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(54) A multicomponent sole support assembly for sports footwear

(57) A sole assembly for an article of sports footwear (11), particularly intended to running is provided. A preferable embodiment comprises an outsole (20) and a midsole (10), wherein the midsole comprises a support cradle element (3), a heel rocker element (2) and a carbon arch element (4). The midsole support cradle element (3) is preferably constructed from a first density ethylvinylacetate (EVA) foam, spreading practically over the total length and width of the foot. The heel rocker element (2) is preferably constructed from a second density EVA foam wherein the second density EVA foam is firmer than the first density EVA foam. The outsole of the sole assembly may include a rubber lateral wall element (5) and a toe lift (6). A midsole support structure is provided, wherein first density support cradle element (3) and the second density heel rocker element (2) are positioned in a way to form a continuous bridge from heel to forefoot region in order to provide an appropriate resilient support and take control over foot twist movements.

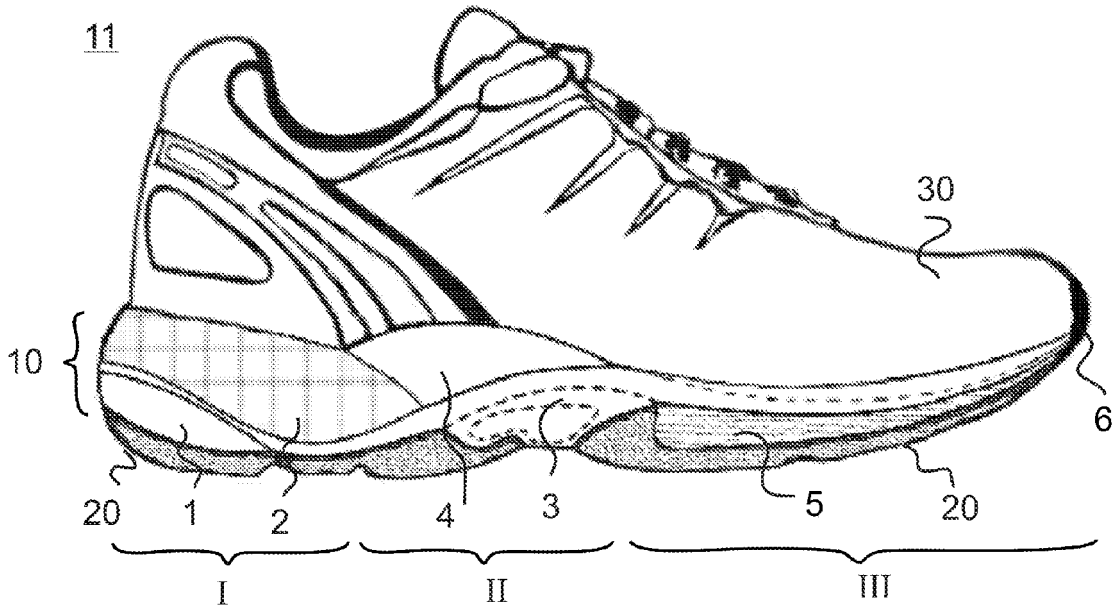

FIG. 1

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Description

Field of the invention

[0001] The present invention relates generally to an article of sports footwear and, in particular, to an article of sports footwear comprising a multicomponent sole support assembly.

Background of the invention

[0002] One of the common problems associated with sports footwear is finding a proper balance between cushioning and support properties of the shoe. The discomfort of wearing a shoe which does not provide sufficient cushioning and support may be a reason for tiredness, premature exhaustion of an individual and, moreover, cause injuries and lead to back pain.

[0003] A usual article of sports footwear consists of two primary elements, an upper and a sole structure. The upper provides a covering for the foot that positions and supports the foot with respect to the sole. The sole assembly is attached to a lower surface of the upper and locates between the foot and the ground. In addition to attenuation of ground reaction force, the sole assembly may provide traction and control foot motions, such as pronation and supination. Although being resilient, the sole has to provide enough support to foot, not being too soft, which may actually drain energy from the wearer.

[0004] The sole structure of sports footwear comprises multiple layers traditionally referred to as insole, midsole and outsole. Optional insole is a thin, comfort enhancing cushioning layer located within the upper and next to the lower surface of the foot. The midsole is traditionally attached to the upper along the entire length of the upper, forms a middle layer of the sole assembly and plays a major role in providing cushioning and controlling foot motions. The outsole is a ground-contacting element of footwear and is usually made from a durable textured material in order to improve traction. A conventional midsole is primarily made from polymer foam materials like ethylvinylacetate (EVA) or polyurethane (PU), which compress resiliently under an applied load to attenuate ground reaction forces created by impacts of physical activity. The properties of the polymer foam material in the midsole depend on various factors, such as, a dimensional configuration of the midsole and the physical characteristics of the polymer foam material. By altering these properties the footwear is made to meet the demands of the activity for which it is intended. For example, during such physical activities like running or even fast walking a foot undergoes certain movements called, as seen from the rear view, pronation and supination, or, an outwards and inwards rolling, respectively. Excessive pronation (when the load weight is on inside edge of the sole) may be a potential reason for foot or leg injury, and for this reason, in addition to polymer foam material, conventional midsoles may include stability devices that resist overpronation, disclosed in US2009100710, and moderators that distribute ground reaction forces, disclosed in W02010104824. Also, soles, including pressurized fluid-filled bladders, disclosed in US4219945 and US2010077556, as well as and non-pressurized fluid-filled chambers, disclosed in US20050178025 and US2010170110, are known. Also, the use of EVA material of different densities in order to stabilize a midsole of sports footwear is disclosed in US6061929.

[0005] As can be seen from the related art, sports footwear is developed in different alternative ways in order to provide adequate support and comfort to a wearer. A midsole, being a major member of a sole assembly has also undergone certain modifications. For example, a two part midsole assembly is disclosed in W02010085485.

[0006] The various examples present in related art are still not optimized in regard to the mentioned characteristics. Therefore, it is desirable to provide a sports shoe which, being adequately cushiony and light, would provide resilient support for various physical activities, in particular, running disciplines, would control and guide foot motions, contribute to energy saving and reduce the risk of potential injury. It is the object of the present invention to reduce or avoid shortcomings of the prior art by offering a sports shoe with some or all advantages mentioned above.

Summary of the invention

[0007] The present invention is generally directed to a multicomponent sole support assembly for an article of sports footwear, in particular to the midsole structure. The footwear to which the invention is related is intended in particular for running disciplines. The assembly of the present invention provides cushioning and support for the rear- and forefoot as well as for foot arch region utilizing structure elements embodied and broadly described herein. It is, therefore, clear to those skilled in art, that such an assembly provides improved cushioning and support for an article of sports footwear.

[0008] The invention is characterized by what is disclosed in independent claims. Some preferred embodiments are disclosed in dependent claims.

[0009] In a preferred embodiment of the invention a multicomponent sole support assembly for sports footwear, particularly intended for running, is provided, wherein a sole support assembly comprises a midsole and an outsole structural units, both comprised of several elements. For the clarity purposes both the midsole and the outsole may be generally divided into three regions, namely, a rearfoot-, a midfoot-and a forefoot regions. However, it should be noted, that elements of the sole support assembly may extend through two regions or through the length of a whole shoe, for example, thus not being divided into the mentioned regions.

[0010] In the invention, a midsole support cradle element is provided. In one embodiment, this multitask element runs practically through the whole length and width

of the shoe, beginning at the rear and extending towards the toes. The midsole support cradle element is preferably made of a first density EVA foam. The rear part of the midsole support cradle element may be referred as a cushioning bed element, since it is the first to make a ground contact in running, thus acting as a shock absorber.

[0011] In a further embodiment of the invention a heel rocker element is provided. This element is a primary part of a midsole support assembly. A heel rocker element is preferably made of a second density EVA foam and placed primarily over the total breadth of the midsole, lightly in the front of the heel bone, and on the medial side of the sole it extends further to the forefoot region, possibly through the length of the shoe towards the toes. This element may be constructed as a single piece or two/several separate pieces, corresponding to the rear- and mid-/forefoot regions. Heel rocker urges the foot to roll forward from the first contact to the stand phase and provides control over foot twist movements, in particular, during pronation.

[0012] In one embodiment of the invention a carbon arch element is provided. This element is located in the middle (midfoot) part of the midsole. This ultralight element is made of carbon and bedded over the cradle support element and heel rocker element underneath the arch of the foot. This element supports the foot's arch and controls the longitudinal torsion of the foot.

[0013] In a further embodiment of the invention an outsole support structure is provided, in particular its forefoot region. The most distinctive features of an outsole herein are the rubber lateral wall element and the toe lift element. The rubber lateral wall element runs on the lateral side of the shoe's outsole from the midfoot towards the toes and controls and guides the foot movements. A toe lift element, being practically a specially shaped tip of an outsole, spreads up and forward underneath the midsole cradle support element, lifting the toes so that during physical activity, like running, the foot rolls faster thus saving energy. In a still further embodiment of the invention the way of a positioning of structural elements constructed from first and second density EVA foams is provided. These elements, constructed from different density EVA foam are positioned in such a way, that they form a bridge from under heel till forefoot, thus enabling a smooth rolling and directed guidance of the foot during running.

Brief description of the drawings

[0014] The invention can be better understood with the reference to the following drawings and description. The components in the figures are not necessarily to scale; emphasis is being placed upon illustrating the principles of the invention. A 'medial side' is referred as an inner part of the foot. A 'lateral side' is referred as an outer side of the foot. Dotted lines are indicative of a decorative embossing and do not refer to any structural division.

FIG. 1 is a lateral side view of a sports shoe.

FIG. 2 is a dimensional section view of a sole. Midsole and outsole are depicted.

FIG. 3 is a medial side view of a sole incorporating a midsole support elements assembly.

FIG. 4 is a lateral side view of a sole incorporating a midsole support elements assembly.

FIG. 5 is a bottom view of a shoe outsole. The figure depicts a left shoe, whereby a lateral (outer) side of the shoe is on the upper part of the figure. A forefoot part of the outsole is shaped to provide a toe lift.

FIG.6. is a view on the shoe's midsole from above. The figure depicts a right shoe, therefore a medial (inner) side of the shoe is on the lower half of a figure. The figure also shows a view of a toe lift element of an outsole.

FIG. 7 is a schematic representation of the foot movement when running. Advantages of an employment of the toe lift technical feature are shown.

Detailed description

[0015] Reference will now be made in detail to a preferable embodiment of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference characters are used throughout the drawings to refer to the same or like parts. For clarity purposes the term 'first density EVA' is related to ethylvinylacetate foam of e.g. conventional density, and the term 'second density EVA' - for ethylvinylacetate foam of higher density than first density EVA. Following citations are used for the parts:

I - a rearfoot sole region

II - a midfoot sole region

III - a forefoot sole region

1 - a cushioning bed element as a part of a midsole support cradle element

2 - a midsole heel rocker element

3 - a midsole support cradle element

4 - a midsole carbon arch element

5 - an outsole lateral rubber wall element

6 - an outsole toe lift

10 - midsole

20 - outsole

30 - upper

[0016] FIG. 1 illustrates an article of sports footwear 11, incorporating a multicomponent sole support assembly, constructed according to a preferred embodiment of an invention. FIG.1 provides a general view on a sports shoe 11 from a lateral side. The sports shoe 11 includes an upper 30 and a sole assembly, secured to the upper. A sole assembly, according to a preferred embodiment of an invention, comprises a midsole 10 and outsole 20. In the following, a multicomponent sole support assembly, constructed according to a preferred embodiment of an invention, will be referred as 'sole'. Both components of a sole, a midsole and an outsole, will be further disclosed in more details. A sole may also comprise an insole, which is not described further herein.

[0017] FIG. 2 provides a dimensional section view of a sole when looking upward from the bottom of the shoe, constructed according the a preferred embodiment of the invention. An outsole **20** and a midsole **10** are depicted. FIG.2 shows that, a midsole, generally, consists here of three main components, a support cradle element 3, a heel rocker **2** and a carbon arch **4.** The combination of these midsole structural components, along with the outsole construction and shape provide a new assembly, that will be further disclosed in more detail.

[0018] FIG. 3 and 4 illustrate a sole for a sports shoe from medial (inner) and lateral (outer) side views, respectively. Shoe sole comprises an outsole **20,** which directly contacts the ground and a midsole **10.** For reference purposes, a sole may be divided into three general regions: a heel (rear) region, a midfoot (arch) region and a forefoot region, indicated on FIG. 1, 3 and 4 by Roman numerals I, II and III, respectively. Heel region **I** corresponds with rear portions of the foot, including the heel bone. Midfoot region **II** generally corresponds with the arch of the foot. Forefoot region **III** corresponds with the toes and metatarsal bones. Medial (FIG. 3) and lateral sides (FIG. 4) extend through each of the regions I-III and correspond with the opposite sides of footwear **11.**

[0019] Regions I-III are not intended to define precise areas or parts of a footwear **11.** Rather, regions I-III are intended to represent general areas of footwear **11** to aid in the following description.

[0020] According to the invention one embodiment of the invention a midsole support cradle element **3** is provided. In one embodiment of the invention this multitask element runs practically through the whole length and width of the shoe, beginning at the rear and extending towards the toes. Support cradle element is preferably made of the first density ethylvinylacetate (EVA) foam. The rear part of the midsole support cradle element may be referred as a cushioning bed element 1, being a soft, rounded member, which is the first to make a ground contact when foot touches the ground, and which is optimized for a sufficient degree of moderation of the impact force.

[0021] A support cradle element 3 is primarily intended to provide cushioning and resilient support during foot movement.

[0022] According to another embodiment of the invention a heel rocker element 2 is provided. This element 2 is the most important member of the rearfoot sole support structure (region I), and extends over the total breadth of the rear part of the midsole, lightly in the front the heel bone. It is placed on the midsole support cradle element 3, which includes a rearfoot cushioning bed element 1. On the medial side of the foot the heel rocker element continues further to the forefoot region and possibly further toward the toe region. FIG.3 and 4 provide a sideview of the heel rocker element 2, however, FIG. 6 shows a location of element 2 from above. Thus, in this embodiment the heel rocker element 2 continues from the foot rear, spreading under the arch element 4 and extending to the forefoot region, and in this case practically over the full length of the medial side of the foot up to the big toe, particularly, under the first metatarsal bone and the big toe. In the forefoot region the heel rocker element thus only extends at the medial side.

[0023] Heel rocker element 2 acts like a rocking chair, rolling the rearfoot from the first ground contact to the stand phase. Heel rocker 2 is built from a second density EVA foam, which has a higher density than the first density EVA foam, and having higher firmness/hardness. Therefore it provides an early control over pronation of the rear I and the mid foot II, and during foot rolling, also in a forefoot region III it controls a pronation movement, or prevents a weight overload on the inside of the sole. In other words, the heel rocker element 2 provides an optimal control over pronation of the foot from the moment when the heel is making the first ground contact till the moment when the toes are taking an upload during the push off phase.

[0024] On the lateral side member 2 controls the supination of the rear foot. In correlation to the heel cap a heel rocker element 2 provides an optimal stability on the medial and on the lateral sides of the rear foot and impulses the foot to roll forward to the stand phase. It should be noted, that, according to a certain embodiment of the invention, a heel rocker element 2 may be represented as a single solid member. However it is not mandatory, and, dependent on the manufacturing method, an element 2 may consist of two separate pieces, a solid three-dimensional rear-foot piece and a thin mid-/forefoot member spreading underneath arch element 4 towards the toes.

[0025] According to yet another embodiment of the invention a carbon arch element 4 is provided. Element 4 refers to a midfoot (arch) structural support part II of a midsole and is bedded into the midfoot region, over elements 2 and 3. Made from carbon this element delivers a midfoot support and reduces the weight of the shoe.

The design of a carbon cradle element **4** allows an efficient support of the foot arch and enables control over the longitudinal torsion of the foot.

[0026] The elements described above on detail are parts of a midsole **10** support assembly. However, according to an embodiment of the invention, an outsole **20** also has some important features, in particular in its forefoot region **III.** A forefoot region of the outsole **III** comprises in certain embodiments such elements as a rubber lateral wall element **5** and a toe lift **6.** These structural elements provide important technical features for a sole support assembly. A lateral rubber wall element **5** is located on the lateral side of sole of the sports shoe and is depicted on FIG. 1 and 4. FIG. 3 does not provide a view of this element since it represents the medial side view of the sole. A rubber lateral wall element **5** runs from the base of the shoe up to the end of the little toe. It is directed to provide an optimal control of the supination of the foot and to optimize the guidance of the foot during the push off phase.

[0027] A toe lift **6**, , or a tip of an outsole, provided by the outsole support assembly, runs through the forefoot length and can be recognized by its shape on the sole tip. A bottom view of a shoe sole (FIG. 5), a view from above on the shoe (mid)sole (FIG.6), as well as a dimensional section view of a shoe sole (FIG.2) provide an outlook on how the shoe tip is shaped. A toe lift feature **6** is fashioned to improve the energy saving characteristics of the sports shoe. The toe lift element **6** facilitates the foot rolling from the stand phase to the push off phase, the foot rolls faster from midfoot forward to the toes by saved energy, thus enabling the wearer to run or walk faster with no additional energy consumption. This is an important technical development, in particular, referring to a running shoe, since during running competitions every second counts and any improvement in footwear design which would help an athlete to save power is valuable for the sports footwear industry.

[0028] As can be viewed from FIG. 3 and 4, a midsole support cradle element 3 (including a cushioning bed element 1) and a heel rocker element 2 form a continuous bridge from the heel until the forefoot and toes. Elements 3 and 2 are constructed from the first and second density EVA foam, correspondingly. The density of the latter has been optimized so as to provide a sufficient guidance of the foot into the correct position during running. The structure of the shoe, wherein a midsole includes those different density EVA elements, positioned in a way to form a continuous bridge, in accordance with some embodiment of the invention, enables an efficient midsole support assembly, the advantages of which will be described next.

[0029] FIG.7 provides a schematic representation of the foot movement during running. Foot movements are divided into four general phases. Phase **00:** foot makes a first contact to the ground. A heel part of the shoe takes a ground forces impact. Phase **O1:** foot rolls from the first ground contact to the stand phase. Phase **02:** stand phase. During phases **01-02** ankle and heel at the greatest flexion. Foot arch acts like a shock absorber. Phase **03:** push-off. Foot leaves the ground. At phase **00** foot is in a supinated position (the load weight in on the outside), with rear foot inverted. Between phases **00** and **01** the ankle is dorsiflexing, or making a movement, which decreases the angle between the superior surface of the foot and the leg, which makes a foot to pronate (the load weight is on the inside of the foot). Pronation allows the foot to be flexible and absorb the impact forces of landing. At between phases **01** and 02 the foot begins to re-supinate. This inverts the rear foot, moving the foot into a more rigid position to allow for a stronger push-off during phase **03.**

[0030] The sports shoe, incorporating a multicomponent sole support assembly, according to the preferred embodiment of invention provides sufficient cushioning and support during running phases **00-03,** thus enabling the most efficient performance by its energy saving properties. A cushioning bed **1** and heel rocker **2** elements are the first to receive an impact from ground forces during phase **00,** and take control on over-pronation and supination. A heel rocker element **2** (primarily its rearfoot part) facilitates foot rolling through phase **01** to the stand phase **02.** During phases **01-02,** when the ankle and heel are at the greatest tension the sufficient foot support is needed. When the foot uptakes a stand position (phase **02)** a carbon cradle element 4 provides a support to the arch and a mid-/forefoot part of a heel rocker element **2** (FIG.6) controls the pronation movement of the foot. A bridge constructed from different density EVA foam, formed by elements **2** and **3** (the latter also includes element 1) guides the foot into a correct position during rolling throughout phases **01-**03. In addition, a forefoot part of element 2 controls foot pronation till the moment when the toes are taking an upload during push-off phase 03, and an outsole rubber lateral wall element 5 guides the foot during phase 03, providing a control over a supination movement. An elongated, shaped structure of an outsole, namely a toe lift element 6, efficiently facilitates a foot movement during phase 03, enabling more powerful push-off by energy saved.

[0031] Acting together, the midsole and outsole structurural elements of a multicomponent sole support assembly according to the invention provide both flexible and rigid support for a wearer. Foot biomechanics is highly complex and dependent on the individual. For example, runner, being an excessive supinator, will typically land in the inverted position and lose the shock-absorbing benefits of the normal pronation movements, this being likely to be prone to stress fractures, because of the highly repetitive impact forces. If the runner pronates too far or too quickly, the rotation forces acting on the tibia bone and knee joints may lead to problems with knee, as well as Achilles and foot soft-tissue injuries. Consequently, adequately supportive sports footwear may eliminate at least some problems connected with individual characteristics of a person.

[0032] The invention has been described above with the reference to the enclosed embodiments. It is, however, clear that the invention is not restricted only to those, but is comprises all embodiments which can be imagined within the inventive idea and the enclosed patent claims.

[0033] It should be noted that the materials have been mentioned as examples only. It would naturally be possible to provide the midsole support cradle and the heel rocker element from other alternative materials than the ethylvinylacetate (EVA) foam having similar characteristics, such as polyurethane (PU). Also it is naturally possible to produce the arch element from some other durable material than carbon.

[0034] It should also be noted that the different elements may be produced as separate pieces, or it is also possible to produce combined elements of single pieces, which may also have varying firmness in different areas of the of the piece. The heel rocker element can extend to the forefoot region as a single piece, but it alternatively possible to provide the rear heel rocker and the front heel rocker parts as separate pieces.

[0035] Although the present invention is especially advantageous for running shoes, it is naturally possible to apply the invention in other types of footwear as well.

Claims

1. A sole assembly (10) for a footwear comprising a midsole (10) and an outsole (20), the sole assembly having a rearfoot region, a middlefoot region and a forefoot region, **characterized in that** the midsole comprises a midsole support cradle element (3), which is constructed from a material of first firmness, and at least one second midsole element (2) made of material of higher firmness than the midsole support cradle element, wherein the midsole support cradle element and the at least one second midsole element are positioned to form a bridge of first firmness material extending from the rearfoot region until the forefoot region and of higher firmness material extending from the rearfoot region until the forefoot region.

2. A sole assembly according to claim 1, **characterized in that** the at least one second midsole element comprises a heel rocker element (2), which covers at least part of the rearfoot region (I) of the midsole (10), being placed substantially over the total breadth of the midsole.

3. A sole assembly according to claim 2, **characterized in that** the heel rocker element extends at the medial side of the foot to the forefoot region (III).

4. A sole assembly according to claim 3, **characterized in that** the forefoot region comprises a toe region at its front part, and the heel rocker element extends at the medial side of the foot to the toe region.

5. A sole assembly according to any of claims 2-4, **characterized in that** heel rocker element extends at the forefoot region only at the medial side of the midsole.

6. A sole assembly according to any of claims claim 2-5, **characterized in that** the front and rear areas of the heel rocker element form a single solid piece, or that the rear part and the front part are made of separate pieces.

7. A sole assembly according to any previous claim, **characterized in that** it comprises a arch element (4) at the midfoot region (II) of the midsole (10), having higher firmness than the midsole support cradle, and preferably made of carbon.

8. A sole assembly according to claim 2 and 7 **characterized in that** in the midfoot region (II) of the heel rocker element is located underneath the arch cradle element (4) and in the forefoot region (III) it is being laid into/onto support cradle element (3).

9. A sole assembly according to claim 1, **characterized in that** the midsole support cradle element (3) spreads over the whole length and width of the shoe from heel to toe areas thus providing cushioning and resilient support.

10. A sole assembly according to claim 1, **characterized in that** a rear part of midsole support cradle element (3) is a cushioning bed member (1), which is arranged to be the first part to make a contact to the ground and thus to take a ground force impact in a running motion.

11. A sole assembly according to claim 2, **characterized in that** the midsole support cradle element (3) is constructed from a first density ethylvinylacetate (EVA) foam, and the heel rocker element (2) is constructed from a second density EVA foam, wherein the second density EVA foam is firmer than a first density EVA foam.

12. A sole assembly according to claim 1, **characterized in that** the second midsole element(s) is/are located inside and/or on the midsole support cradle element.

13. A sole assembly according to any previous claim, **characterized in that** the outsole includes a rubber lateral wall element (5), locating on the lateral side of a forefoot region (III) of the outsole (20) in order to provide control over supination movement.

14. A sole assembly according to any previous claim,

characterized in that the outsole includes a toe lift structure (6) at the forefoot region of the outsole, in particular at the outsole tip, and provides a specific elongated shape to the tip of the outsole.

15. An article of sports footwear, preferably designed for running disciplines, **characterized in that** it comprises an upper and a sole assembly according to any of claims 1-14 secured to the upper.

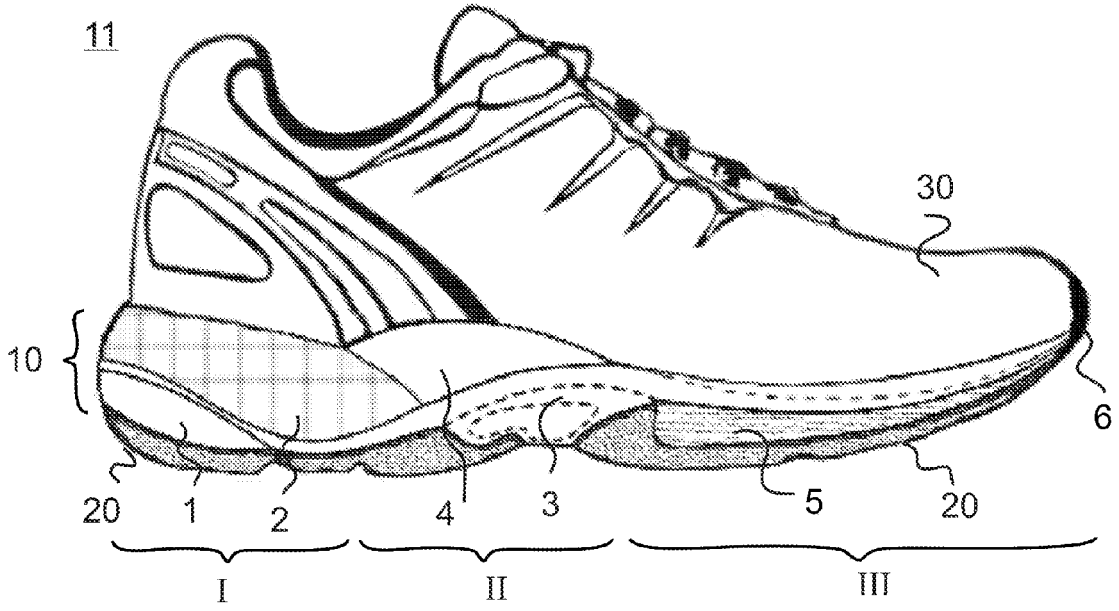

FIG. 1

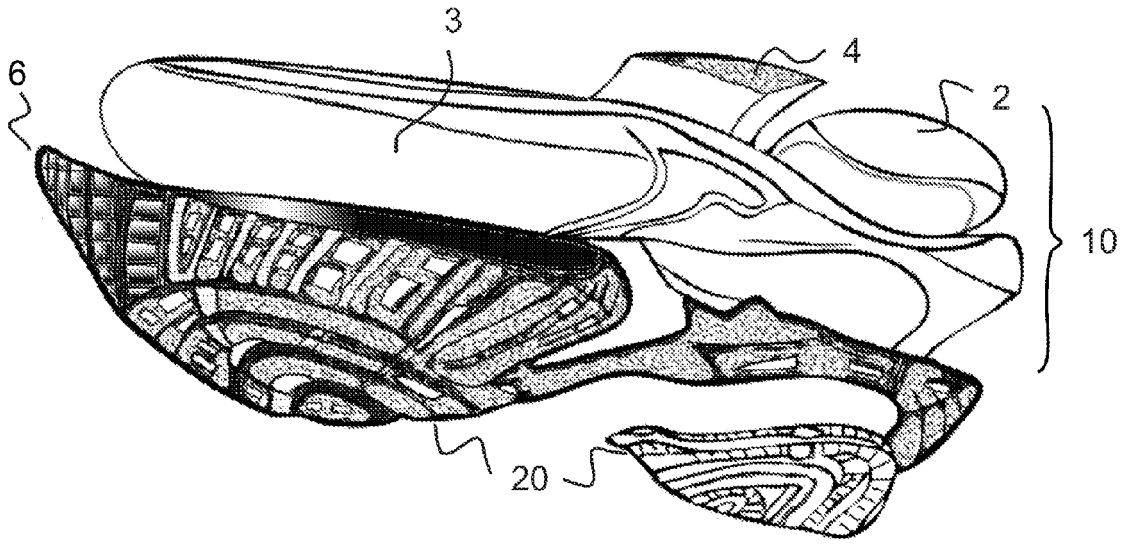

FIG. 2

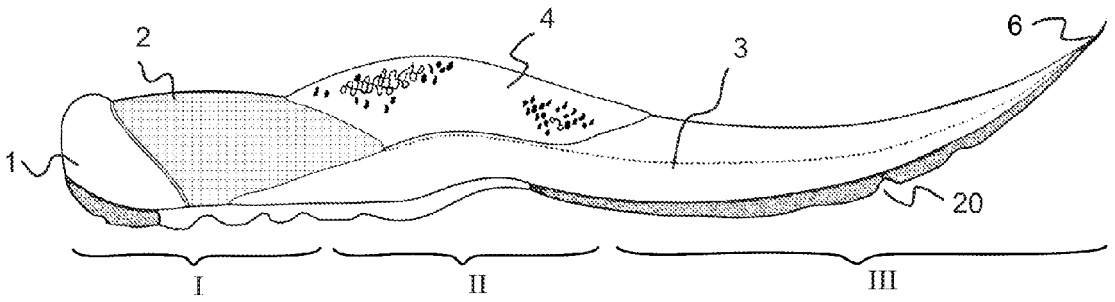

FIG. 3

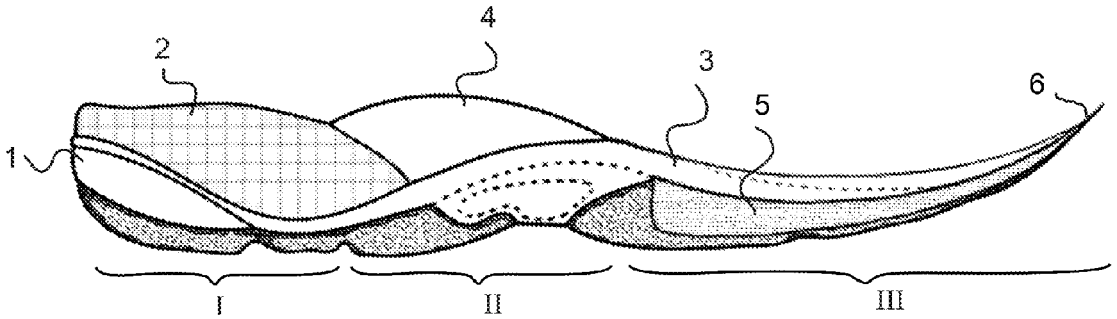

FIG. 4

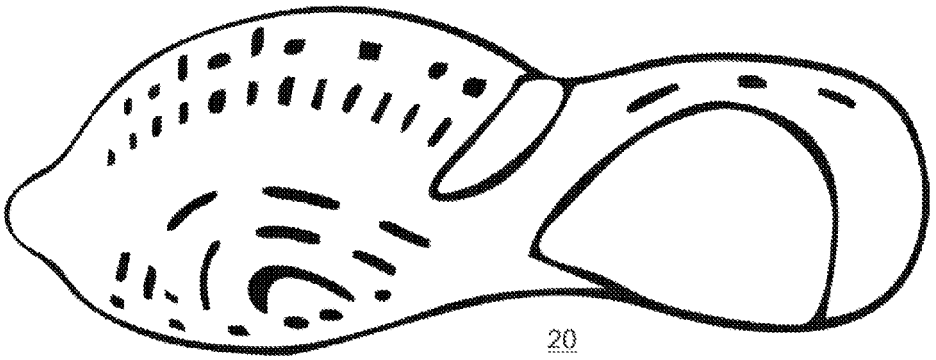

FIG. 5

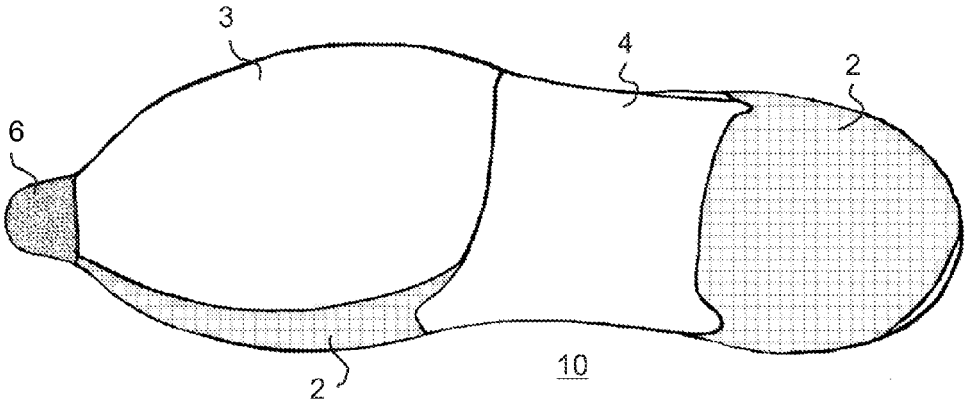

FIG. 6

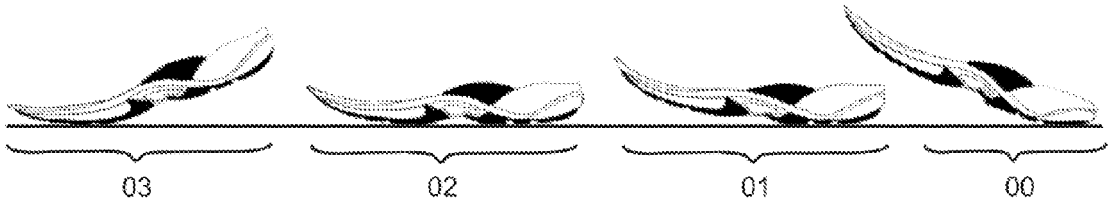

FIG. 7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 10 19 1990

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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