AIR CIRCULATING FOOTBED AND
METHOD THEREOF

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An air circulating footbed adapted for insertion into a shoe
including first and second layers of material shaped and
attached to each other so as to define at least two cavities
therebetween, the first cavity being disposed generally in
the forefoot region of a shoe and the second cavity being disposed
generally in the heel region of a shoe, the first and second
 cavities being in fluid communication with each other
 whereby foot pressure exerted by a wearer’s foot in the fore-
foot and heel regions of the footbed during a wearer’s walking
or running gait will circulate air flow back and forth between
the at least two cavities. The cavities may also include low
density polyurethane (PU) foam in the density range of 0.20
to 0.50 pounds per cubic foot.
AIR CIRCULATING FOOTBED AND METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of and priority to U.S. Provisional Patent Applications Ser. No. 61/173,955, filed Apr. 29, 2009, entitled AIR CIRCULATING FOOTBED AND METHOD THEREOF, which application is hereby incorporated by reference to the extent permitted by law.

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to the construction of a shoe and the manufacture thereof and, more particularly, to a footbed or sock lining with an improved air cushioning system to enhance the comfort of a user’s foot.

[0003] The footwear industry has seen numerous design features introduced in order to enhance the comfort and/or performance of a shoe on the foot of the wearer. Many of the technological advances have occurred in the sole, particularly the midsole. Most footwear, the midsole often provides both protective cushioning and a stable platform for the user’s foot. In an effort to provide improved performance, it is often desirable to vary the support characteristics of the sole from one region to another. A wide variety of soles have been developed to provide variable support over the foot. Although a marked improvement over conventional uniform sole constructions has occurred over the years, there remains a need for a footbed construction that can be adapted to accommodate the mechanical stresses arising on a wearer’s foot during different kinds of activities and which provides a high degree of functionality and wearing comfort.

[0004] A shoe is generally composed of an upper connected to a sole. The sole is generally composed of an outsole, a midsole and an insole disposed on top of the midsole. A footbed is disposed within the shoe on top of the insole. The footbed lies adjacent to the bottom surface of a user’s foot when the shoe is worn. Because the footbed is in direct contact with a user’s foot, it is important that the footbed be anatomically conformed to the user’s foot and help the foot remain cool and comfortable when inside the shoe.

[0005] It has been known to provide a footwear sole to cushion the impact of a person’s foot with a supporting surface. The concept of shock absorption by transfer of fluid from the heel to the ball or forward portion of the user’s foot has been known as illustrated in U.S. Pat. No. 4,458,430 to Peterson. The Peterson patent describes a cushioning device having cushions disposed beneath the heel and front transverse arch of the foot. The cushions are filled with a fluid. A major deficiency of the Peterson device is the ‘bulging effect’ when the Peterson device is made in the form of footbed or sockliner. Particularly, the Peterson device leads to “bottoming out” of heavily loaded chamber and the simultaneous ballooning of unloaded chamber, creates a very uncomfortable bulge within the unloaded chamber and causes discomfort of the foot portion contacting the unloaded chamber due to the uneven surface of the footbed or sockliner. Further, when one of the cushions is heavily compressed, the foot portion contacting the compressed chamber could feel some impact due to lack of threshold level of support as fluid is forced from the compressed chamber to the expanding one. Furthermore, extremely high level of quality control in some manufacturing environment is needed to keep all the air cavities at a consistent air pressure.

[0006] The demands for comfort in other athletic events has resulted in the use of the inflatable bladders in various types of athletic footwear. There are presently available athletic shoes incorporating an air pump, such as depicted within U.S. Pat. No. 5,074,765, to inflate air bladders located within the sole of the shoe, or alternatively, bladders located in portions of the midsole or outsole of the athletic shoe. However, the prior art footwear utilizing bladders have made them costly and time consuming to manufacture.

[0007] It is a general object of this invention to provide an improved shoe sole structure which avoids the drawbacks of the known constructions. Still another object of the present invention is to provide a shoe sole structure which is durable in construction and inexpensive to manufacture, and which affords additional advantages over the known shoe sole constructions. The present devices attempt to enhance cushioning and energy return by transferring a fluid between the area of impact and another area of the device and to keep the threshold level of support by adding low density foam insert to air cavities. The basic concept of the present devices is to have cushions containing foam and air disposed adjacent the heel or forefoot areas of a shoe which transfer air to the other of the heel or forefoot areas.

[0008] Thus, it would be desirable to provide an improved footbed which is capable of providing damping and support for the foot.

[0009] It would also be desirable to provide a footbed for a shoe which is capable of circulating cushioning air through the interior of the shoe.

SUMMARY OF THE INVENTION

[0010] The present invention relates to an improved footbed including multiple cavities capable of holding air and foam, and an interconnecting channel capable of circulating air between the cavities. The term footbed refers to a layer of material or the like placed over the entire insole to protect the foot from seams or other constructional workings on the inside of the shoe. The sole of a shoe is generally comprised of an outsole, a midsole, and an insole. A conventional footbed may be placed inside the shoe above the insole. The present invention is directed to a footbed construction having enhanced air cushioning capability.

[0011] In one aspect of the present invention, an air circulating footbed is provided which includes a multi-layered construction enabling it to provide the above-described objectives. The footbed includes two main layers and an air circulating system formed therebetween. A top layer, sometimes called a sock liner, provides a layer between the bottom surface of a wearer’s foot and the footbed. The top layer has an upper surface and a lower surface, the top layer providing a sock-contacting surface as well as protection for the footbed and an area to display the manufacturer’s information. Beneath the top layer, a bottom layer of molded ethyl vinyl acetate (EVA) is attached. The bottom surface of the top layer forms two concave surfaces, one located in the area of the forefoot and the other located in the heel area. These two concave surfaces, when positioned adjacent the bottom layer, form two cavities enclosed by the top and bottom layers. The two cavities are connected together by an interconnecting air transfer channel located in the arch area, the interconnecting air channel extending between the two cavities. The bottom layer extends from the heel to the forefoot area, namely, in the
area corresponding to the ball of a wearer’s foot. The front end portion of the bottom layer is securely affixed to the lower surface of the top layer at a location corresponding to the ball of the foot and the rear end portion of the bottom layer is securely affixed to the lower surface of the top layer in the vicinity of the heel area. The method of attaching the top layer of the footbed to the bottom layer of the footbed, thereby closing the cavities, can be by adhesion or by heat sealing.

The air circulating system of the present invention includes a front cavity, a rear cavity and an interconnecting air transfer channel. The interconnecting air transfer channel is designed to optimize circulation of air between the two cavities. The front cavity formed at the forefront area is in direct air communication with the rear cavity formed at the heel area through the interconnecting air transfer channel formed at the arch area in the middle section of the footbed. The flow of air from one cavity to the other cavity is accomplished by pressure from the wearer’s foot during various parts of a wearer’s walking or running gait.

The present cavities are at least partially filled with foam and air function as a pummeling and cushioning device. In one embodiment, each cavity is substantially filled with suitable low-density polymer foam insert, such as polyurethane, which is resiliently compressible under an applied load to attenuate ground reaction forces and absorb energy. In another embodiment, at least one cavity is partially filled with suitable low-density polymer foam insert. In a preferred embodiment, the foam insert is not bonded to the inner surface of the cavities that hold some air between the inner surface of the cavities and the outer surface of the foam insert. Each of the front and rear cavities form a foam holding volume which is vertically moved by the force or pressure applied in the footbed and heel areas of the top layer respectively. When pressure is applied to the forefront area during toe-off, air moves rearward from the front cavity to the rear cavity. When pressure is applied to the heel area during heel strike, air moves forward from the rear cavity to the front cavity. The cavities are formed in order to maximize the amount of air trapped within such cavities and the amount of air pushed through the interconnecting air transfer channel.

The bottom layer is affixed to the top layer, the air enclosed between the two layers will be sealed such that no air enters the enclosed area and no air can escape therefrom.

It is an object of the present invention to provide an air-circulating footbed which provides enhanced cushioning by adding ambient air as well as low density foam insert to the cavities.

It is a further object of the present invention to provide an improved footbed which is simple to manufacture and which can be utilized in any standard shoe.

Specific advantages and features of the present system will be apparent from the accompanying drawings and the description of several illustrative embodiments of the present invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan form view of one embodiment of a footbed constructed in accordance with the teachings of the present invention.

FIG. 2 is a side cross-sectional view of the footbed of FIG. 1 taken only line 2-2 of FIG. 1.

FIG. 3A is a fragmentary cross-sectional view of the present footbed without showing foam insert within the cavities, taken along line 3-3 of FIG. 1.

FIG. 3B is a fragmentary cross-sectional view of the present footbed showing foam insert within the cavities, taken along line 3-3 of FIG. 1.

FIG. 4 is the side cross-sectional view of FIG. 2 showing a user’s foot positioned on the footbed.

It should be understood that the drawings are not necessarily to scale and that the embodiments disclosed herein are sometimes illustrated by fragmentary views. In certain instances, details which are not necessary for an understanding of the present invention or which render other details difficult to perceive may have been omitted. It should also be understood that the invention is not necessarily limited to the particular embodiments illustrated herein. Like numbers utilized throughout the various figures designate like or similar parts or structure.

DETAILED DESCRIPTION

Referring now to the drawings and, in particular, FIGS. 1-4, a first embodiment of a new and improved removable shoe footbed having an air circulating system embodying the principles and concepts of the present invention and generally designated by the reference numeral 10 will be described.

A shoe generally includes an upper and a sole assembly that is affixed to the upper. The sole assembly includes an insole, a midsole, and an outer sole, each having a peripheral shape designed to conform to the shape of a wearer’s foot. The shoe may also include a footbed that is removably fitted into the shoe upper on top of the sole assembly. To facilitate disclosure of the present invention, reference will be made to various general areas of the foot, such as the heel, arch and footbed areas. When used to refer to locations on the various sole components, these terms should be interpreted to include those areas of the footbed that are disposed generally (and not necessarily directly) beneath the corresponding elements of the foot. It should be understood, however, that the boundaries between the heel, arch and footbed areas are not precise and that these terms should be interpreted loosely and with a great deal of flexibility.

A footbed 10, as shown generally in FIGS. 1 and 2, has a medial side and a lateral side. Footbed 10 also has a toe end 12 and a heel end 14. The length and width of footbed 10 are completely dependent upon the size of shoe into which footbed 10 will be placed. Footbed 10 is shown in FIGS. 2-4 to comprise two main layers. A top layer 16, sometimes called a sock liner, provides a layer between the wearer’s foot and the footbed 10 and may include multiple layers. Top layer 16 has an upper surface 18 and a lower surface 20. Upper surface 18 of the top layer 16 also defines the upper surface of the footbed 10. The specific material of the top layer 16 may be chosen depending on the nature and type of shoe in which it will be used. Top layer 16 may be made from a variety of materials including, but not limited to, grain leather, suede leather, PVC coated materials, or any other thin synthetic or natural material. The material selected will be determined by the type of footwear into which footbed 10 is intended to be placed. Top layer 16 is used to provide general protection to the footbed 10 from normal wear and tear. The height or thickness of the top layer 16 may be raised at the arch and footbed areas to support the foot in a conforming fashion. Lying underneath top layer 16 and providing a seal to circulating air is a bottom layer 22. The footbed includes an air circulating system 24 between the top layer 16 and the bottom layer 22.
Referring now to FIGS. 2-4, the bottom layer 22 has an upper surface and a lower surface. The upper surface of bottom layer 22 traps or encloses air within the air circulating system 24 formed between the top and bottom layers 16 and 22. Bottom layer 22 extends from the heel area to the forefoot area as best seen in FIGS. 2 and 4. In the embodiment illustrated, the bottom layer 22 extends from the heel area of footbed 10 to a location corresponding to about two-thirds the length of footbed 10. Although bottom layer 22 may extend to other portions of the footbed, or the entire length of footbed 10, it is preferable that bottom layer 22 extend only to the location corresponding to the ball of the foot for increased forefoot flexibility. The front end portion 26 of the bottom layer 22 is securely affixed to the lower portion of the top layer 16 at a location corresponding generally to the ball of the foot. The rear end portion 28 of the bottom layer 22 is securely affixed to the lower portion of the top layer 16 generally at the heel area. The height or thickness of the bottom layer 22 may be uniform across the entire length of the bottom layer 22.

The air circulating system 24 includes a front cavity 30, a rear cavity 32 and an interconnecting air transfer channel 34. The material of the top layer 16 is molded by conventional molding techniques, such as injection molding, to form two concave surfaces 19 and 21 in the forefoot and heel areas respectively, which concave surfaces when enclosed by the bottom layer 22, form cavities 30 and 32 as well as the interconnecting air transfer channel 34 at the arch area between the two cavities. The top and bottom layers 16 and 20, when mated and attached to each other, form and define the front and rear cavities 30 and 32 respectively and the interconnecting channel 34. The upper surface of bottom layer 22 traps or encloses air within the air circulating system 24 formed between the top and bottom layers 16 and 22. In a preferred embodiment, the cavities 30 and 32 are filled with suitable low-density polymer foam insert 36 and 38, such as polyurethane, which is resiliently compressible under an applied load to attenuate ground reaction forces and absorb energy. Each of the front and rear cavities form a foam holding volume which is vertically moved by the force or pressure applied in the forefoot and heel areas of the top layer respectively. The quantity of foam insert 36 and 38 placed in the mold cavities is sufficient to substantially fill the cavity when it is closed. During walking, running, or other ambulatory activities, the cavity and the foam insert therein are compressed between the foot and the ground, thereby attenuating ground reaction forces and absorbing energy.

While at least some portions of the cavities 30 and 32 are filled with the foam insert 36 and 38, the remaining portion of each cavity 30 and 32 will be filled with air. In one embodiment, each cavity 30 and 32 is substantially filled with suitable low-density polymer foam insert 36 and 38, such as polyurethane, which is resiliently compressible under an applied load to attenuate ground reaction forces and absorb energy. In another embodiment, at least one cavity 30 and 32 is partially filled with suitable low-density polymer foam insert 36 and 38. In a preferred embodiment, the foam insert 36 and 38 is not bonded to the inner surface of the cavities 30 and 32 that hold some air between the inner surface of the cavities and the outer surface of the foam insert 36 and 38. Further, the foam material is resiliently compressible, in part, due to the inclusion of a plurality of open or closed microcells that define an inner volume substantially displaced by air. As the cavity 30 and 32 is compressed, the air enclosed in the cavity 30 and 32 is transferred to the other cavity through the interconnecting air transfer channel 34 such that the partially or substantially filled cavities 30 and 32 enable excess air to be squeezed out of the compressed cavity 30 and 32. Air transfer channel 34 is designed to optimize circulation of air between the two cavities 30 and 32. The front cavity 30 formed in the vicinity of the forefoot area is in direct air communication with the rear cavity 32 formed in the vicinity of the heel area through the interconnecting air transfer channel 34 which is formed in the vicinity of the arch area towards the middle section of the footbed 10. The height or depth of the cavities 30 and 32 and the air transfer channel 34 may vary depending upon the particular application and the type of shoe involved. In a preferred embodiment, the front and rear cavities 30, 32 may have a height in the range of approximately 5–8 mm, while the interconnecting air transfer channel 34 may have a height in the range of approximately 3–5 mm. The flow of air from one cavity to the other cavity is accomplished by pressure from the wearer’s foot during various parts of a user’s walking or running gait. Upon removal of the compressive force caused by the foot and the ground, the original configuration of the cavity is restored by the difference of the air pressure between the cavities and recovery of the foam insert to its original shape.

In order to fully appreciate the present invention, implementation of the footbed 10 utilized in accordance with the present invention will now be described. In use, footbed 10 is placed inside a conventional shoe with bottom layer 22 pressed in face-to-face contact with the insole of the shoe. As shown in FIGS. 2 and 4, when employing the cavities 30 and 32 as a pumping device, the heel of the wearer’s foot during heel strikes exerts or causes sufficient pressure to be applied to the rear cavity 32 with significant impact to force the air trapped within cavity 32 to move forward through the transfer channel 34 to the front cavity 30. In similar fashion, the forefoot of a wearer’s foot during toe-off exerts or causes sufficient pressure to be applied to the front cavity 30 with significant impact to force the air trapped within cavity 30 to move rearward through the channel 34 to the rear cavity 32. Each of the front and rear cavities 30 and 32 forms an area which is vertically moved by the force or pressure applied in the forefoot and heel areas of the footbed 10. The cavities are formed by and between the top and bottom layers 16 and 22 of the footbed 10 in order to maximize the amount of air trapped within such cavities and the amount of air pushed through the interconnecting air transfer channel 34. During the wearer’s walking or running gait, the increased pressure exerted by the ball of the wearer’s foot on the front cavity 30 will create sufficient pressure to push air from the front cavity 30 to the rear cavity 32, and the increased pressure exerted by the heel of the user’s foot on the rear cavity 32 will create sufficient pressure to push air from the rear cavity 32 to the front cavity 30 thus providing the ball and heel of the wearer’s foot with repeated blasts of air. Once the bottom layer 22 is affixed to the top layer 16, the air enclosed between the layers of the footbed 10 will be sealed and trapped so that no air can enter or exit the enclosed area, namely, cavities 30 and 32 and channel 34.

The precise composition of the bottom layer 22 is not critical so long as it meets the physical and performance criteria set out above. The top layer 16 may be comprised of a conventional foam plastic material with a fabric sock liner integrally secured to the upper surface of the top layer 16. The bottom layer 22 is preferably made from a firm, compressible, lightweight, and moldable material such as ethyl vinyl acetate.
(EVA). A number of different polymers may be compounded and formed in a manner to meet the necessary criteria but EVA is preferred. The density and hardness of a suitable polymer foam insert may vary within the scope of the present invention. In a preferred embodiment, the low density foam insert is a polyurethane (PU) foam with a density between 0.20 and 0.50 pounds per cubic foot.

[0031] The two layers 16 and 22 of the footbed 10 perform very separate and distinct functions. The bottom layer 22 functions to provide a conforming interface between the shoe and a wearer's foot. Cushioning of the foot is provided primarily by the top layer 16 which functions as a pumping device for circulating air between the cavities 30 and 32 and also acts to absorb lateral movements of the foot relative to the shoe. The provision of the air circulating system 24 within the footbed 10 prevents the top layer 16 from bottoming out or reaching an uncompressible state.

[0032] The method of attaching the top layer of the footbed to the bottom layer of the footbed, thereby closing the cavities, can be by adhesion or by heat sealing. A surface roughening treatment which can be formed by roughening the surface is often necessary prior to application of an adhesive, or by high frequency, sonic or conductive heat sealing. A suitable heat sealing apparatus applies a current, whereby localized resistance heating causes the thermoplastic materials to melt locally and to at least partially fuse to join the thermoplastic materials. Preferably, the materials become fused when they are cooled, to form a bond.

[0033] Although FIGS. 1-4 illustrate only a pair of cavities 30 and 32, it is also recognized and anticipated that the present footbed 10 could include any plurality of cavities interconnected by any plurality of air transfer channels such as air channel 34. In this regard, some or all of the cavities could be interconnected by the transfer channels, or groups of the cavities could be interconnected by certain air transfer channels. Further, although FIGS. 1-4 illustrate only substantially filled or unfilled cavities 30 and 32, it is also recognized and anticipated that the present footbed 10 could include a partially filled cavities. Other cavity arrangements and interconnection schemes are also envisioned.

[0034] Thus, there has been shown and described several embodiments of a novel invention. As is evident from the foregoing description, certain aspects of the present invention are not limited by the particular details of the examples illustrated herein, and it is therefore contemplated that other modifications and applications, or equivalents thereof, will occur to those skilled in the art. The terms "having" and "including" and similar terms as used in the foregoing specification are used in the sense of "optional" or "may include" and not as "required". Many changes, modifications, variations and other uses and applications of the present invention will, however, become apparent to those skilled in the art after considering this specification and the accompanying drawings. All such changes, modifications, variations and other uses and applications of the present invention are deemed to be covered by the invention which is limited only by the claims which follow.

What is claimed is:

1. A footbed adapted to be removably inserted into a shoe comprising:
   a first layer having an upper surface and a lower surface;
   a second layer having an upper surface and a lower surface, said second layer being attached to said first layer so as to define a sealed air circulating area therebetween;
   said air circulating area including:
   a first cavity disposed at a location corresponding to a location where a forefoot of a wearer's foot would sit on said footbed;
   a first low density foam insert disposed within the first cavity;
   a second cavity disposed at a location corresponding to a location where a heel of a wearer's foot would sit on said footbed;
   a second low density foam insert disposed within the second cavity; and
   said second cavity being in fluid communication with said first cavity for allowing air to circulate between said first and second cavities.

2. The footbed of claim 1 wherein said air circulating area comprises an interconnecting air transfer channel disposed between said first and second cavities for allowing air to communicate between said first cavity and second cavity.

3. The footbed of claim 2 wherein the interconnecting air transfer channel has a height in the range of about 3.5-5 mm.

4. The footbed of claim 1 wherein each of said first and second cavities has a height in the range of about 5-8 mm.

5. The footbed of claim 1 wherein said first and second low density foam inserts comprise a polyurethane (PU) foam with a density between 0.20 and 0.50 pounds per cubic foot.

6. The footbed of claim 1 wherein at least one of said first and second cavities is sealed in fluid-proof manner by a heat sealing method.

7. The footbed of claim 1 wherein said first and second cavities are substantially filled with said first and second low density foam inserts.

8. The footbed of claim 1 wherein the volume of said first low density foam insert is less than the volume of said first cavity.

9. The footbed of claim 1 wherein the second layer is formed of ethyl vinyl acetate (EVA).

10. A footbed adapted to be removably inserted into a shoe, said footbed having a forefoot region and a heel region, said footbed comprising:
   a first layer having an upper surface and a lower surface, said lower surface defining at least two concave surfaces formed therein;
   a second layer having an upper surface and a lower surface, said second layer being attached to said first layer so as to define at least two cavities therebetween, wherein a low density foam insert is disposed within each of said at least two cavities;
   said first cavity being disposed at a location corresponding generally to the forefoot region and being defined by one of said concave surfaces and the upper surface of said second layer;
   said second cavity being disposed at a location corresponding generally to the heel region and being defined by one of said concave surfaces and the upper surface of said second layer; and
   an interconnecting channel disposed between said first and second cavities for allowing air to communicate between said first cavity and second cavity;
whereby foot pressure exerted on the forefoot region and the heel region of the footbed will circulate air between said first and second cavities through said interconnecting channel.

11. The footbed of claim 10 including a plurality of cavities and a plurality of interconnecting channels disposed between said first and second layers.

12. The footbed of claim 10 wherein the interconnecting air transfer channel has a height in the range of about 3-5 mm.

13. The footbed of claim 10 wherein each of said first and second cavities has a height in the range of about 5-8 mm.

14. The footbed of claim 10 wherein said first and second low density foam inserts comprise a polyurethane (PU) foam with a density between 0.20 and 0.50 pounds per cubic foot.

15. The footbed of claim 10 wherein at least one of said first and second cavities is sealed in fluid-proof manner by a heat sealing method.

16. The footbed of claim 10 wherein said first and second cavities are substantially filled with said first and second low density foam inserts.

17. The footbed of claim 10 wherein the volume of said first low density foam insert is less than the volume of said first cavity.

18. The footbed of claim 10 wherein the second layer is formed of ethyl vinyl acetate (EVA).

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