US 20110314699A1

(19) **United States**

(12) **Patent Application Publication**

Byrne

(10) **Pub. No.: US 2011/0314699 A1**

(43) **Pub. Date: Dec. 29, 2011**

(54) **FOOTWEAR WITH ROCKER SOLE**

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(21) Appl. No.: **12/822,596**

(22) Filed: **Jun. 24, 2010**

Publication Classification

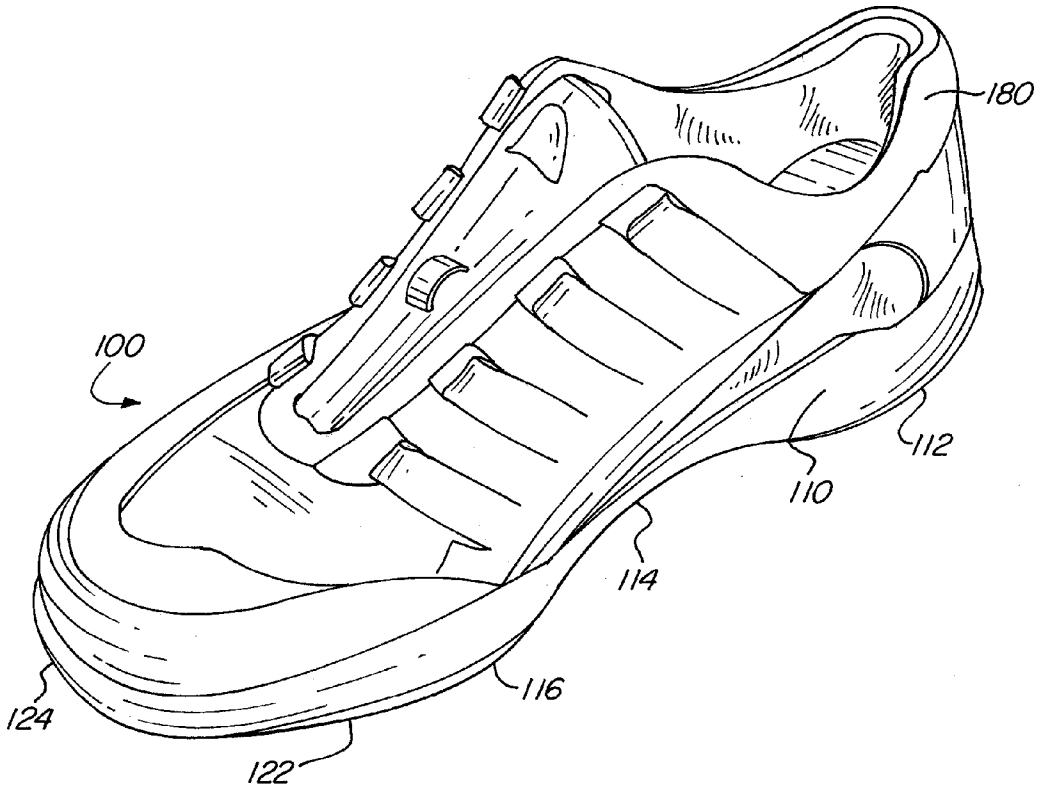
(51) **Int. Cl.**

A43B 13/00	(2006.01)
A43B 13/18	(2006.01)
A43B 21/24	(2006.01)
A43B 13/38	(2006.01)

(52) **U.S. Cl.** ..... **36/103**; 36/43; 36/28; 36/34 R

(57) **ABSTRACT**

An article of footwear with a rocker sole has an outsole with a rocker sole element that has a rear apex located 20 to 45 millimeters, preferably, 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area of the footwear and a generally curved surface extending forwardly and upwardly from the apex to a toe area of the footwear.



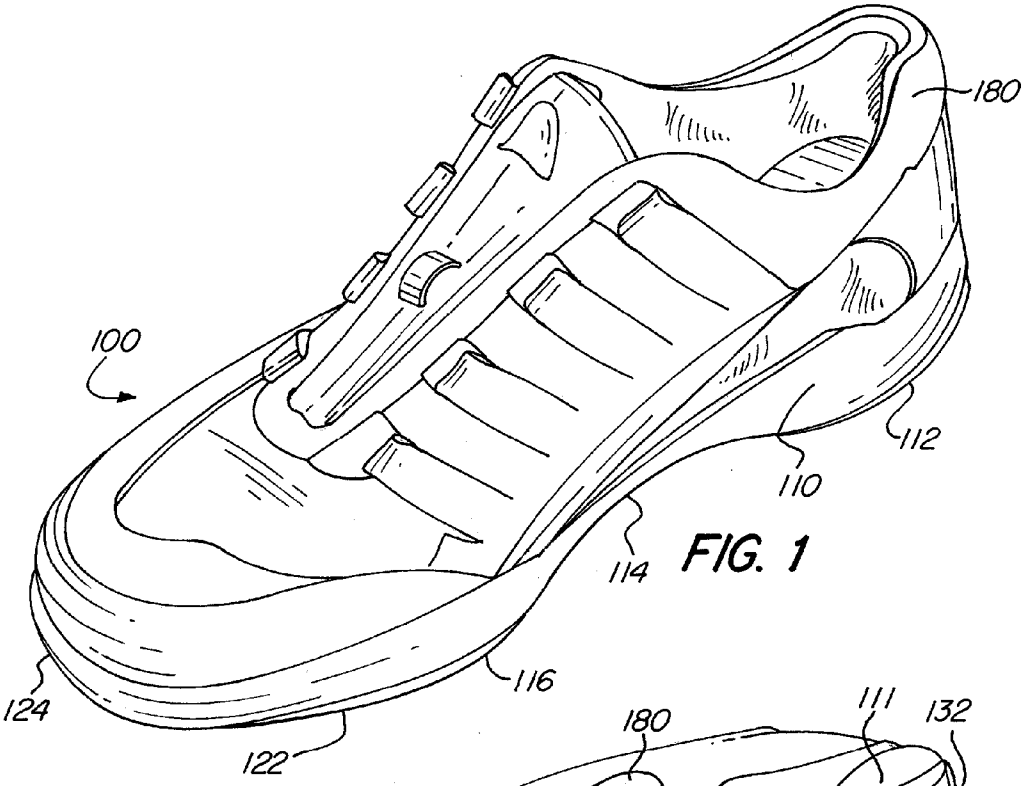

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FIG. 1

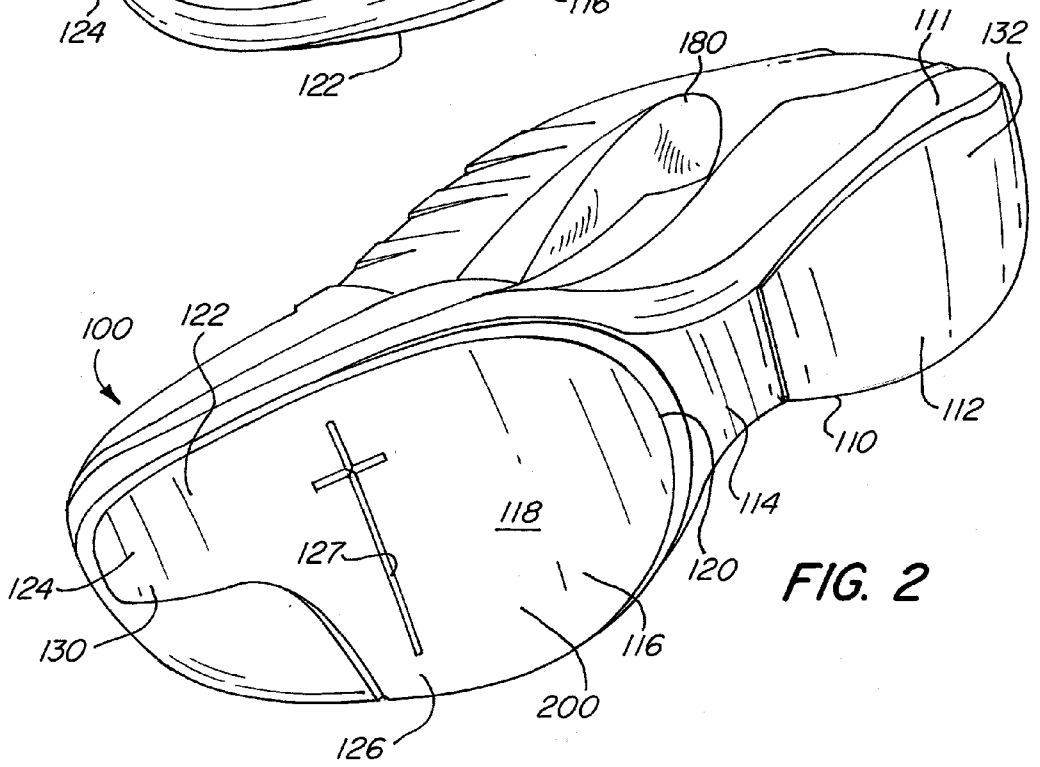
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FIG. 2

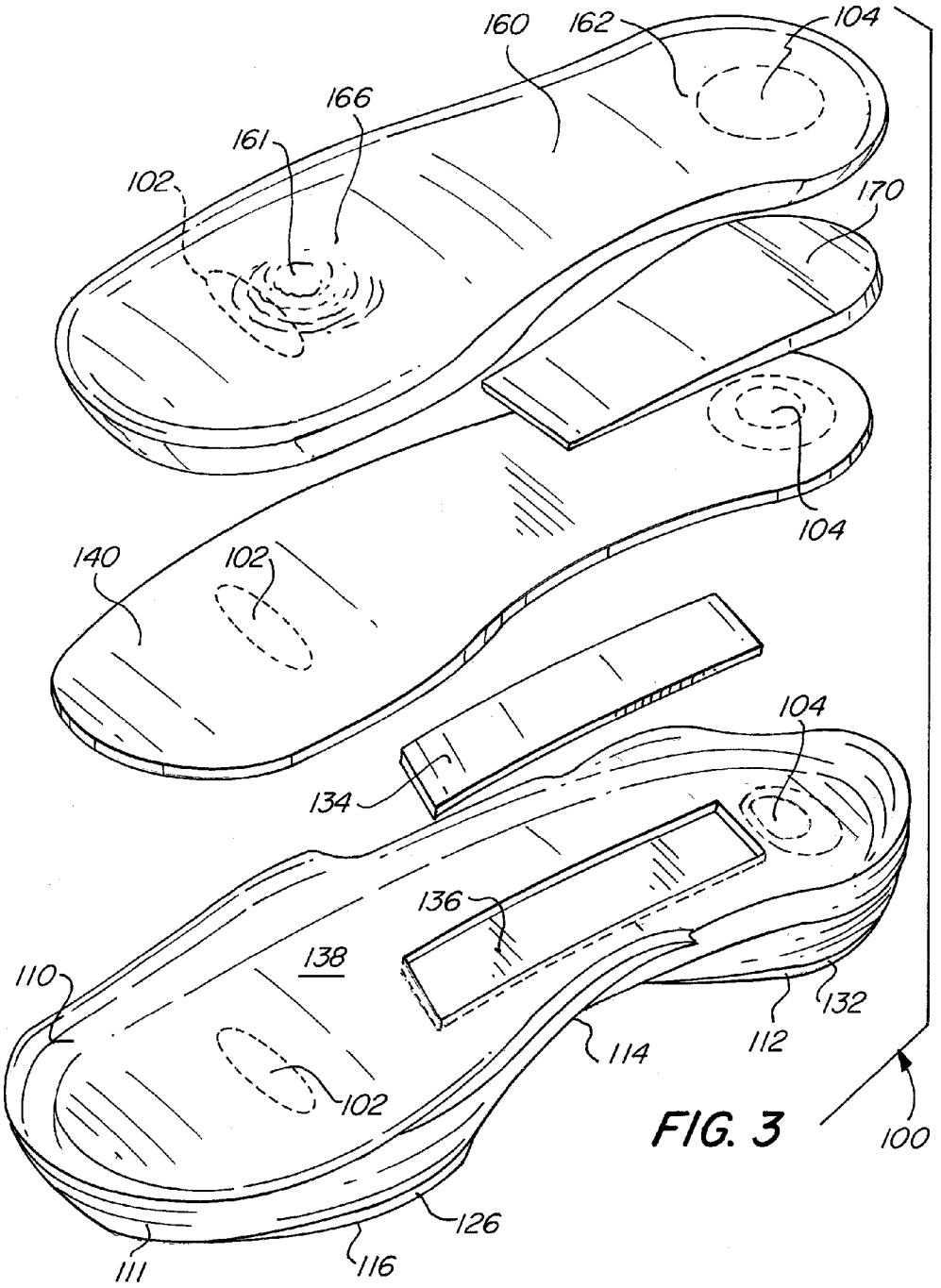
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FIG. 3

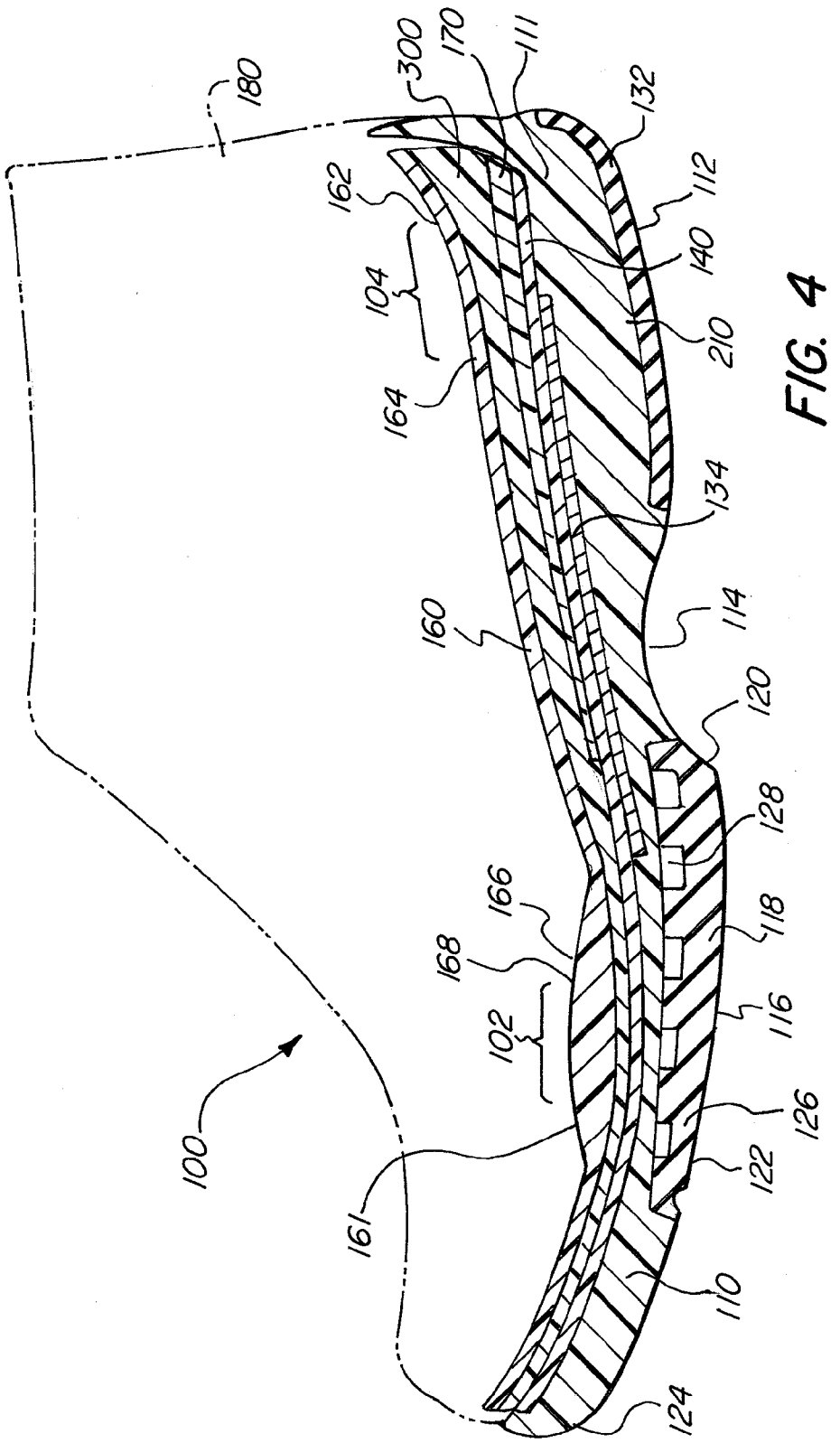
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FIG. 4

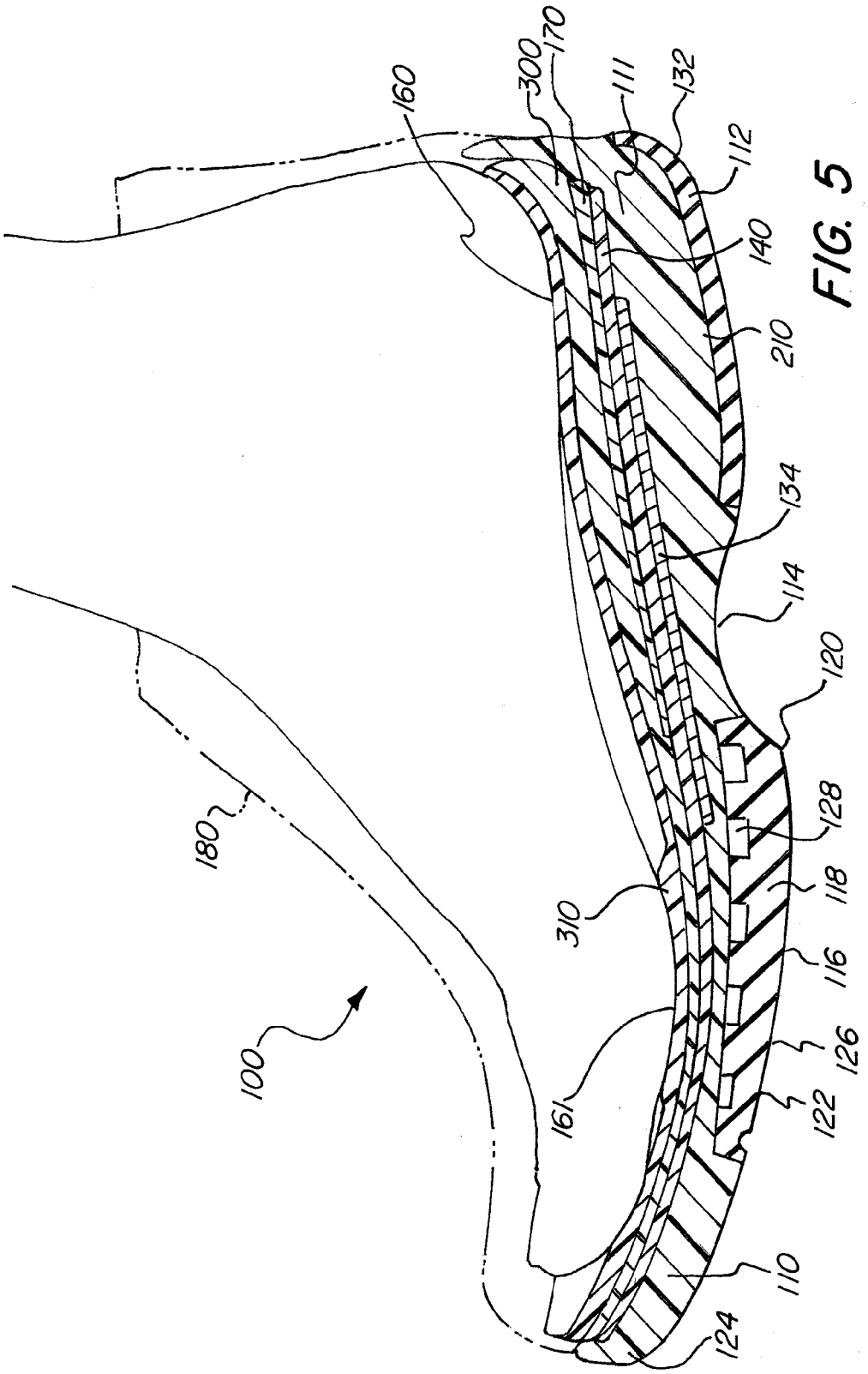
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FIG. 5

FOOTWEAR WITH ROCKER SOLE

TECHNICAL FIELD

[0001] The present invention relates to the field of footwear; and, more particularly, to footwear sole and insole combinations known as rocker soles.

BACKGROUND

[0002] The normal operation of the foot provides a smooth rolling motion throughout a step when walking. In a normal walking gait, the load on a person's foot moves from heel to toe and at an angle from the outside of the foot (supination) to the inside of the foot (pronation). A normal step begins with the heel strike as the heel is set down on the walking surface and ends with the toe off as the large toe pushes the foot off the walking surface. Generally, in a barefoot walking gait, the toe at the end of the step and the heel at the beginning of the step are on the same horizontal plane.

[0003] Traditional shoe constructions provide a sole with a heel that raises the bottom horizontal plane of the heel above the bottom horizontal plane of the ball of the foot and toes. With these traditional shoe soles, the heel is set down on the walking surface and the ball of the foot drops, rather than rolls, onto the walking surface. Conventional shoe soles have a flat upper surface. A formed insole is the placed on top of the shoe midsole and outsole. This insole is typically made of a soft, cushioning material, but due to the outsole construction, often cannot provide an even, continuous support along the bottom of the foot when walking.

[0004] Many efforts have been made over the years to construct a shoe sole that promotes a healthy and natural walking gait, alleviates foot pain, and does not cause fatigue. One such sole construction is a rocker sole construction. A rocker sole typically has a continuously curved bottom surface. The shoe sole has a bottom surface that contacts the walking surface and an upper surface that contacts the foot of the wearer. The continuous curve curves downward from the heel section through a mid-section that presents the lowest point of the continuous curve, and then upward to the toe section. In conventional rocker sole configurations, the apex of the rocker is located directly under the first metatarsophalangeal joint (ball) of the foot. Rocker soles with a rocker apex located under the center of the arch of the foot have been proposed for use in orthopedic footwear worn by persons in foot casts and in post-surgical footwear constructions.

[0005] Conventional rocker soles are generally perceived by the wearer as unstable. While there is a specific market for unstable shoe constructions targeted at customers who desire to obtain muscle toning effects associated with the constant position and balance adjustments necessitated by the unstable shoe construction, this is a distinct market and is not applicable to all customers.

[0006] In particular, unstable rocker sole shoe constructions are undesirable where the wearer is elderly or disabled, as the wearer is at greater risk of losing their balance and falling.

[0007] An additional known problem with conventional rocker soles is that they may cause undesirable biomechanical compensations, such as toeing out during walking gait, which in the long term will cause problems for the wearer.

[0008] There remains a need in the art for shoe sole designs that increase wearer comfort and stability, and which provide a maximum energy return when walking.

SUMMARY OF THE INVENTION

[0009] An article of footwear in accordance with an embodiment of the invention comprises an outsole having a rearward heel section, a raised arch section, and a forward rocker section. The footwear has a metatarsophalangeal joint area, and the forward rocker section has a rocker sole element which has a rear apex located 20 to 45 millimeters rearwardly of the metatarsophalangeal joint area. Preferably, the rear apex is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area. The rocker sole element has a generally curved surface extending forwardly and upwardly from the apex to a toe area of the footwear. A stiff shank extends from the heel section to the rocker section.

[0010] An insole is provided in the footwear. In one embodiment, the insole has a rearward heel section and a forward metatarsophalangeal joint area section, and upper surfaces of the insole rearward heel section and the insole forward metatarsophalangeal joint area section have about the same elevation. In another embodiment, the upper surface of the insole rearward heel section has a greater elevation than an upper surface of the insole forward metatarsophalangeal joint area section. A wedge-shaped heel lift is preferably located between the insole and the outsole in the heel sections thereof. Preferably, the metatarsophalangeal joint area of the insole has an increased thickness to provide a metatarsal support pad.

[0011] In preferred embodiments, the rocker sole element comprises a rubber rocker insert, and in most preferred embodiments, the forward rocker section of the outsole comprises a thickness which is about 80% rubber rocker insert and about 20% EVA outsole.

[0012] The present invention provides an article of footwear which provides increased energy return to the wearer as the wearer's stride causes the forward rocker section of the outsole to roll forwardly and propel the walker with each step. The stiffness of the outsole provides support for the wearer and encourages the rolling gait associated with a rocker sole construction. At the same time, the increased thickness of the rubber rocker insert that provides the desired stiffness is more durable and longer lasting than conventional sole designs and provides reduced problems of compression set associated with conventional EVA sole constructions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** is a front, top and left side perspective view of an embodiment of an article of footwear in accordance with the invention;

[0014] FIG. **2** is a bottom and left side perspective view thereof;

[0015] FIG. **3** is an exploded front, top and left side perspective view of an embodiment of a sole thereof;

[0016] FIG. **4** is a left side elevation view in cross-section of one embodiment of a sole thereof showing an upper in phantom outline; and

[0017] FIG. **5** is a left side elevation view in cross-section of one embodiment of a sole thereof showing a wearer's foot therein and showing an upper in phantom outline.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Referring now to FIGS. **1-5**, where like elements are identified with the same reference numerals, an article of footwear **100** comprises outsole **110**, a midsole **140**, an insole **160**, and an upper **180**. Footwear **100** has a metatarsophalangeal joint area **102** which is shown on each of the outsole **110**, midsole **140**, and insole **160** in FIG. **3**, and in the footwear **100** in FIG. **4**. The metatarsophalangeal joint area **102** is the area where a wearer's metatarsophalangeal joints (ball of the foot) will be located when the footwear **100** is worn by a wearer. Footwear **100** has a heel area **104** which is shown on each of the outsole **110**, midsole **140**, and insole **160** in FIG. **3**, and in the footwear **100** in FIG. **4**. The heel area **104** is the area where a wearer's heel will be located when the footwear **100** is worn by a wearer.

[0019] Outsole **110** has a rearward heel section **112**, a raised arch section **114**, and a forward rocker section **116**. The forward rocker section **116** has a rocker sole element **118** which has a rear apex **120**. The rocker sole element **118** has a generally curved surface **122** extending forwardly and upwardly from the rear apex **120** to a toe area **124** of the footwear **100**. The generally curved surface may be smooth or be provided with tread elements as are customary on footwear. The rear apex **120** is the lowest point of the rocker sole element **118** and serves as the fulcrum point of the shoe when a wearer is walking. Rear apex **120** is located 20 to 45 millimeters rearwardly of the metatarsophalangeal joint area **102**. Preferably, the rear apex is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area **102**.

[0020] In preferred embodiments, the outsole **110** is comprised of an ethylene-vinyl acetate ("EVA") body **111** with a rubber rocker insert **126** in the forepart of the footwear **100** and a rubber heel insert **132** in the heel part of the footwear **100**.

[0021] Rubber rocker insert **126** is best seen in FIGS. **2** and **4-5**. Rubber rocker insert **126** may be a solid piece, but preferably has hollow cavities **128** provided in its upper portions as seen in FIG. **4**. Rubber rocker insert **126** preferably is shaped so that it provides an outsole surface from the rear apex **120** forwardly, but is shaped at its forward end **130** so that the rubber rocker insert **126** surface is extends forwardly below the wearer's big toe area but not below the littlest toe. In one preferred embodiment, the forward part of the outsole surface is divided approximately in half from left to right with the rubber rocker insert **126** located below the half that receives the wearer's big toe, and the body **111** being exposed in the other half of the outsole surface.

[0022] EVA materials such as used in body **111** are used for footwear because of their shock absorption qualities. However, they are not suitable for the contact surface of the outsole because the materials do not have the durability to withstand vigorous abrasion on pavement. Thin rubber layers such as the rubber heel insert **132** are conventionally used as the lower surface of footwear because they are durable, resist abrasion, and have good traction qualities.

[0023] Outsole stiffness is provided by a stiff shank **134** which extends from the heel section **112** through the raised arch section **114** to the rocker section **116**. Shank **134** is a rectangular strip formed of a stiff plastic material and is seated in a rectangular cavity **136** in the top surface **138** of outsole **110** and retained by an appropriate adhesive.

[0024] Additional stiffness may be provided by sizing the thickness of the rubber rocker insert **126** to provide stiffness to the outsole **110** in the area of the forward rocker section **116**.

[0025] In one preferred embodiment, the rubber rocker insert **126** has a thickness which ranges between 50% of the thickness of the outsole **110** at the forward end of the rubber rocker insert **126**, to about 80% of the thickness of the outsole **110** at the rearward end of the rubber rocker insert **126**. In each case, the remaining thickness of the outsole will be the EVA body **111**.

[0026] A secondary advantage of this construction is that it extends the useful life of the footwear. EVA materials have a tendency over time to develop a compression set and to lose some of their resiliency. In use, the forward rocker section **116** will be subject to a repeated compressive load during the walking cycle. The use of a thicker rubber layer increases the usable life of the footwear, without compromising comfort.

[0027] Optionally, a thin channel **127** may be provided in the lower surface of the rubber rocker insert **126** if a bending location is desired.

[0028] Midsole **140** is provided as a cushioning layer between the outsole and the insole, and may constitute one or more foam layers, optionally sandwiched between fabric covers.

[0029] Insole **160** provides an additional cushioning layer above the midsole, and typically will have an upper fabric layer known as the sock liner. In preferred embodiments, the metatarsophalangeal joint area **102** of the insole **160** has an increased thickness to provide a metatarsal support pad **161**.

[0030] In one preferred embodiment, the insole **160** has a rearward heel section **162** and a forward metatarsophalangeal joint area section **166**, and upper surfaces **164**, **168** of the insole rearward heel section **162** and the insole forward metatarsophalangeal joint area section **166** have about the same elevation. In other words, when the footwear is placed on a level surface, the upper surfaces **164**, **168** of the insole rearward heel section **162** and the insole forward metatarsophalangeal joint area section **166** are about level with each other.

[0031] In another embodiment, the upper surface **164** of the insole rearward heel section **162** has a greater elevation than an upper surface **168** of the insole forward metatarsophalangeal joint area section **166**. In other words, when the footwear is placed on a level surface, upper surface **164** of the insole rearward heel section **162** is higher than an upper surface **168** of the insole forward metatarsophalangeal joint area section **166**.

[0032] A wedge-shaped heel lift **170** may optionally be provided between the insole **160** and the outsole **110** in the heel areas **104** thereof. The heel lift **170** may be needed because the positioning of the rear apex **120** of forward rocker section **116** rearwardly of the ball of the foot will tend to raise the ball of the foot about 5 millimeters above where it would normally be located. To avoid possible instability of the footwear that could occur if the wearer's heel is lower than the ball of the foot when the wearer is in a stationary standing position, it is recommended that the footwear construction include elements that will lift the heel by 5 or more millimeters. In the preferred embodiment, the heel lift **170** will typically have a 5 millimeter thickness to raise the heel 5 millimeters so that the upper surfaces **164**, **168** of the insole

rearward heel section **162** and the insole forward metatarsophalangeal joint area section **166** are about level with each other.

[0033] When a user wearing footwear **100** stands still, footwear **100** rests on the ground on forward rocker section **116** and rearward heel section **112**. As the user takes a step, rear apex **120** acts as a fulcrum so that the footwear **100** rolls forward off of rearward heel section **112** and onto rocker forward rocker section **116**. The curvature of the forward rocker section **116** gently propels the user through the gait cycle by assisting the normal transfer of energy from one foot to another as the user steps forward in walking. Forward rocker section **116** rocks the foot from heel strike through toe-off, in a manner designed to minimize bending of both the footwear **100** and the foot. This makes the act of walking smoother and easier for the user. Footwear **100** may reduce plantar pressure and loads on the ankles, toes and metatarsals. Footwear **100** will conserve some of the energy of locomotion and return energy to the wearer by smoothing out the gait cycle. Furthermore, the profile of forward rocker section **116** reduces or eliminates the need to flex footwear **100** during the course of walking. It reduces the need to flex the metatarsophalangeal joints of the user during walking. Thus footwear **100** may be helpful to individuals with stiffness, pain, or a limited range of motion in the metatarsophalangeal joints, the ankle, or elsewhere in the foot or leg. However, it is also advantageous for normal users because it improves the smoothness and ease of walking.

[0034] The angle of the rocker profile can be varied to vary the effect the ease with which a footwear **100** rocks forward. A profile with multiple angles or multiple radii may be employed to rock footwear **100** at different rates during different parts of the gait cycle. Forward rocker section **116** has a rocker axis, around which footwear **100** rocks forward. The orientation of the rocker axis determines which direction footwear **100** rocks forward and can be at varying angles with respect to outsole **110** and the wearer's foot. In one embodiment, the rocker axis is parallel to a line drawn through the centers of the first and second metatarsal heads of the foot, and is approximately perpendicular to the long axis of the footwear **100**. In this embodiment, the rocker axis is aligned for efficient high-speed walking. In another embodiment, the rocker axis follows a line passing through the third through fifth metatarsal heads of the foot, aligning it for efficient low-speed walking.

[0035] The present invention provides an article of footwear which provides a smoother gait and increased energy return to the wearer as the wearer's stride causes the forward rocker section of the outsole to roll forwardly and propel the walker with each step. The stiffness of the outsole provides support for the wearer and encourages the rolling gait associated with a rocker sole construction. At the same time, the increased thickness of the rubber rocker insert that provides the desired stiffness is more durable and longer lasting than conventional sole designs and provides reduced problems of compression set associated with conventional EVA sole constructions.

[0036] Although the invention has been described with reference to embodiments herein, those embodiments do not limit the scope of the invention. Modification to those embodiments or different embodiments may fall within the scope of the invention.

What is claimed is:

1. An article of footwear comprising:

an outsole having a rearward heel section and a forward rocker section, separated by a raised arch section, the outsole having a stiff shank extending from the heel section to the rocker section, the rocker section having a rocker sole element having a rear apex located 20 to 45 millimeters rearwardly of a metatarsophalangeal joint area of the article of footwear and a generally curved surface extending forwardly and upwardly from the apex to a toe area of the article of footwear.

2. The article of footwear of claim **1** further comprising an insole.

3. The article of footwear of claim **2** wherein the insole has a thickness, and the metatarsophalangeal joint area of the insole has an increased thickness to provide a metatarsal support pad.

4. The article of footwear of claim **2** wherein the insole has a rearward heel section and a forward metatarsophalangeal joint area section, and upper surfaces of the insole rearward heel section and the insole forward metatarsophalangeal joint area section have about the same elevation.

5. The article of footwear of claim **2** wherein the insole has a rearward heel section and a forward metatarsophalangeal joint area section, and an upper surface of the insole rearward heel section has a greater elevation than an upper surface of the insole forward metatarsophalangeal joint area section.

6. The article of footwear of claim **4** further including a wedge-shaped heel lift located between the insole and the outsole in the heel sections thereof.

7. The article of footwear of claim **5** further including a wedge-shaped heel lift located between the insole and the outsole in the heel sections thereof.

8. The article of footwear of claim **1**, wherein said rocker sole element comprises a rubber rocker insert.

9. The article of footwear of claim **8**, wherein said forward rocker section of said outsole comprises a thickness which is about 80% rubber rocker insert and about 20% EVA outsole.

10. The article of footwear of claim **1**, wherein the apex of the rocker sole element is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area.

11. The article of footwear of claim **4**, wherein the apex of the rocker sole element is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area.

12. The article of footwear of claim **5**, wherein the apex of the rocker sole element is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area.

13. The article of footwear of claim **6**, wherein the apex of the rocker sole element is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area.

14. An article of footwear comprising:

an outsole having a rearward heel section and a forward rocker section, separated by a raised arch section, the outsole having a stiff shank extending from the heel section to the rocker section, the rocker section having a rocker sole element having a rear apex located 20 to 45 millimeters rearwardly of a metatarsophalangeal joint area of the article of footwear, and a generally curved surface extending forwardly and upwardly from the apex to a toe area of the article of footwear; and

an insole.

15. The article of footwear of claim **14** wherein the insole has a rearward heel section and a forward metatarsophalangeal joint area section, and upper surfaces of the insole

rearward heel section and the insole forward metatarsophalangeal joint area section have about the same elevation.

16. The article of footwear of claim **14** wherein the insole has a rearward heel section and a forward metatarsophalangeal joint area section, and an upper surface of the insole rearward heel section has a greater elevation than an upper surface of the insole forward metatarsophalangeal joint area section.

17. The article of footwear of claim **15** further including a wedge-shaped heel lift located between the insole and the outsole in the heel sections thereof.

18. The article of footwear of claim **16** further including a wedge-shaped heel lift located between the insole and the outsole in the heel sections thereof.

19. The article of footwear of claim **14**, wherein said rocker sole element comprises a rubber rocker insert.

20. The article of footwear of claim **19**, wherein said forward rocker section of said outsole comprises a thickness which is about 80% rubber rocker insert and about 20% EVA outsole.

21. The article of footwear of claim **15** wherein the insole has a thickness, and the metatarsophalangeal joint area of the insole has an increased thickness to provide a metatarsal support pad.

22. The article of footwear of claim **14**, wherein the apex of the rocker sole element is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area.

23. The article of footwear of claim **17**, wherein the apex of the rocker sole element is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area.

24. The article of footwear of claim **18**, wherein the apex of the rocker sole element is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area.

25. The article of footwear of claim **20**, wherein the apex of the rocker sole element is located 35 to 40 millimeters rearwardly of the metatarsophalangeal joint area.

26. An article of footwear, comprising:

an outsole having a rocker outsole element;

an apex of the rocker outsole element located between a heel and metatarsophalangeal joints of a foot of a user wearing the footwear;

wherein the article of footwear supports the heel at at least the same elevation as metatarsophalangeal joints when the user is in a typical mid-stance posture, and rocks forward along a profile of the rocker element when the user takes a step.

27. The article of footwear of claim **26**, wherein the apex of the rocker element is located 20 to 45 millimeters behind the metatarsophalangeal joints.

28. The article of footwear of claim **27**, wherein the apex of the rocker element is located 35 to 40 millimeters behind the metatarsophalangeal joints.

29. The article of footwear of claim **26**, further comprising a heel lift located underneath the heel of the foot.

* * * * *