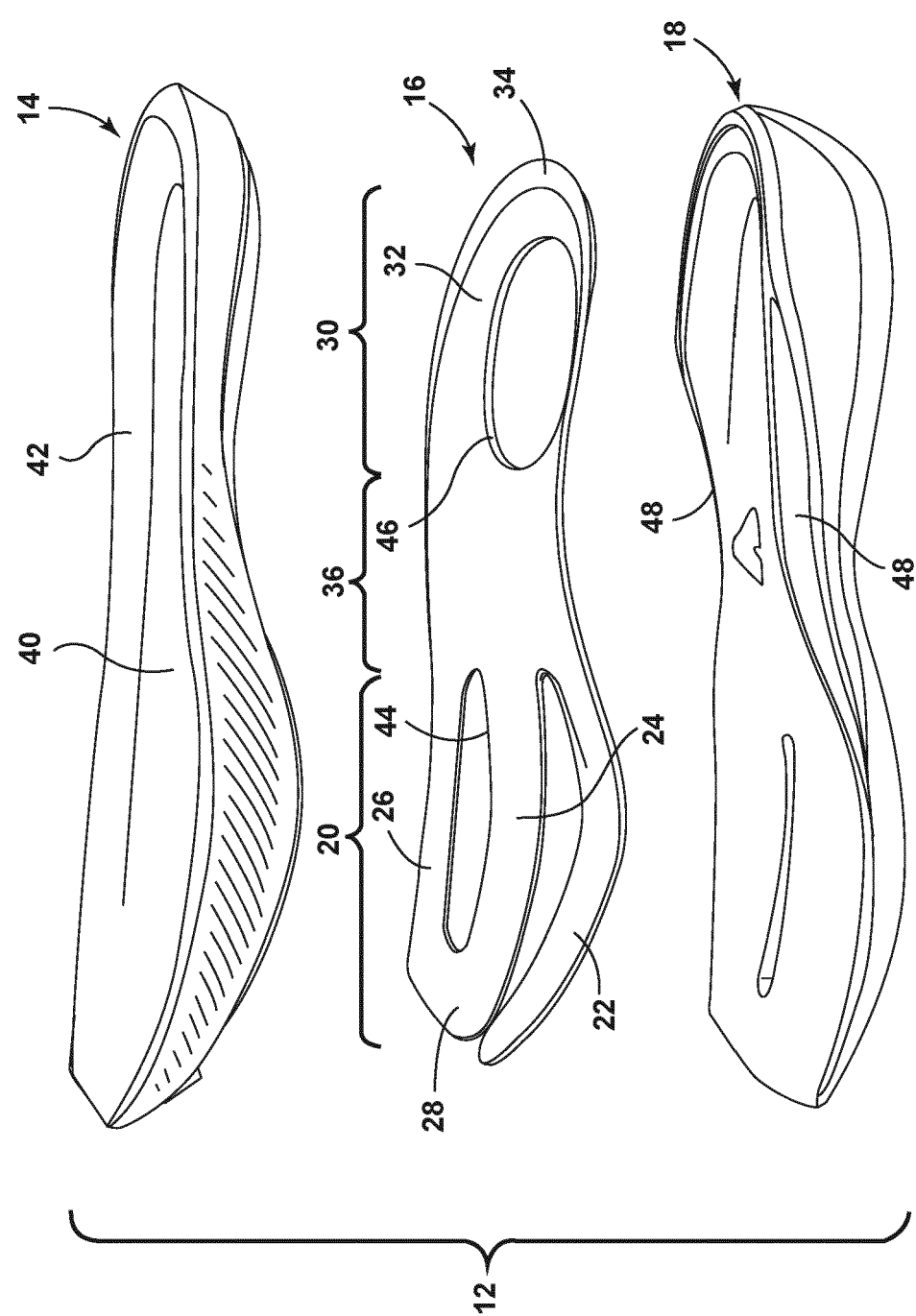
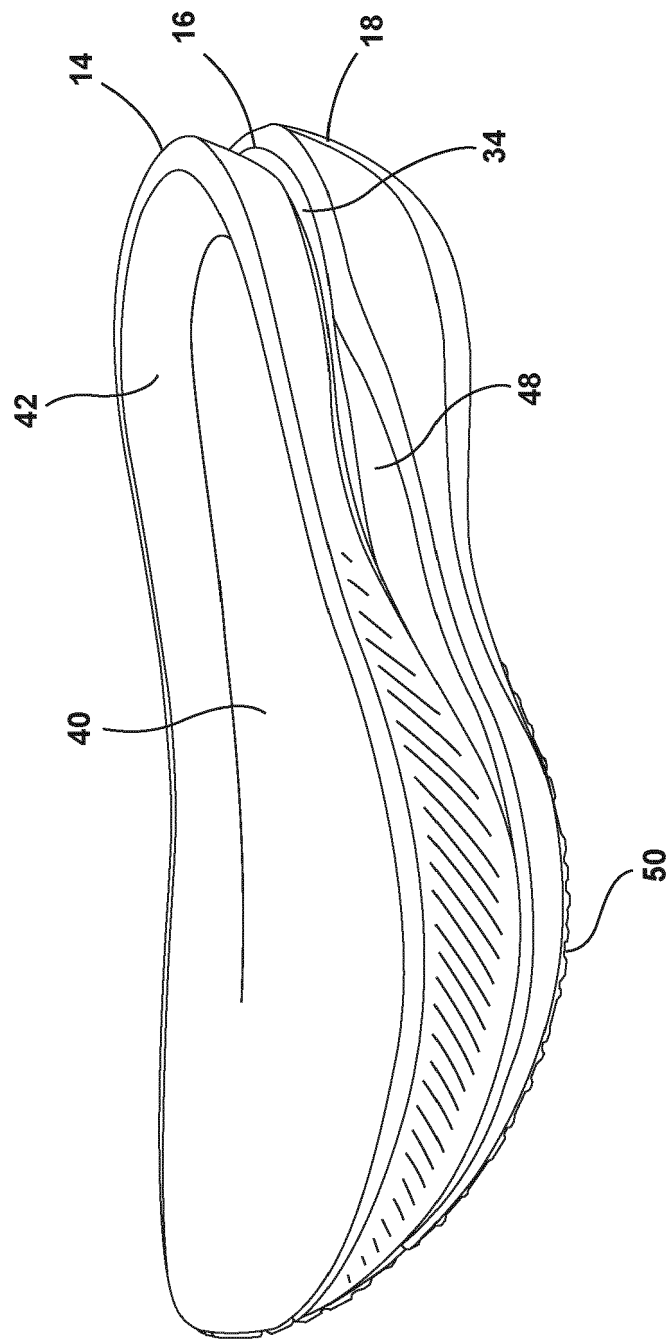


FIG. 4



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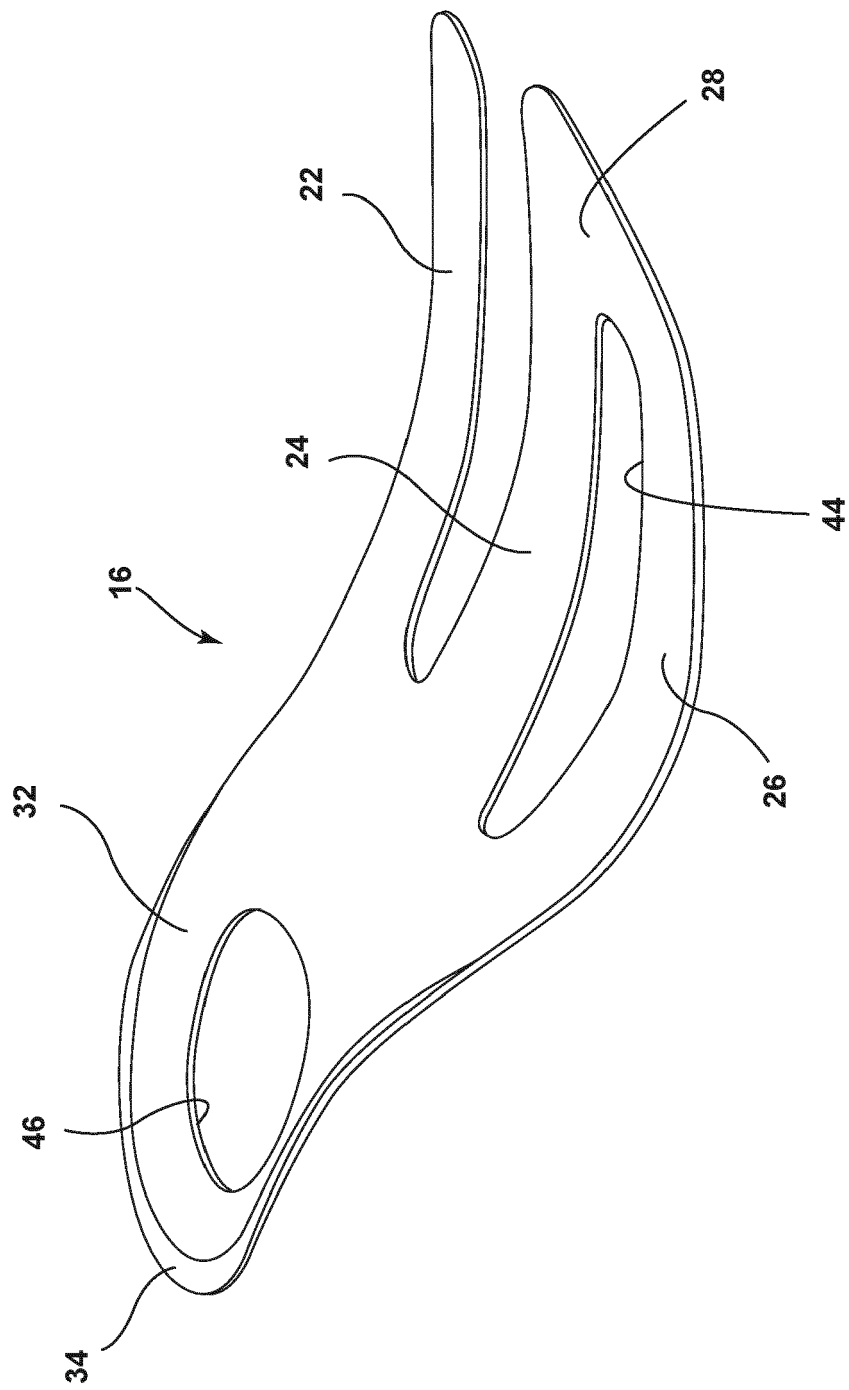


FIG. 6

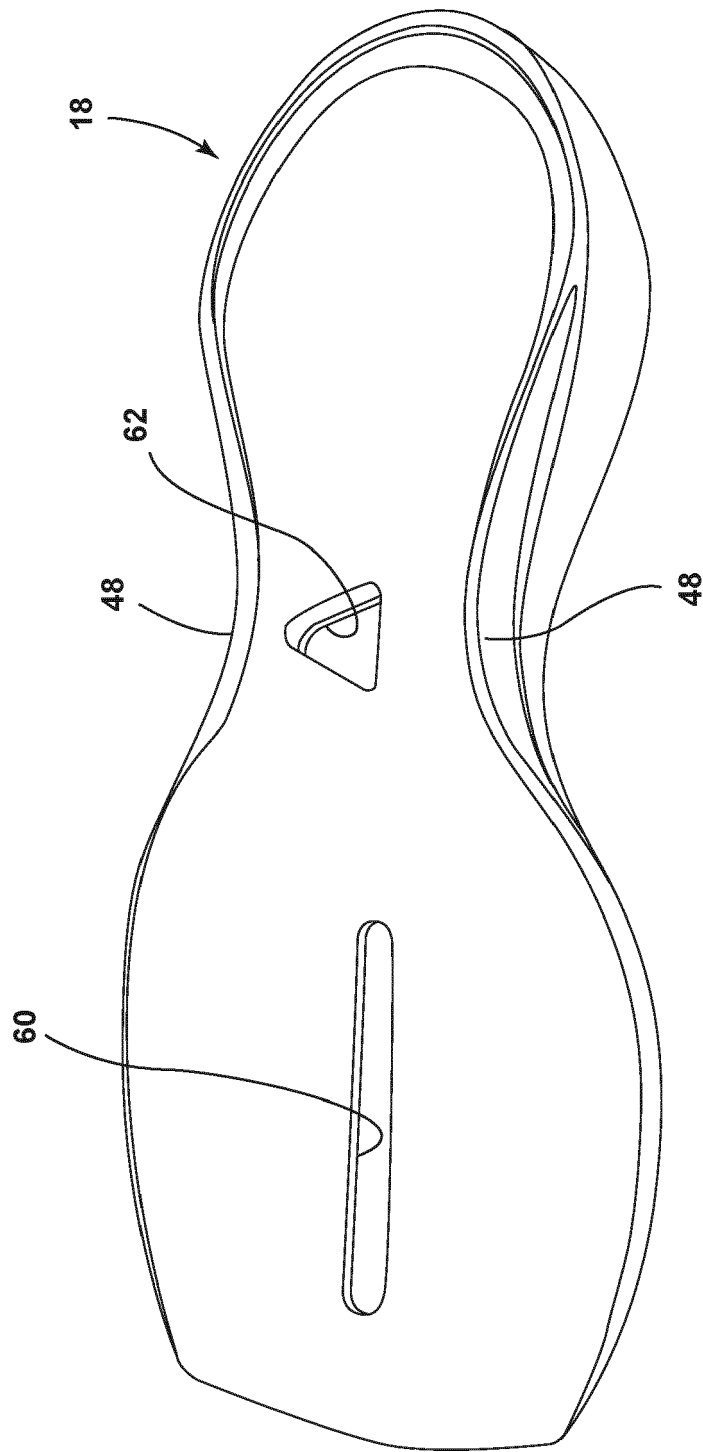


FIG. 7

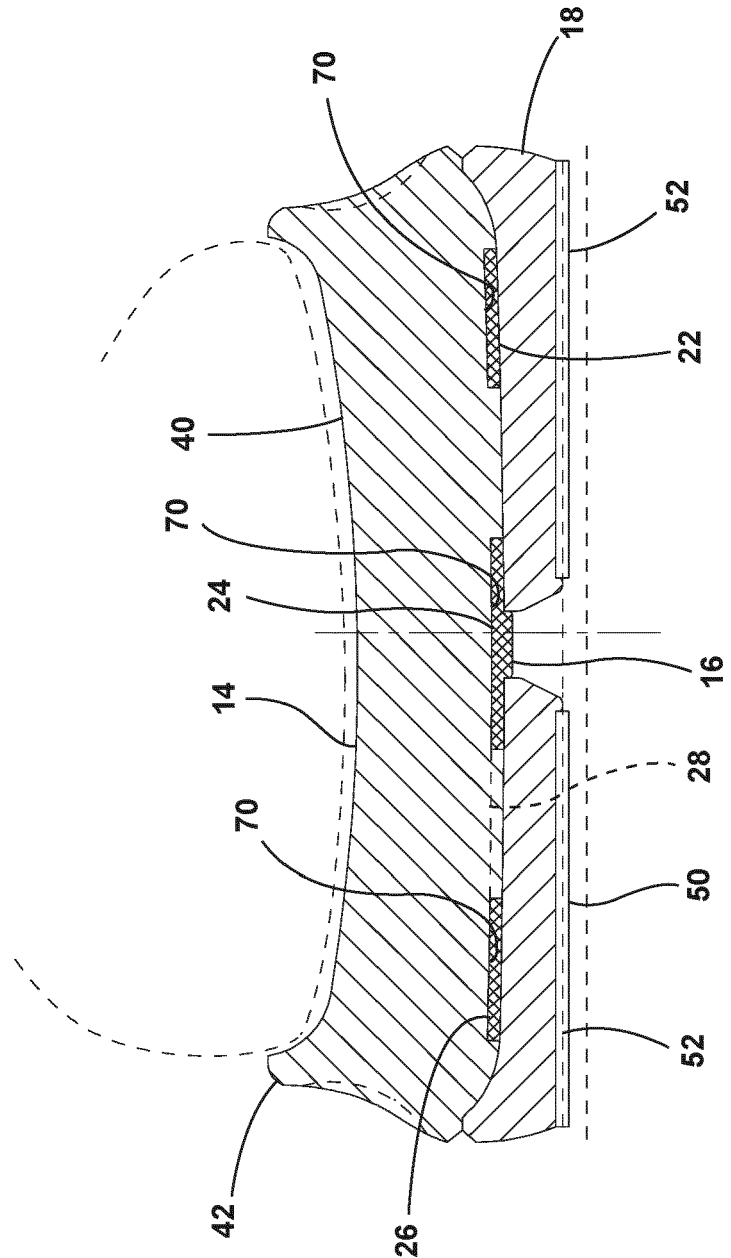


FIG. 8

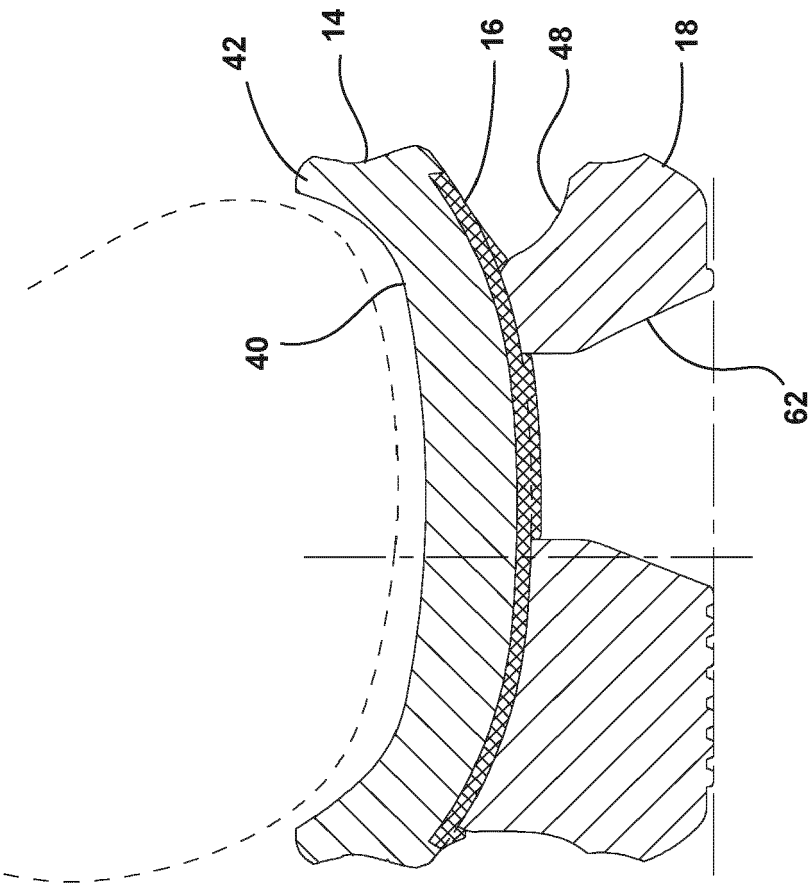


FIG. 9

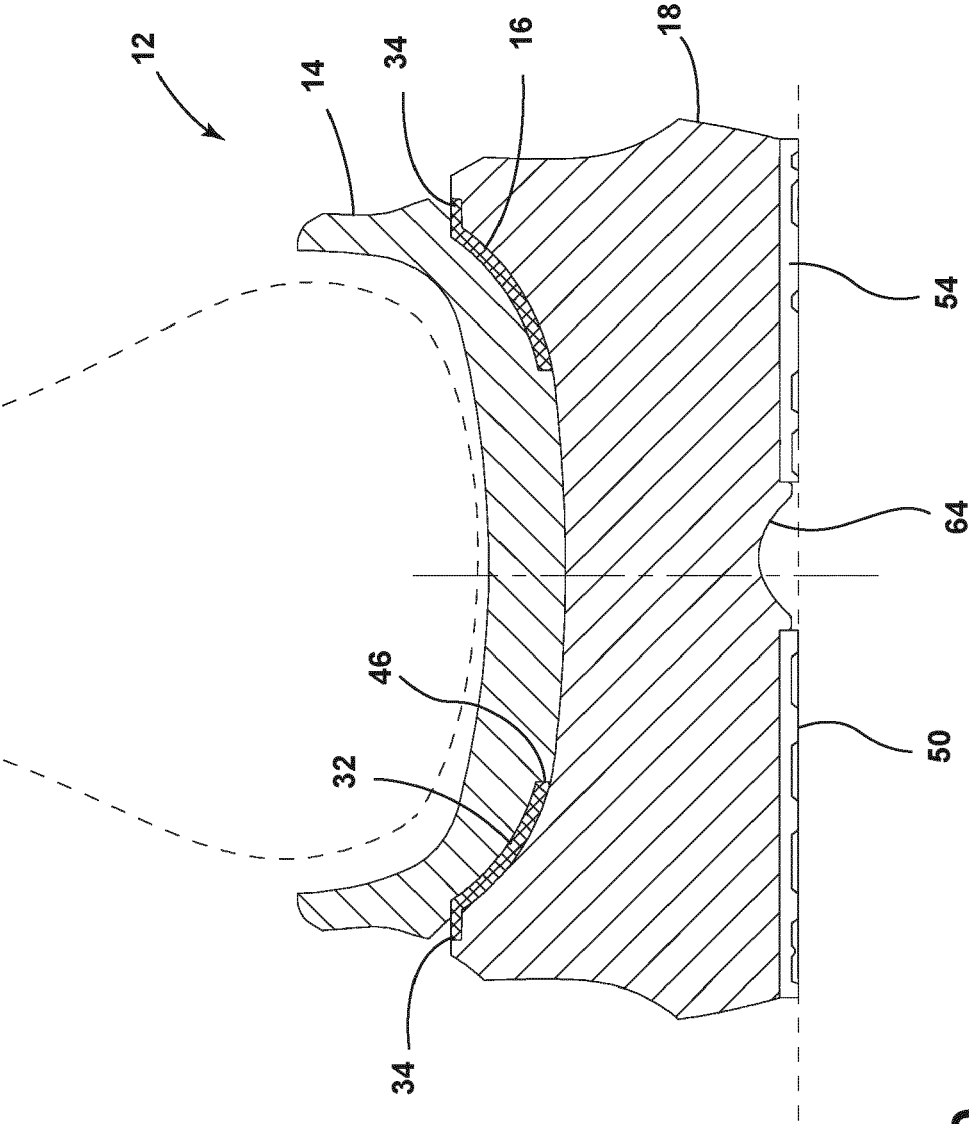


FIG. 10

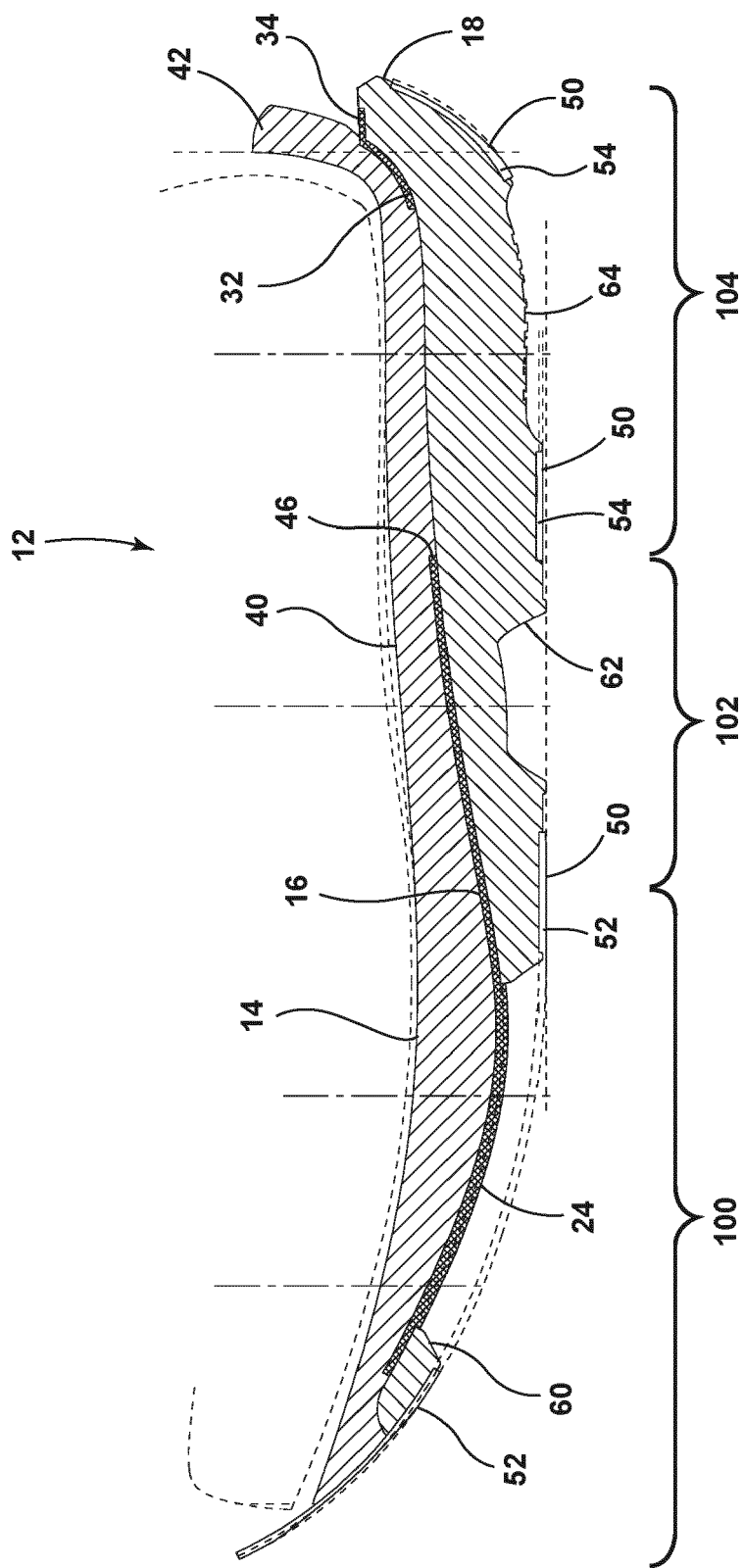


FIG. 11

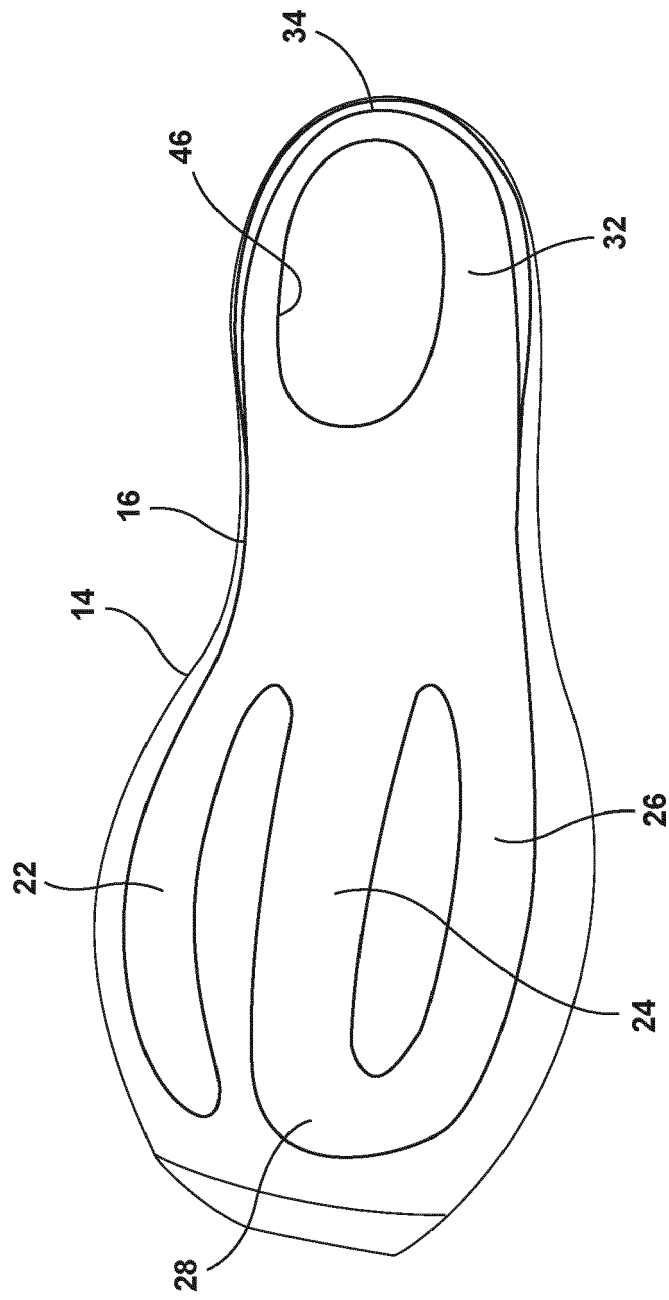


FIG. 12

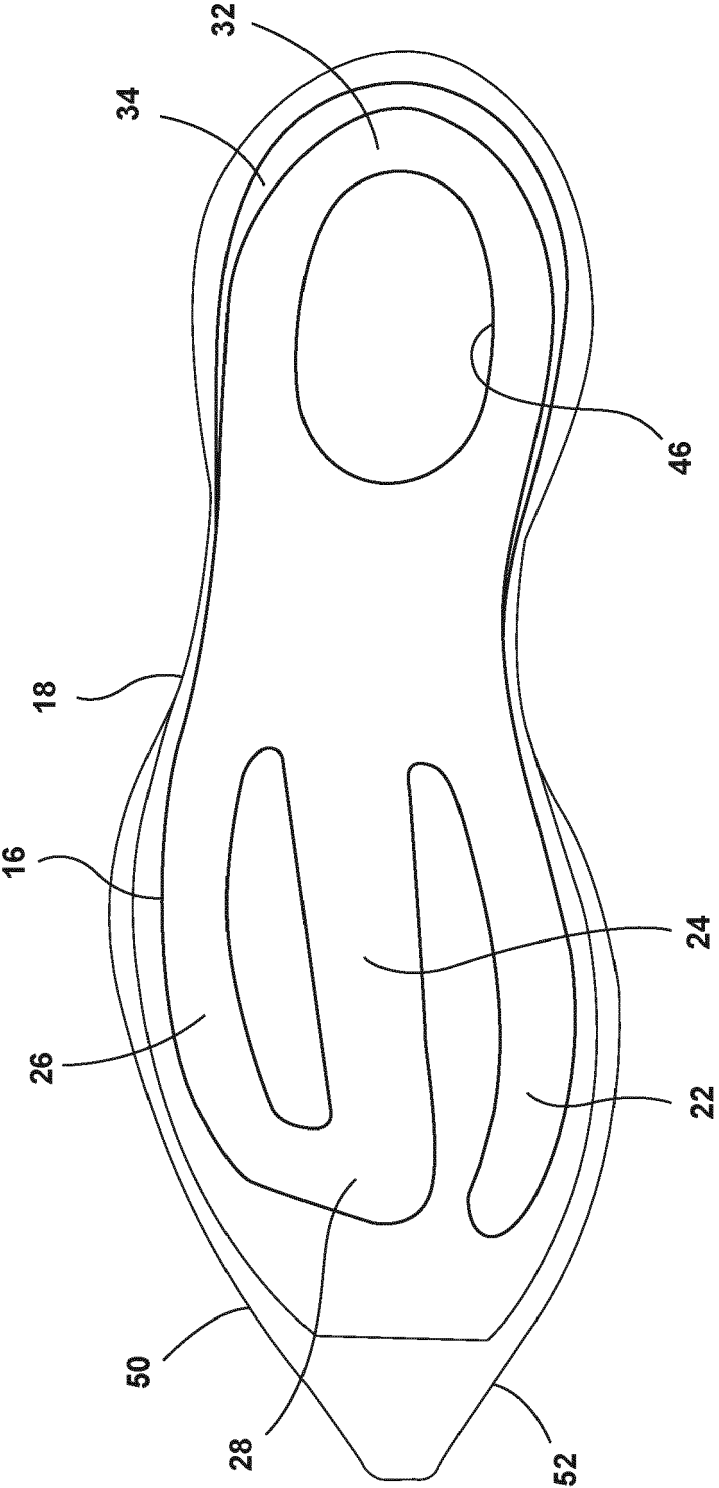


FIG. 13



## EUROPEAN SEARCH REPORT

Application Number

EP 23 21 5695

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category                                                                                                                                                                                                                | Citation of document with indication, where appropriate, of relevant passages          | Relevant to claim                                                                                                                                                                                                                                                                     | CLASSIFICATION OF THE APPLICATION (IPC)          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| A                                                                                                                                                                                                                       | US 2017/079373 A1 (HUARD ROGER L [US] ET AL) 23 March 2017 (2017-03-23)<br>* figures * | 1-15                                                                                                                                                                                                                                                                                  | INV.<br>A43B7/142<br>A43B7/143<br>A43B7/144      |
| A                                                                                                                                                                                                                       | US 2013/205620 A1 (HSU HENRY [US]) 15 August 2013 (2013-08-15)<br>* figures *          | 1-15                                                                                                                                                                                                                                                                                  | A43B7/1445<br>A43B13/12<br>A43B13/18<br>A43B3/00 |
|                                                                                                                                                                                                                         |                                                                                        |                                                                                                                                                                                                                                                                                       | TECHNICAL FIELDS SEARCHED (IPC)                  |
|                                                                                                                                                                                                                         |                                                                                        |                                                                                                                                                                                                                                                                                       | A43B                                             |
| The present search report has been drawn up for all claims                                                                                                                                                              |                                                                                        |                                                                                                                                                                                                                                                                                       |                                                  |
| Place of search                                                                                                                                                                                                         |                                                                                        | Date of completion of the search                                                                                                                                                                                                                                                      | Examiner                                         |
| The Hague                                                                                                                                                                                                               |                                                                                        | 7 February 2024                                                                                                                                                                                                                                                                       | Gkionaki, Angeliki                               |
| CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                             |                                                                                        | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>.....<br>& : member of the same patent family, corresponding document |                                                  |
| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                        |                                                                                                                                                                                                                                                                                       |                                                  |

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ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.

EP 23 21 5695

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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07-02-2024

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| US 2017079373 A1                          | 23-03-2017          | CA 2923715 A1              | 17-03-2017          |
|                                           |                     | CN 106539186 A             | 29-03-2017          |
|                                           |                     | US 2017079373 A1           | 23-03-2017          |
|                                           |                     | US 2017202305 A1           | 20-07-2017          |
| US 2013205620 A1                          | 15-08-2013          | NONE                       |                     |