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(54) Title of the Invention: **Footwear with plantar fascia reinforcement**
Abstract Title: **Footwear with plantar fascia reinforcement**

(57) According to the present invention there is provided a rigid sole plate 6 situated on top of and attached to a highly compliant soft sole part 7. It is configured to receive the foot of a wearer, with the plate having one or more grooves 13 directly underneath the distal part of the calcaneus 20, the navicular bone, the cuboid 21, the cuneiform bones and the metatarsal bones 22 of the wearer. On impact, during such activities as running, the sole plate, together with the rubber material below, enhances the function of the wearer's plantar fascia. It supports the arch of the foot and provides both shock absorption and energy return. It assists in the prevention of overstrain on the musculoskeletal structures of the legs and lower back of the wearer during standing, walking, running and jumping.

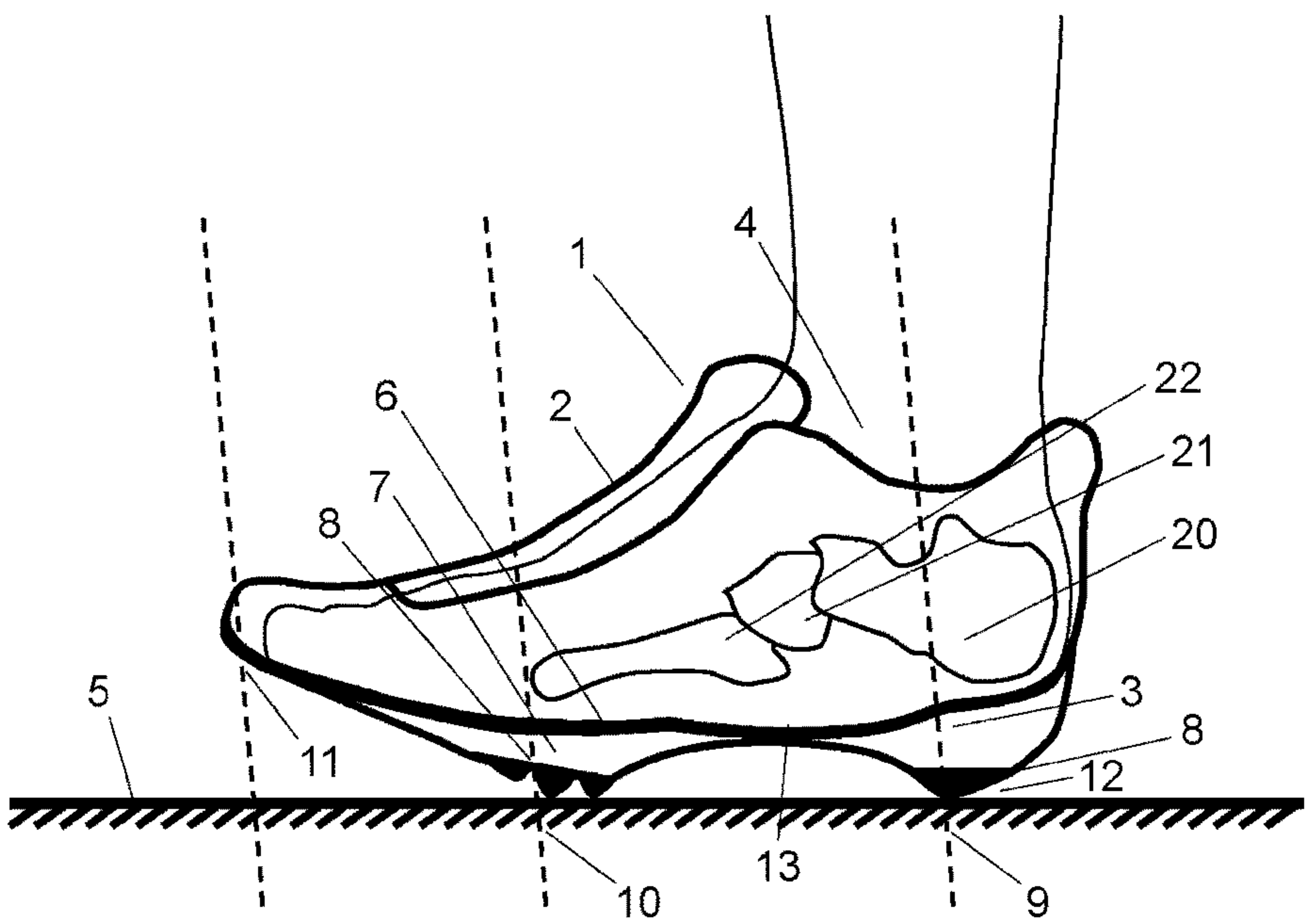

Figure 1

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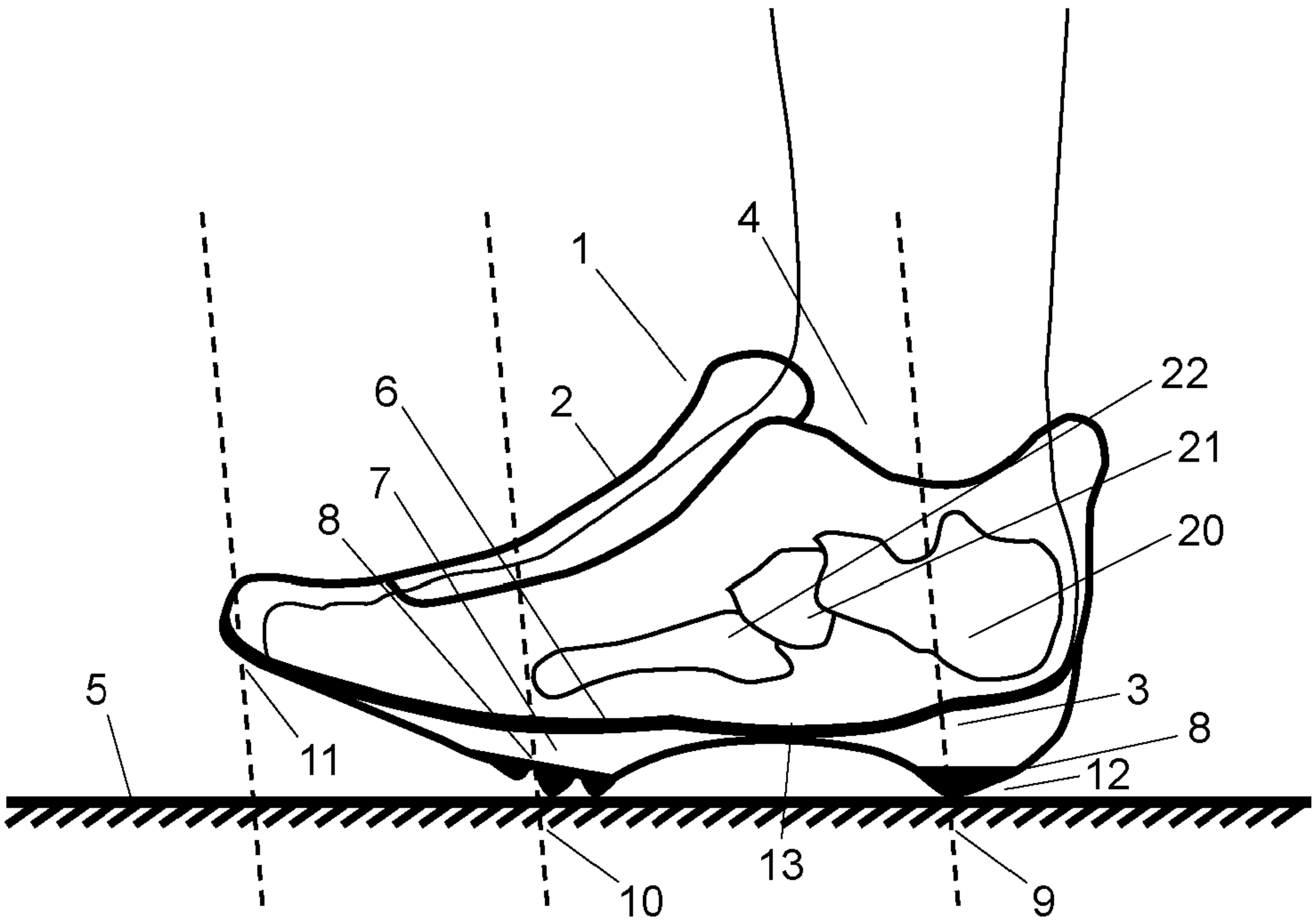

Figure 1

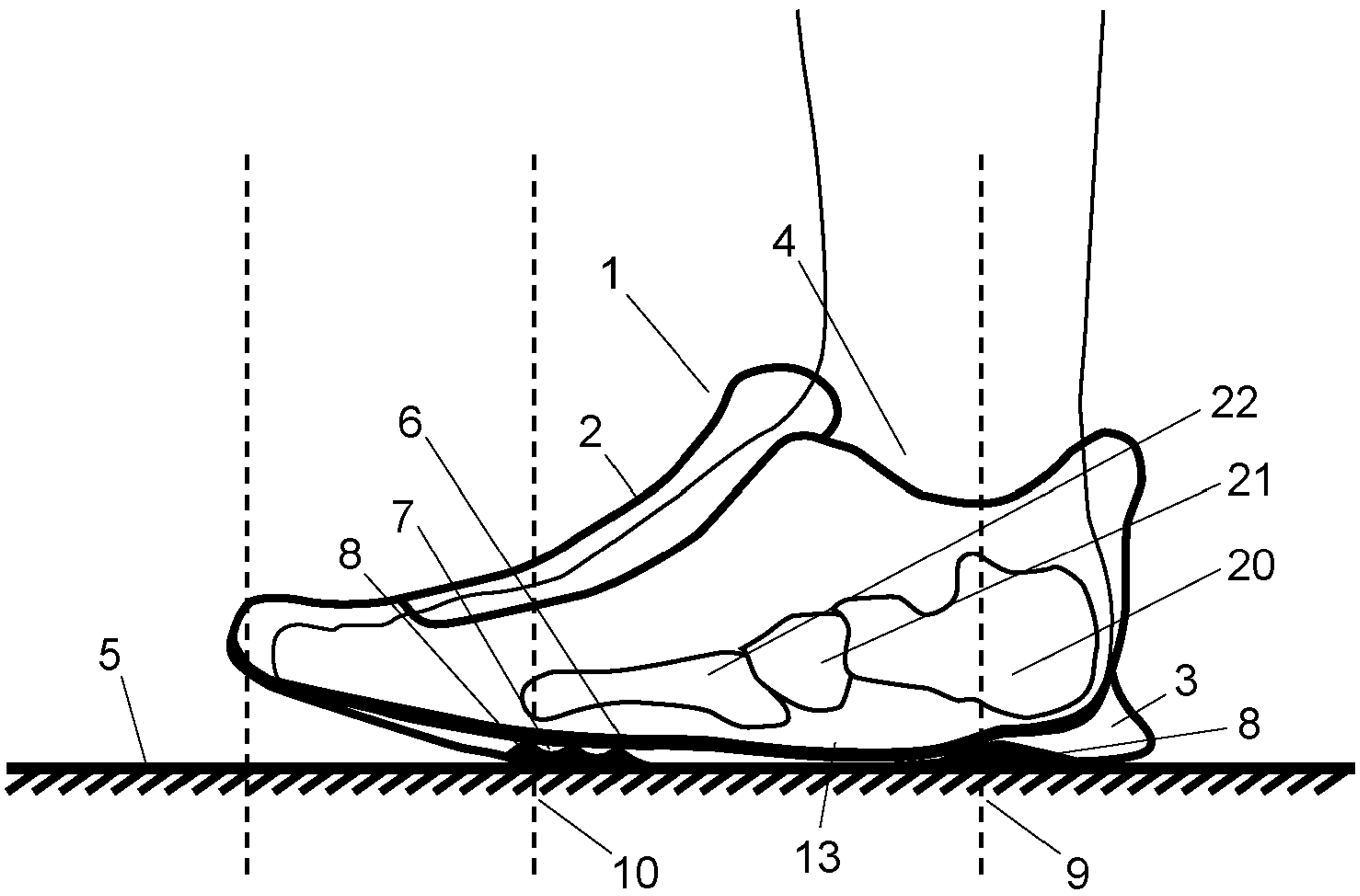

Figure 2

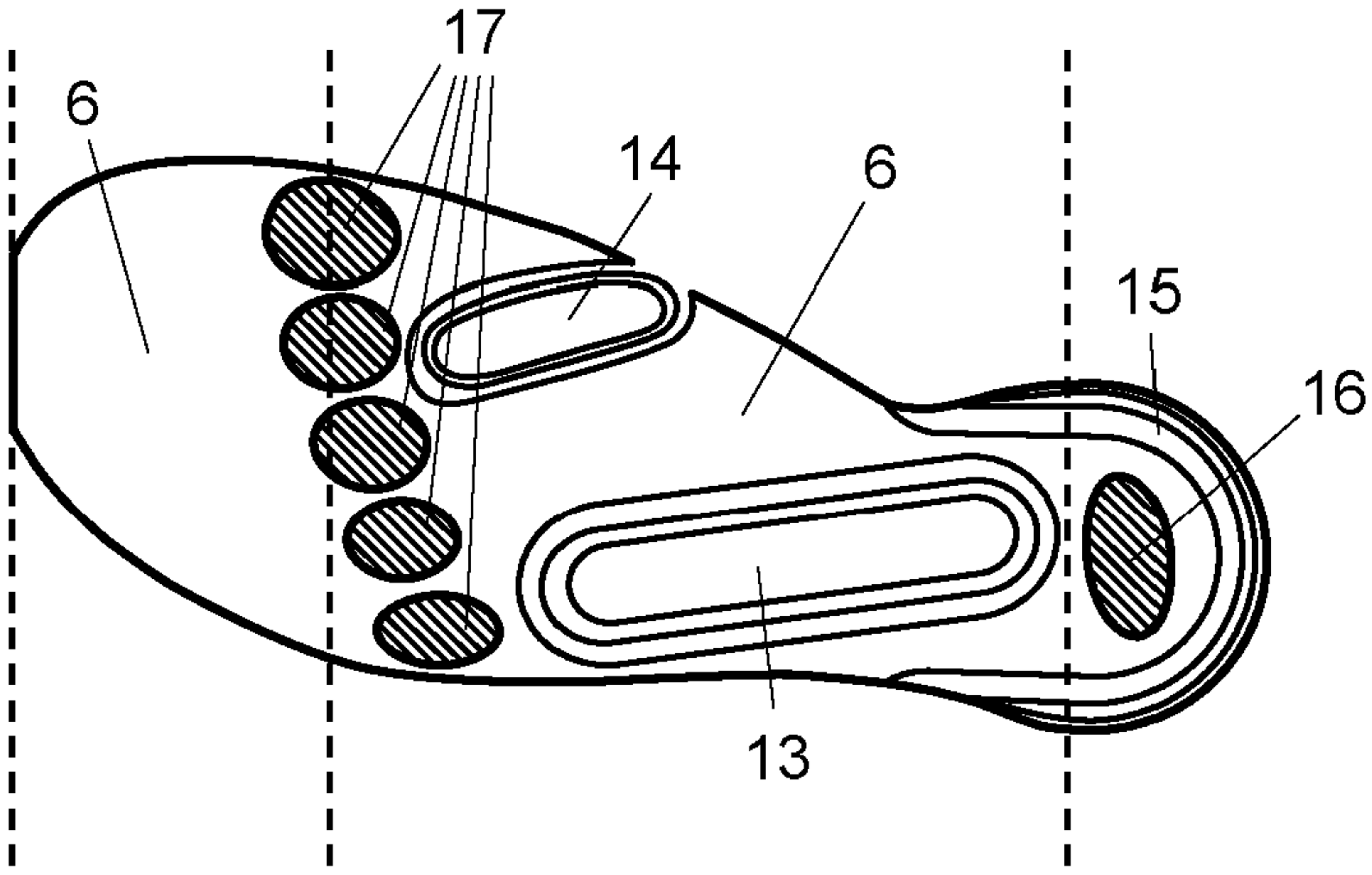

Figure 3

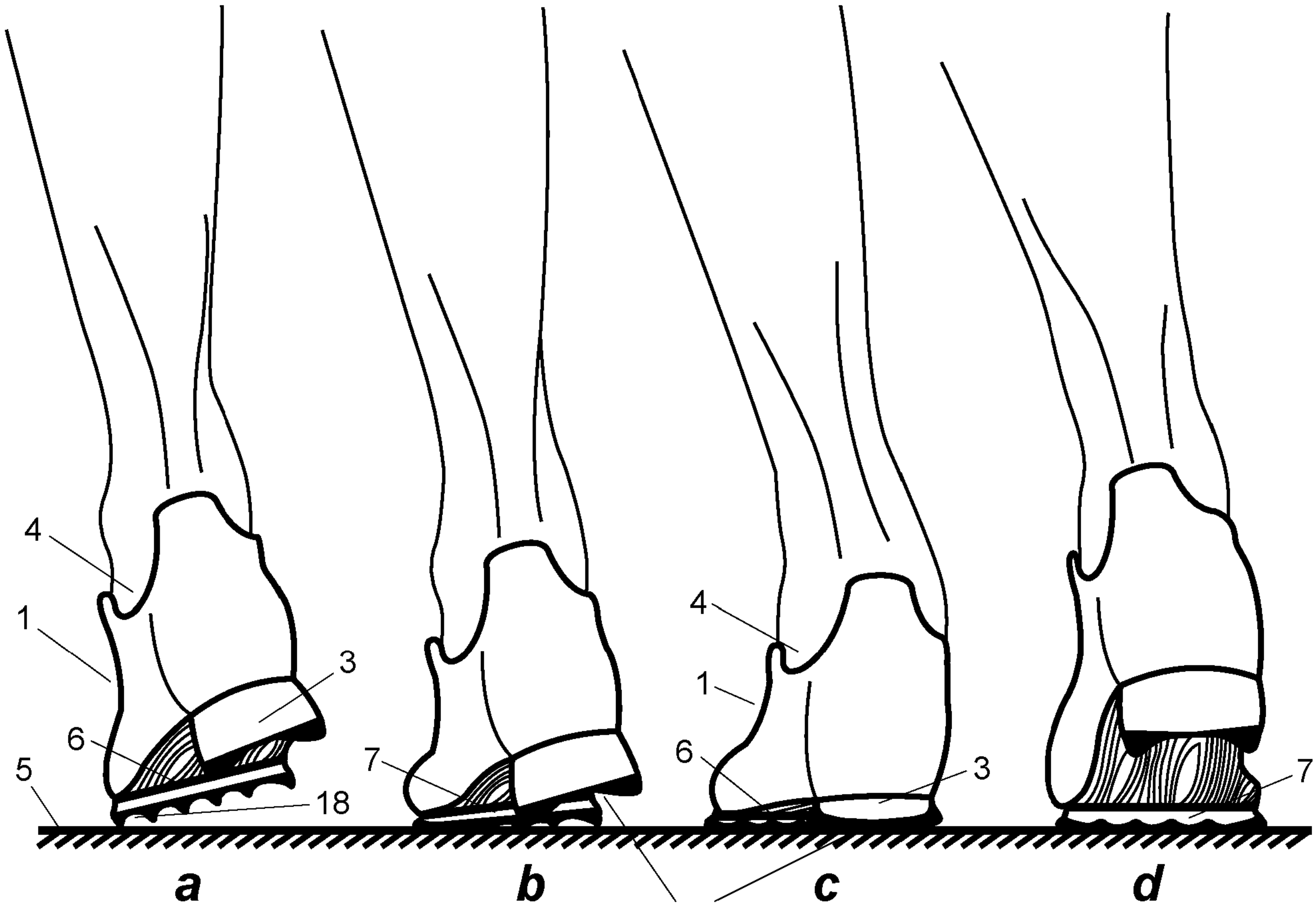

Figure 4

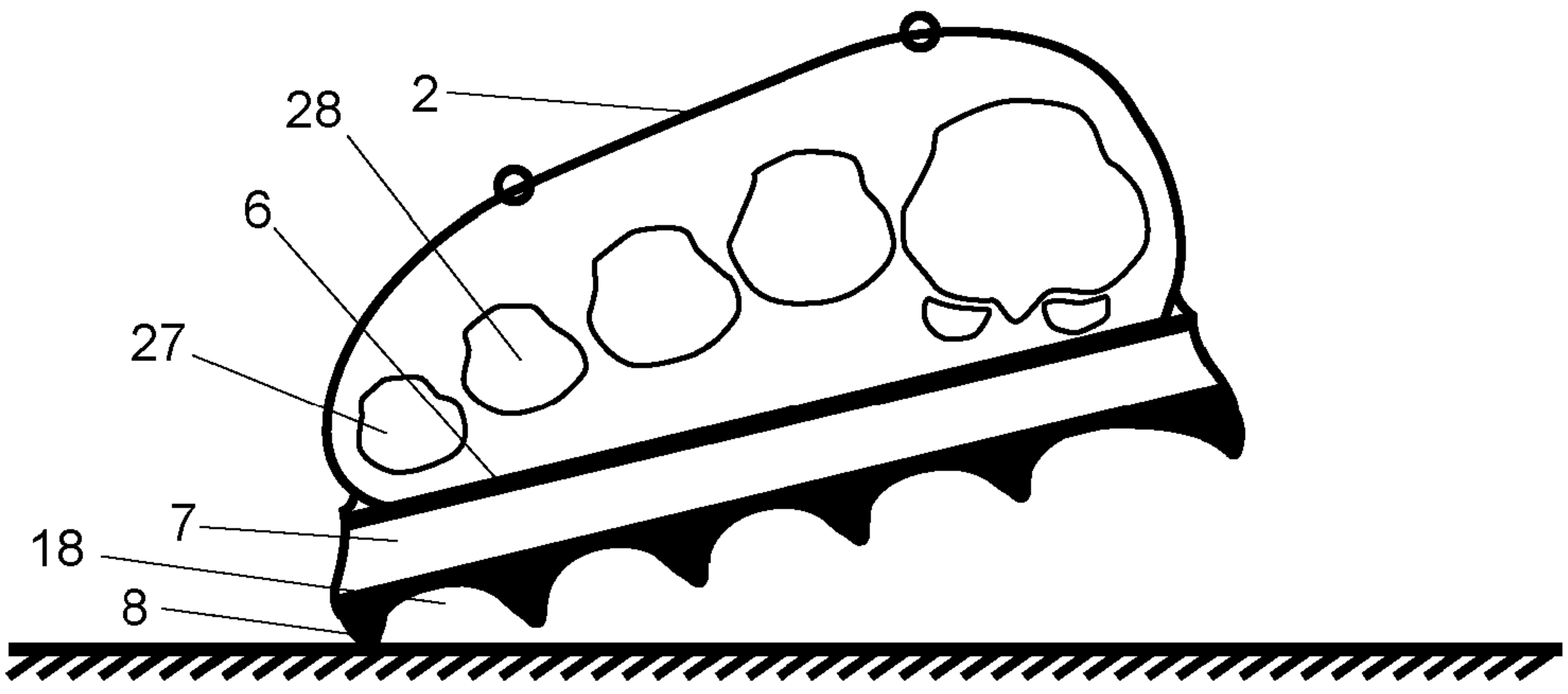

Figure 5a

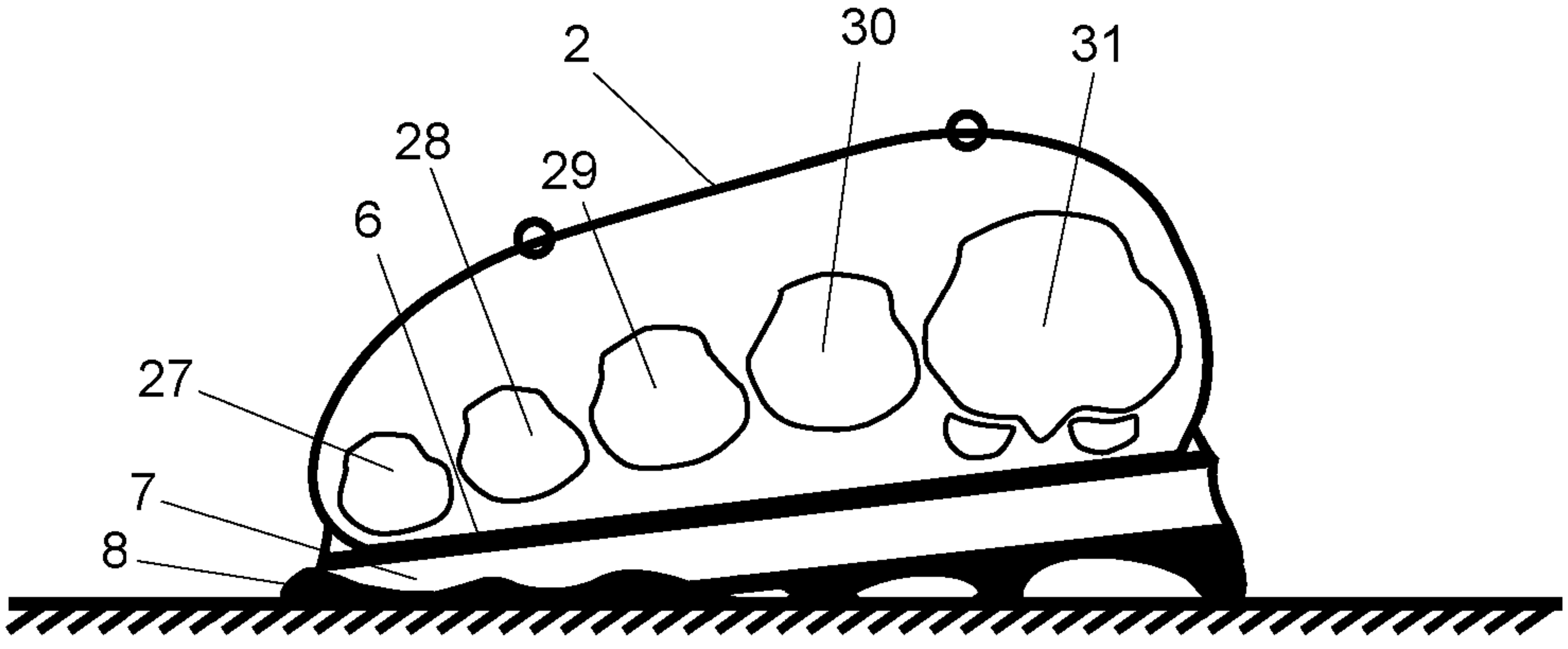

Figure 5b

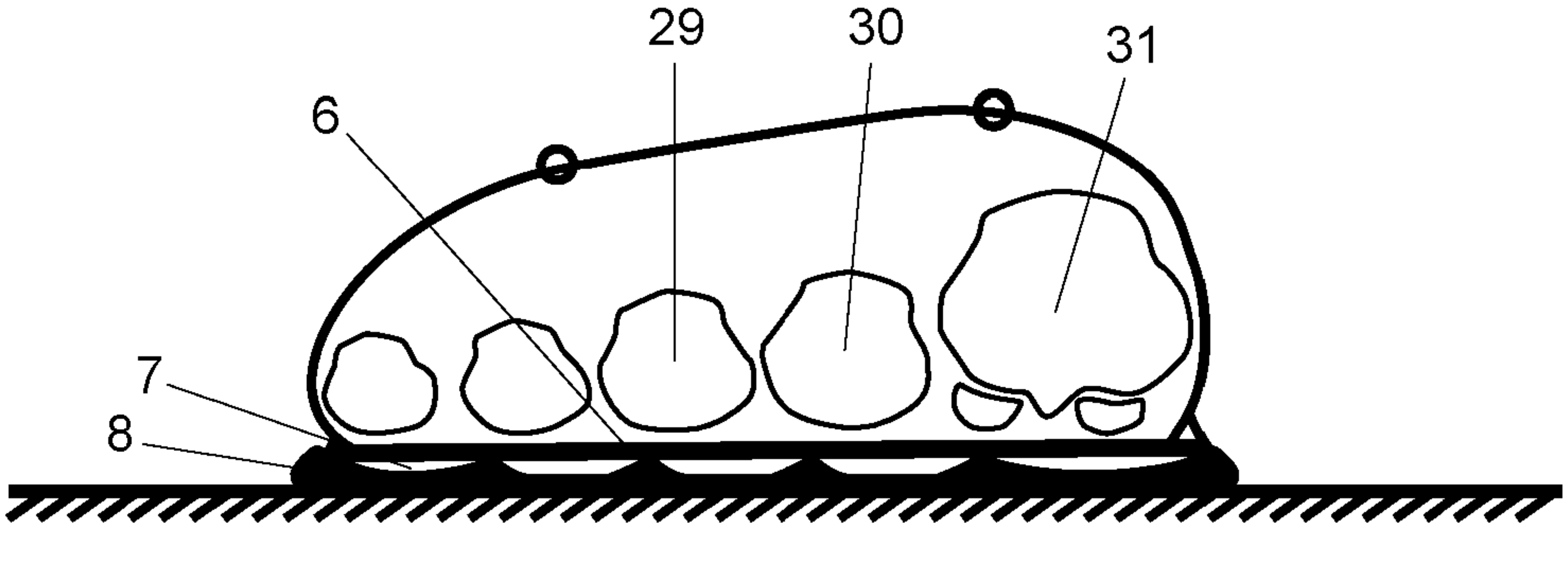

Figure 5c

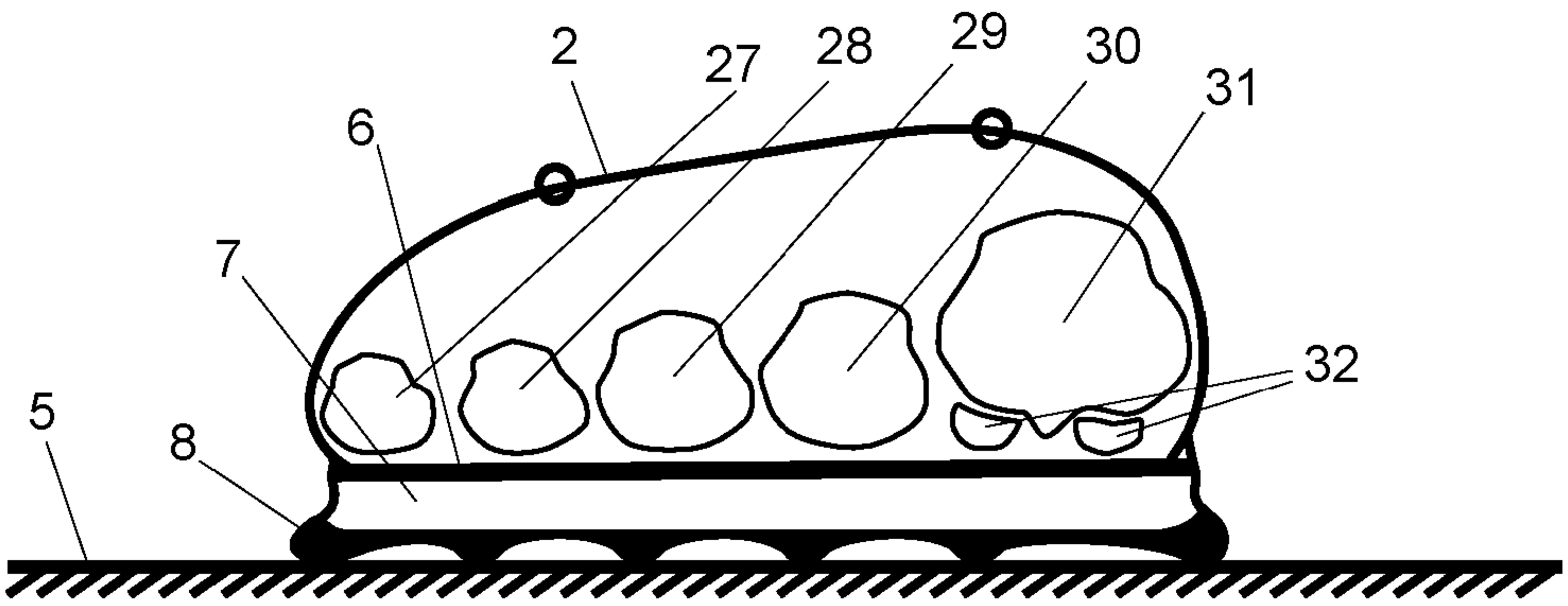

Figure 5d

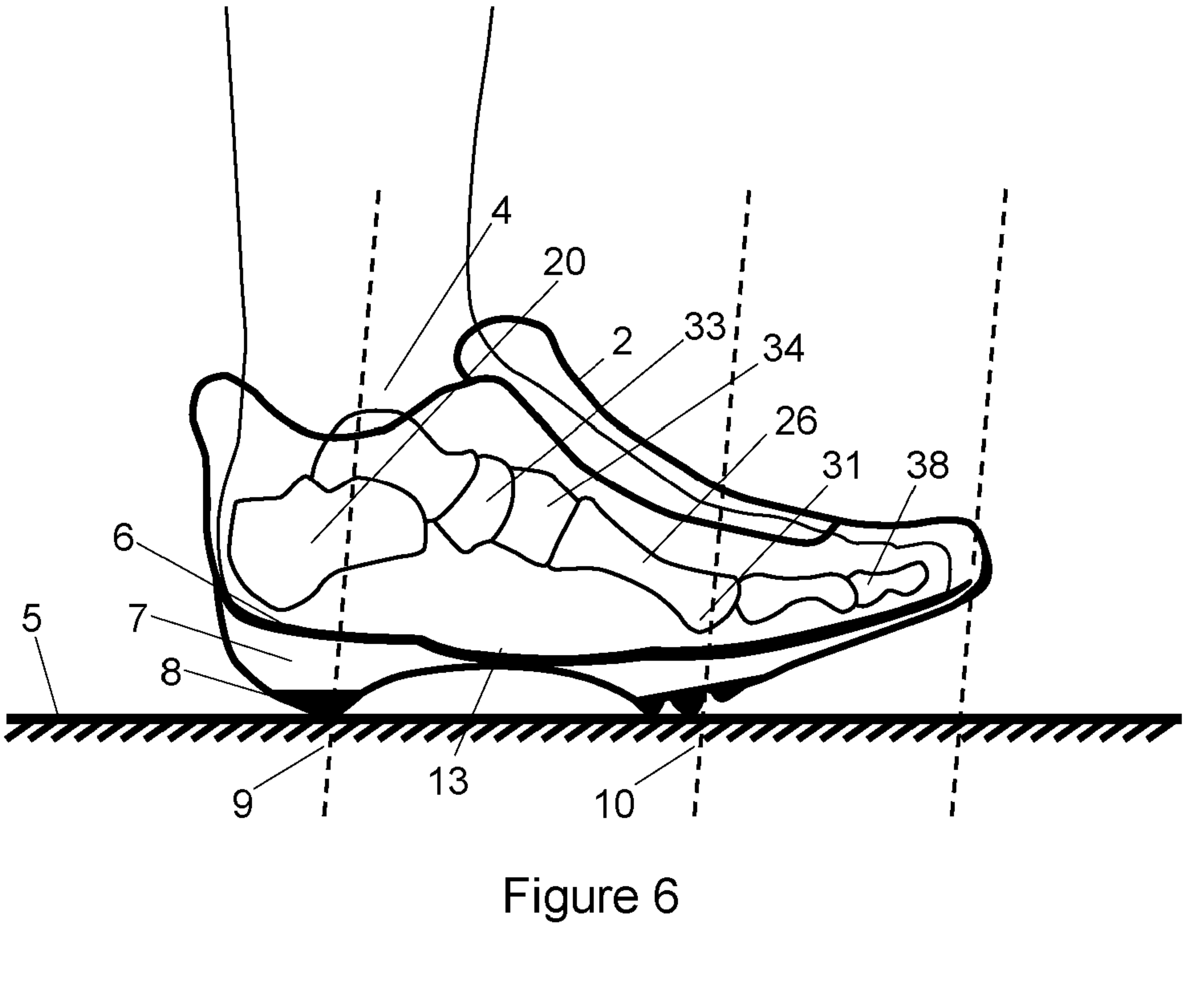

Figure 6

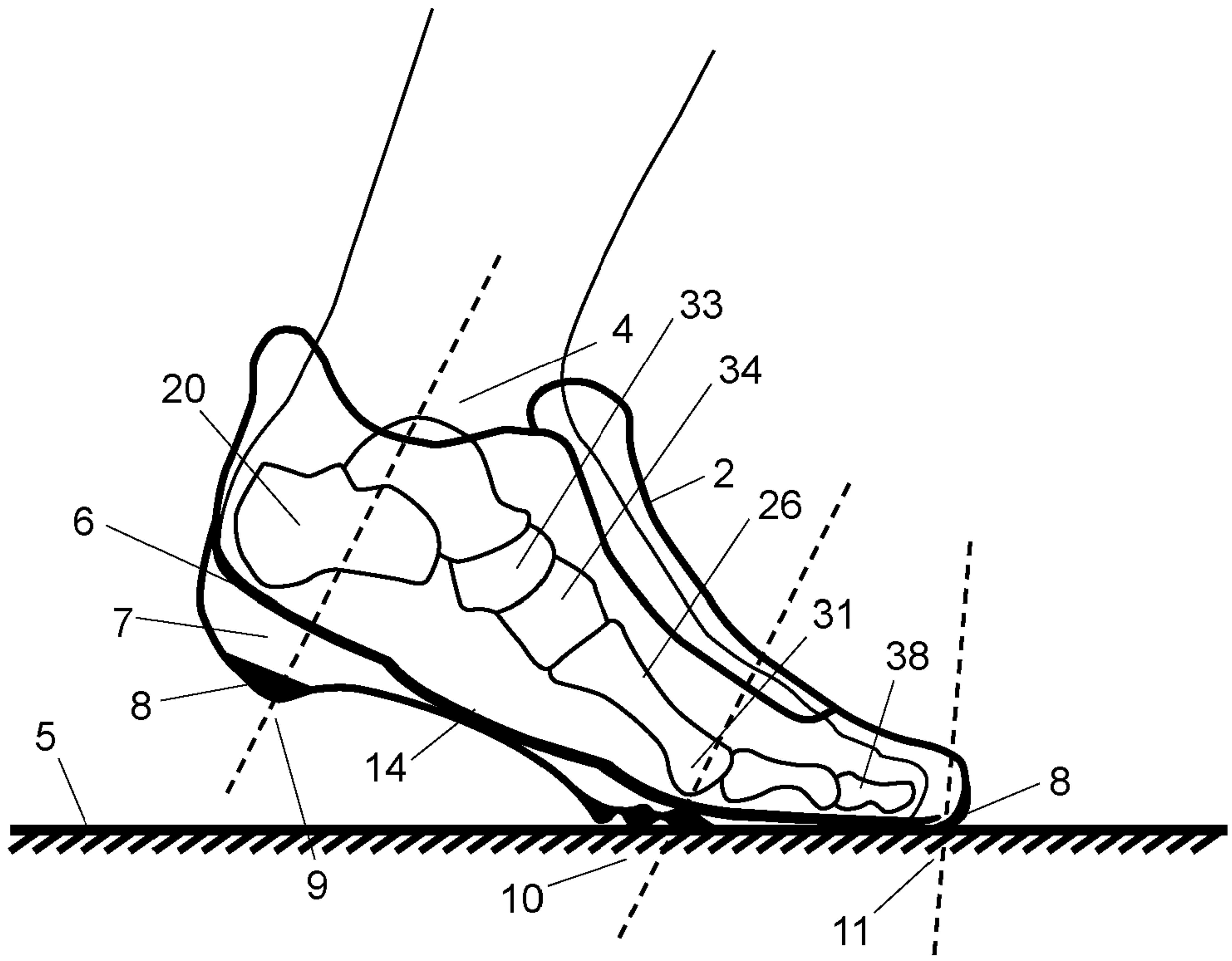

Figure 7

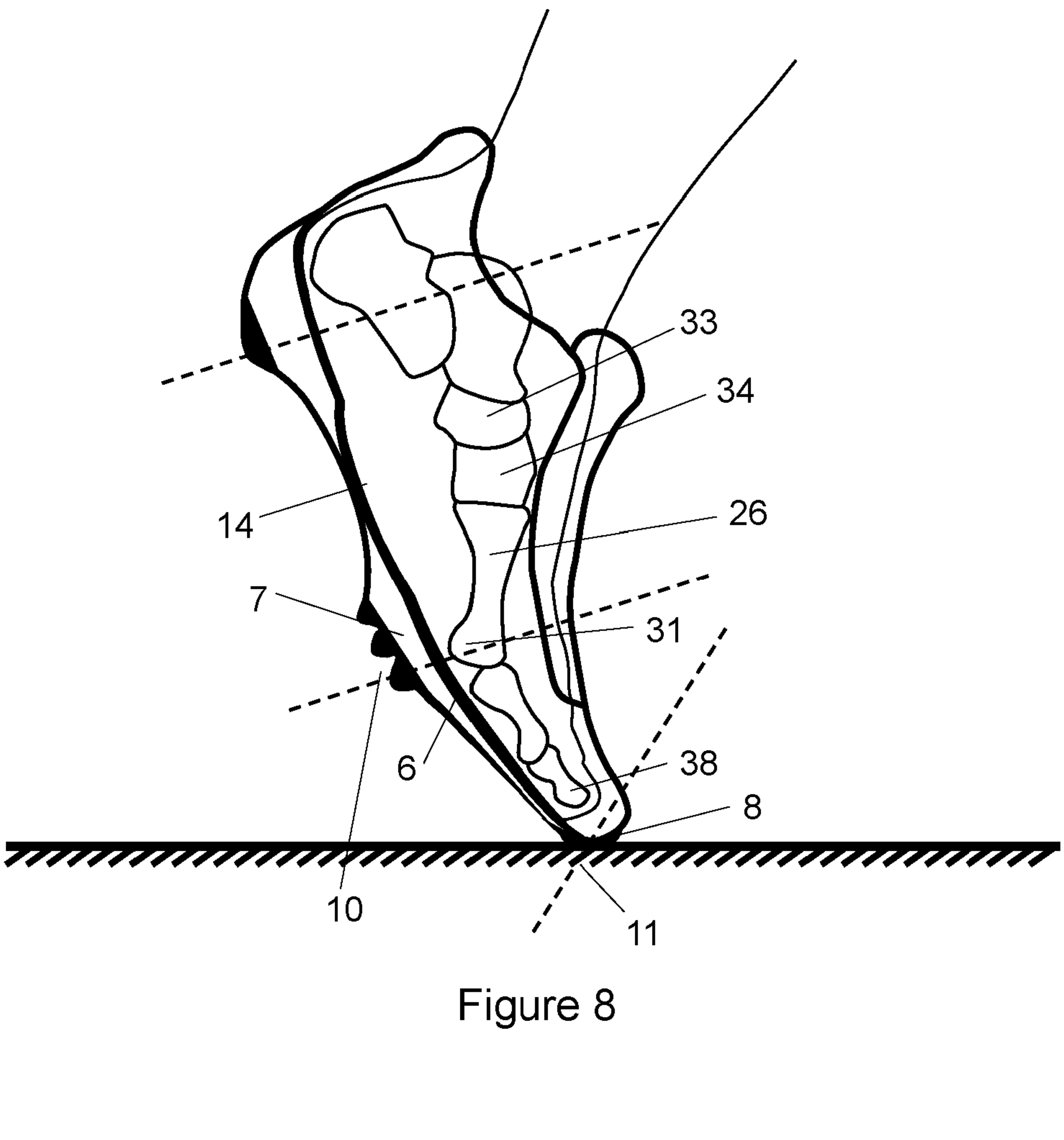

Figure 8

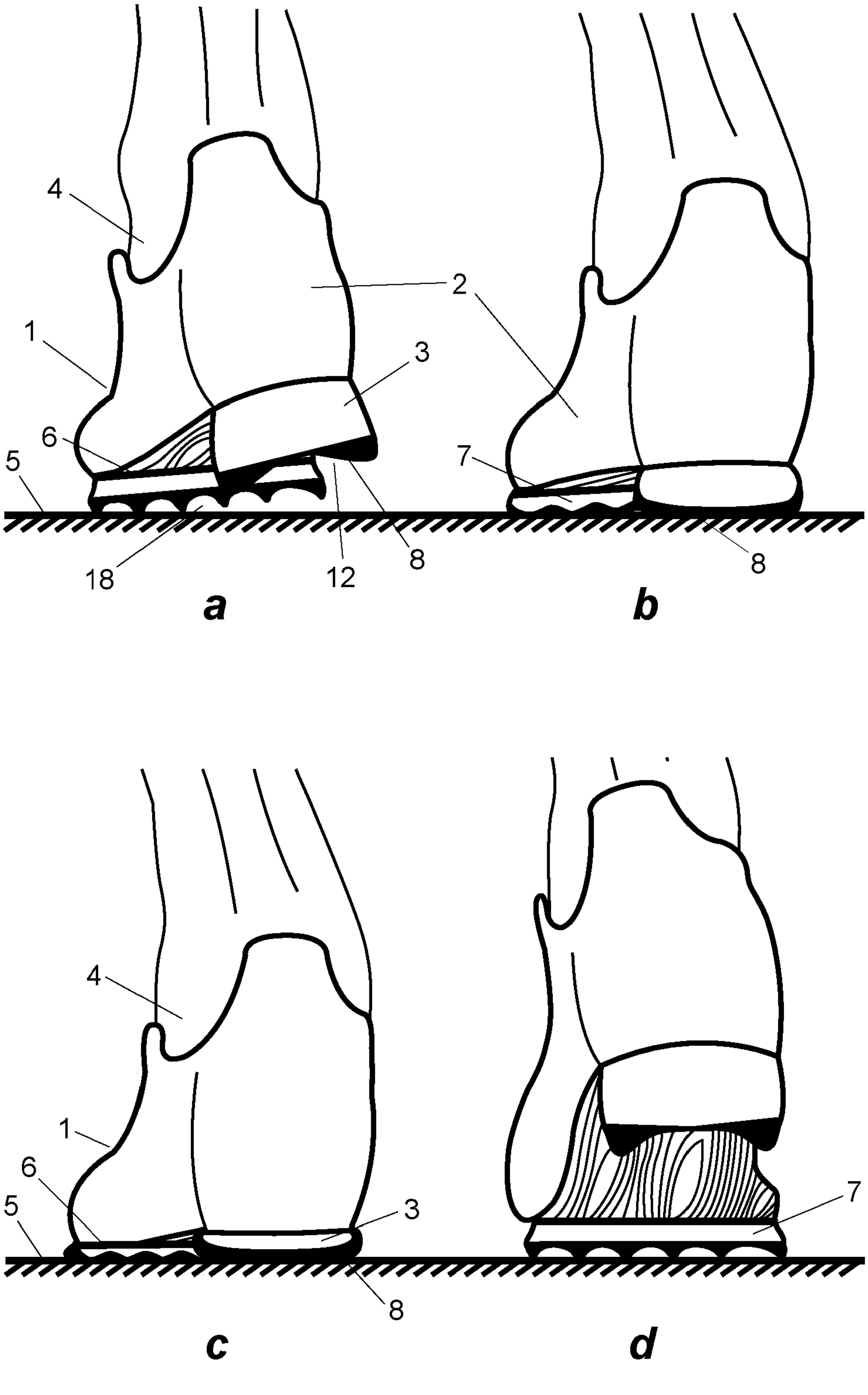

Figure 9 a, b, c & d

Footwear with plantar fascia reinforcement

(Background)

The present invention relates to a shoe sole and particularly to a sole as part of training footwear for use in connection with activities which involve walking, running and jumping. The sole is designed to enhance the function of the plantar fascia of the foot, and therefore to give a natural reinforcement to the body during physical activities. The sole will take some of the strains on the body, that result from high impact forces and lateral twists. The unique construction of the plate on top of a low-density sole, reduces the strain during landing, and facilitates recoil for upwards and forwards movement of the body. The grooves and fibres in the plate, together with the foam and rubber material below, are configured as such that the natural function of the plantar fascia of the wearer's foot is complemented. The enhanced elasticity results in superior shock absorption and energy return.

Overuse injuries occur when the cumulative load, the body is exposed to during a single high impact physical activity session, exceeds its load tolerance of the structure at the time of loading. Shock absorbing and energy returning shoe soles are an important tool for runners, who build their resilience for distance running. Runners want to run many miles on hard roads and reduce the strain on their musculoskeletal tissues with protection under their feet. Such soles also have a role in the rehabilitation of athletes to aid the regeneration of muscle tissues. Shock absorbing soles can also reduce the strain on the feet of people who need to stand and walk a lot.

The plantar fascia is the thick band of fibrous connective tissue, which supports the arch at the bottom of the foot. It runs from the calcaneus (heel bone) forward to the heads of the metatarsal bones. It radiates towards the bases of the toes and is made up of predominantly longitudinally oriented collagen fibres. The plantar fascia contributes to walking, running and jumping by acting as a tie-rod, where it undergoes tension when the foot bears weight. It behaves like a spring, which may assist in conserving energy. When the resilience of the fascia is insufficient, in a condition called "plantar fasciopathy", the relatively large loads, applied repeatedly, cause a breakdown of the fibres, with subsequent pain and reduced function.

Such degeneration of body tissues, which means that there is a lack of resilience in the tissue, is common. A period of insufficient physical activity, as well as a period of overloading of the fasciae, can lead to degeneration.

For younger users of training footwear, the effective resilience of the soles is particularly important for sports performance. Conventional trainers only give limited protection to the foot. They do not give the user assistance to jump higher or run faster.

Older people are affected by sarcopenia, which is the aspect of aging that results in the loss of fast twitch muscle fibres and a gradual degeneration of the tendons and fasciae in the body. This reduces the elasticity of the body tissue. It also decreases the protection from impact during running and walking. The connective tissue in the muscles and tendons and in the plantar fascia, as well as the cartilage in the leg joints, are less able to withstand repetitive strains and stresses.

What is required to achieve regeneration of the tissue is optimal loading for months. A training programme, for example a weekly running schedule together with specific loading exercises for the plantar fascia, can lead to such repair and strengthening of fasciae. The plantar fascia can regain its resilience, both in terms of durability as well as in terms of elasticity and strength. Conventional trainers are used as a tool to carry out such training programme. The soles of this kind of footwear has limited shock absorption and energy return and have a considerable weight, which can limit the user's performance and enjoyment.

When running or jumping, the human body experiences a sudden increase in vertical ground reaction force, during the first phase of the step: at the time that the foot contacts the ground. This rapid force is commonly termed shock or impact loading. This shock on the body is reduced when the time between the outer sole of the shoe contacting the ground and the foot bones coming to a standstill is increased. In conventional sports shoes this time can be very brief, as the midsole and outer sole parts that are situated between the tuber calcanei (heel bone) and the ground, and the sole parts that are situated between the fifth metatarsal head and the ground, are typically of limited thickness, continuous and made of medium and high density rubber and foam materials. The weight of such soles as well as the resistance to the normal roll of the foot reduces the efficiency of walking and running. The sole materials are typically constructed from viscoelastic materials. Therefore, during walking, running and jumping, such shoe soles will attenuate energy, that is not returned to the body. This means that the sole does not push the person upwards and forwards during the second part of the stance phase during walking and running. The weight of conventional sport shoes, the resistance to the roll of the foot and the lack of elasticity of the materials of the soles all contribute to a reduction of energy efficiency during walking and running.

Shoe soles with elastic composites with variable properties have been around for centuries. Throughout history artisans and craftsmen have exploited the diverse properties of various materials, and used elastomers, especially natural rubber for shoe soles. They mastered skilful techniques to combine and convert such raw materials into footwear. Natural rubber has a high density and can therefore soles of this material can’t be high and lightweight. In modern times, the footwear industries’ fabrication methods have mainly focused on fashion. The construction of shoes has, at best, not given optimal protection, and often has hindered the wearer’s feet as well as his walking, running and jumping.

Footwear with plates to reinforce the plantar fascia have been invented by Michel Marc in 2006 (US 7578077), by Teuvo Niskanen and Matti Salminen in 2012 (WO2014068169) and by Edward Weaver, Sherry Hinds and Beth Gramza in 2014 (WO2014110029). None of these inventions use a grooved fibre reinforced plate underneath the full foot, to increase the shock absorption and energy return during the full stance phase of running and walking.

The invention will now be described solely by way of example. Features of the invention are described in relation to embodiments of the present invention described with reference to the accompanying drawings in which:

Figure 1 shows a cross section of the shoe from a lateral view with three bones of the wearer's foot. The shoe touches the ground whilst minimal weight is applied to the sole, as at the very start of the stance phase of running.

Figure 2 shows the same cross section of the footwear as Figure 1. A high downwards force is applied to the sole, which results in full compression of the sole, as during the middle of the stance phase of running.

Figure 3 is a top plan view of the grooved sole plate with markings to show the location of the weight bearing skeletal structures of the wearer's foot in relation to the plate.

Figure 4 represents a rear view of the shoe and the wearer's left lower leg during the 4 stages of the stance phase of fast running: a, b, c & d.

Figures 5 a, b, c & d show a cross section of the shoe and the wearer's foot from a rear view, at the level of the five metatarsal heads. As in Figure 4, 5a, 5b, 5c and 5d represent the sole and the foot during the 4 stages of the stance phase of fast running.

Figure 6 shows a cross section of the shoe across seven bones of the wearer's foot, from a medial view, when the shoe is resting on ground 5, but no weight is applied on to the sole.

Figure 7 shows the cross section as in Figure 6 when part of the sole is compressed, as it would be at a time during the fourth quarter of the stance phase of running.

Figure 8 shows the cross section of the shoe as in Figure 6. The sole is only compressed at the tip of the shoe as it would be at the very end of the stance phase of running and jumping.

Figures 9 a, b, c & d show an enlargement of Figures 4 a, b, c & d with a rear view of the shoe and the wearer's left lower leg during the 4 stages of the stance phase of running: a, b, c & d., at a slower pace than in Figure 4.

According to the present invention there is provided a shoe generally designated 1. The shoe comprises of an upper part 2 within which a wearer's foot 4 is received, and a sole generally designated 3. The sole is conventionally located on the underside of the upper part 2 such that, in use, it is orientated between the wearer's foot 4 and the ground 5. The sole has a sole arrangement, which includes a hard and rigid reinforced plate 6. The reinforcement is enhanced by the longitudinal grooves and long fibres running from the heel to the forefoot. Plate 6 is situated on top a compressible portion 7, also referred to as midsole, and a bottom sole portion 8, also referred to as outer sole. The outer sole 8, in use, is ground engaging and as such may be configured appropriately to impart the required grip properties with the ground 5.

The mid sole 7 may be of uniform mechanical properties, for example density, over its entire extent. Alternatively, the midsole 7 may be configured as to have differing mechanical properties over its extent. This compressible portion 7 and the outer sole section 8 may have various shapes with recesses to provide a trampoline effect during running, fast walking and jumping. Various shapes of these sole sections may result in the provision of pivots 9, 10 and 11 as illustrated in Figure 1, 2, 3, 6 and 7 with arrows. Pole vault effects are provided through the construction of the plate as featured in Figure 3, in combination with various shapes of the midsole 7 and outer sole 8, creating pivots to bring about the energy return from the shoe sole.

Figure 3 illustrates the location of the high pressure areas 16: under the tuber calcanei, and 17: under the metatarsal heads. The high rigidity of the sole member protects the foot against high pressure on the wearer: underneath the cuboid bone 21, the navicular bone 33, the cuneiform bones 34 and the metatarsal bones 22, 23, 24, 25 and 26 of the foot, as drawn in Figure 1, 2, 6, 7 and 8.

In embodiments of the present invention, the fibre reinforced plate 6 acts as a beam to support the plantar fascia and the longitudinal arch of the foot between the calcaneus 20, the cuboid bone 21 and the metatarsal bones 22, 23, 24, 25 and 26 of the wearer. It needs to be rigid in this area, and therefore a groove 13 or multiple grooves 13 and 14 run longitudinally. This ensures that the plate gives a greater resistance to stress during brisk walking, running and jumping. As with a bamboo pole and with pole vaulting the highest stresses occur on the outside of the bent beam. As with a pole, within the middle zone of the pole or groove there are minimum or no stresses at all. Therefore, there is no need to put a high-density material inside the groove. As bamboo, that is a naturally hollow material, the plate is much lighter per unit length than a solid flat plate, yet it resists greater stresses. Given that pole-vaulting essentially involves the conversion of the kinetic energy of the running athlete to the potential energy of the jump using strain energy stored in the pole (the energy stored in elastic deformation), a lighter pole enables an athlete to run faster. In the same way the plate in the footwear according to the present invention, provides little resistance to running, but more energy return. In its elastic recovery, the plate is sufficiently strong and flexible to allow substantial amounts of energy to be transformed into elastic strain energy stored in the deformed plate. In this way it complements the function of the plantar fascia.

The grooves in the present invention also allow the foot to roll how it needs to roll for shock absorption and propulsion. Because they are positioned longitudinally in the plate at the level above the distal part of the calcaneus, the navicular bone, the cuboid, the cuneiform bones and the metatarsal bones, pronation of the foot is not impeded. This ensures a normal roll of the foot during walking, running, as in Figure 4, and jumping. This specific localised rigidity and flexibility of the plate is a result of a combination of fibre orientation and the singular or multiple grooves, which run from proximal to distal.

As illustrated in Figure 2, during faster running, when the midsole is fully compressed in this area the deepest point of the groove(s) could come to a standstill whilst the calcaneus 20 and the head of metatarsal bone 22 continue to move in a downwards direction. In this way the plate could provide a further deceleration to the calcaneus and metatarsal bones. Once the calcaneus and metatarsal bones reach their lowest point the plate is at its most stressed. Very shortly after that point of time, through its elasticity, the upper sole member will provide an additional force to assist the body in the upwards and forwards direction away from the ground surface through upwards pressure on the calcaneus and heads of the metatarsal bones, as illustrated in Figure 7. The plate with its fibres, for example flax fibres, is attached at the edges to a compliant but robust sole material, for example polyurethane, that is ground engaged. This can be compared to a trampoline where the springs at the outside provide the shock absorption and kinetic energy return.

The recesses below the calcaneus 20, and below the metatarsal heads 22, 23, 24, 25 and 26, together with the rubber material 7 and 8, above the recesses 18 allow for a greater ‘rubber elasticity’. The elasticity is provided by both the plate and by the crosslinking of the molecules of the rubber material, also referred to as elastomer. In the present invention, when the body impacts on to the ground surface, the part of the foot directly above the recess and the rubber material decelerates over a greater distance. This gives the human body tissues more space to absorb the shock. The leg bones are decelerated by the plate and the elastomer below the plate, over a greater distance than with a conventional sole. The recesses also allow for more stretch on to the sole materials, enabling it to spring back and give more energy return.

In the elastomer of the present invention, the elastic force is due to the thermal interactions of the molecules within the material. The sole can be produced through direct injection molding. During the mixing and heating of this molding process, the crosslinking molecules cause a reaction that chemically bonds the rubber molecules together into a crosslink. In this way a molecular network of very long molecules (polymers) is being created, with the addition of a few percent of a cross linking molecule, through chemical reactions. Because the rubber molecules are so long, each one crosslinks with many other rubber molecules. These network chains in the sole are transformed into continuous sole molecules. When it is stretched, some of the network chains are forced to become straight. The elastomer's resistance to this straightening, together with the fibre-reinforcement of the plate, attached to the elastomer, provides the bending stiffness of the sole. In the present invention the tensile strength of the midsole 7 and outer sole 8 is increased considerably, due to the attachment to the fibres in the plate, with a reduction in extendibility of the lightweight sole. The elasticity of elastomers is combined with the rigidity of the plate, and therefore superior resistance to impact forces is achieved.

In various embodiments of the present invention, the midsole 7 is made of a low-density elastomer. The tensile strength of the midsole 7 is greatly increased by joining it with a fibre reinforced thermoplastic plate. The outer sole pieces 8 contain a higher density elastomer, to make it more robust and long lasting. The resistive force to the human body, impacting on the ground, is partially provided by the resistance to stretching of this high-density elastomer. Figure 9 illustrates how the midsole 7 and outer sole 8 provide a deceleration to the downwards force during running. The top layer of outer sole 8 stretches and bulges to the medial and the lateral side of the foot. This bulging provides a stabilizing force, assisting in the prevention of overpronation and oversupination of the ankle and foot, during running and walking. As can be seen in Figures 1, 4, 5, 6, 7 and 9 the outer sole pieces 8 have small recesses in between the top layer of the outer sole pieces 8 and the ground 5 when there is no body weight compressing the sole. Therefore, on initial contact of the shoe sole to the ground, during walking and running, the shoe does not slip. This is particularly important for the stability. The outer sole pieces 8 are made from a hard-wearing elastomer, and therefore remain its shapes for many miles of walking and running.

In embodiments of the current invention the outer sole material is situated above recess 18 underneath the fifth metatarsal bone, above recess 12 underneath the calcaneus and above the recesses underneath the first and second metatarsal heads. These sections of high density, strong rubber material give a greater resistance to stretching as well as compression. The constructions of the various embodiments of the present invention allow for a low total sole weight because the high-density elastomer material is only required in small selected sections at the bottom of the sole.

The elastomer in the sole also provides elasticity through compression of the sole. Both through the release of the stretch on the sole as well as through compression and a return to the initial sole height, energy return takes place. The elastomer together with the rigid fibre-reinforced plate gives a higher energy return than conventional training shoe soles. There is a high restoring force, which causes the polymer chain to return to its equilibrium or unstretched state, and the bended plate to return to its original shape, once the external force is removed.

In an embodiment of the present invention the rigid sole member 6 is constructed as such that the plate like structure is curved with the ground facing side being convex, especially at the level of the grooves 13 and 14 as illustrated in Figure 3. In order to provide an effective trampoline and pole vault effect the plate with its composite fibre reinforced layers has an overall high rigidity. The flexular rigidity is particularly high both in the anterior-posterior direction directly below the calcaneus 20, cuboid 21 and metatarsal bones 22, 23, 24, 25 and 26, and in the lateral-medial direction directly below the calcaneus 20. This bending resistance is the result of a combination of fibre reinforcement, the curving of the plate through its cupping 15, and single or multiple grooves 13 and 14.

Striking the foot, as such that the fifth metatarsal head 27 is the first bony point of the human body that has force applied from the ground, is the most effective way to run fast, as is picture in Figure 4a&b and Figure 5a&b. It is also the most efficient way of landing and jumping. Whilst the musculoskeletal system works best in this way, with this unique and optimal design the sole enhances the system’s effectiveness and gives additional protection to the body.

In an embodiment of the present invention there may be provided a substantially inflexible portion to the rigid member in the area below the calcaneus 20, cuboid bone 21 and fifth metatarsal bone 22, whilst the remainder of the rigid member 6 is less rigid. This would be to permit a desired degree of transverse and rotational flexibility so as to allow pronation of the ankle and foot, as is illustrated in Figure 4 a, b, c and d, and flexion of the metatarsal phalangeal joints, as is illustrated in Figure 6 and 7. The areas of differing rigidity may be provided as a result of the construction of the plate member 6. For example, three grooves in the rigid member 6 may be manufactured through compression moulding of fibre reinforced composites.

According to a further embodiment of the present invention, in combination with other features of this invention, as shown in Figure 4a,b,c&d and Figure 5a,b,c&d, there is provided a small recess 18 directly under the fifth metatarsal head 27 of the wearer. This recess allows the fibre reinforced plate 6 and midsole 7 above the recess to absorb the impact from the foot strike when the wearer lands on this area of the foot. The fifth metatarsal head 27 of the wearer 4, and therefore the entire human body, will be decelerated over a considerable distance by the fibre reinforced plate and the compliant low-density midsole material that are situated directly underneath. As in a trampoline, the material in this area will also give energy return when the force on this area reduces, later in the stance phase of the step during the run, or later during the jump.

The mid sole 7 is manufactured from a compressible material, for example low density polyurethane foam. The rigid member 6 is manufactured from a substantially incompressible composite. The material of the rigid member may comprise a polymer such as an organic fibre reinforced composite, for example flax fibre reinforced thermoplastics. To reduce the environmental and financial costs of producing the plates, they can be made from a hybrid thermoplastic prepreg polymer. This material is then compression moulded and thermoformed into the required shape as described in the various embodiments of this invention. The combined materials and construction of the sole 3, preferably provides a sole that can be compress to 10% up to 90% of its original thickness, when subjected to the application of a compressive force in the region of 1000 to 6000 Newton.

As illustrated in Figure 4 a and b, in use, when striking the foot during running, the immediate shock is dissipated across the rigid member 6, which results in a lower initial force under the foot compared to that experienced with conventional running shoes.
Due to the natural build of the foot, the body weight impacts on the calcaneus 20 and the fifth metatarsal head 27 during walking and running. The shape and rigidity of the sole member 6 ensures that the force ground reaction force transmitted from the ground 5 does not cause unnatural and excessive pressure on the area of the longitudinal arch of the foot, including cuboid bone 21. The shape of the rigid sole member 6 is as such that it has

a groove 13 or multiple grooves 13 and 14, which are convex from the side of the ground 5.

According to a further embodiment of the present invention there is provided a shoe 1 in a “heel-less” configuration, which is to say that a recess 12 is provided in the sole in the region below the posterior portion of calcaneus or heel bone 20 of the wearer’s foot 4. A rear pivot 9 is provided through the shape of the outer and midsole below the fibre-reinforced plate. Because there is a recess 12 directly below the tuber calcanei of the wearer, there is energy return after the downwards movement of the calcaneus during running, walking and jumping. The resilient and compliant sole part below the plate is compressed and springs back into its original shape when the pressure on the calcaneus is reduced. This transverse energy return is a similar mechanism as a trampoline with springs around the canvas on which the user jumps. On impact the fibre reinforced plate 6 is also stretched in the longitudinal direction through pivot 9, and springs back when the pressure on the calcaneus is reduced. Therefore, it also provides a similar mechanics as a pole vault.

In an alternative embodiment, the shoe sole 3 may be provided with a heel. In this way it can provide a pole vault effect or a trampoline effect with varying densities across the sole. In another embodiment of the present invention, the rigid member 6 may extend to only just anterior to the metatarsal heads 27, 28, 29, 30 and 31.

In an embodiment of the present invention, during fast running, the deepest point of the plate member 6 could come to a standstill whilst the calcaneus 20 and the heads of metatarsal bones 27, 28, 29, 30 and 31 continue to move in a downwards direction. This is illustrated in Figures 5, 6 and 7. The high ground reaction forces result in a slight bending of the sole plate. During this point of the stance phase during running the mid sole 7 is fully compressed in this area. Therefore, the upper sole member 6 provides a further deceleration to the calcaneus 20. Once the calcaneus 20 and the metatarsal heads 27, 28, 29, 30 and 31 reach their lowest point the sole plate 6 is at its most stressed. Immediately after that point of time, through its elasticity, the plate 6 will provide an additional force to assist the body in the upwards and forwards direction away from the ground surface through upwards pressure on the calcaneus 20 and heads of the metatarsal heads 27, 28, 29, 30 and 31. The grooves in the plate increase the bending stiffness of the plate. In this way the current invention is instrumental to improved protection to the body, as well as increased running speed.

In various embodiments of the present invention the greater height of the low density mid sole 7, as a result of the considerable thickness under the tuber calcanei 20 and under the metatarsal heads, is also highly advantageous. The mid sole 6 may be configured as to compress to a close to flat configuration in parts of the sole. An example of localised flattening of the sole is shown in Figure 4b, during running, with the centre of pressure from the runner under the metatarsal heads 27 and 28, as shown in Figures 5a, b and c. The high nature of the mid sole 7 ensures that both the first bony parts to come into contact with the ground are supported at a greater height off the ground 5 at the very start of a foot strike, in comparison to conventional running shoes. Therefore the body is decelerated over a greater distance during the first parts of the stance phase, as is illustrated in Figure 4a,b&c and Figures 5a,b&c. This results in a less rapid increase in vertical ground reaction force experienced by the wearer 4. The lowering of such impact forces reduces the risk of injury.

In an embodiment of the present invention there is provided a sole arrangement, including a plate member 6 and a compressible portion 7 that, in use, has a total sole height of between 25 and 40 mm between the calcaneus and the ground and a total sole height of between 15 and 35 mm between the metatarsal heads and the ground, when little to no weight or pressure is applied to the sole. In any embodiment of the present invention such heights are variable dependent on the shoe size and the use of the footwear. For example in one embodiment of the present invention, for a shoe size UK 9 / EU 43, there is no differential in these two heights, with the sole height being 30 mm both rear and front. In another embodiment, for a shoe size UK 9 / EU 43 there is a 10mm differential with 35mm between the calcaneus and the ground, whilst there is 25mm between the metatarsal heads and the ground.

According to another embodiment of the present invention, in combination with some of the previous features, there is provided a pivot in the area directly below the first and second metatarsal heads 31 and 32 of the wearer, as is illustrated with dotted line 10 in Figure 1, 2, 3, 6 and 7. This pivot is the result of a difference in sole height between the area directly below the metatarsal heads 30 and 31 and the area directly below the distal phalange 38 of the second and first toes. Due to this difference in sole thickness, and the upwards curve of plate member 6, there is a gap between the front of the shoe and the ground during the first stages of the stance phase. In one such embodiment of the present invention there is 15-20mm greater height below the metatarsal heads than below the distal phalange. In another such embodiment there is 10-15mm greater height. In another such embodiment there is 5-10mm difference. As illustrated in Figure 1, 6 and 7 the grooved plate member 6 supports the foot at the rear of this pivot and tilts forwards when the centre of pressure from the body weight moves ahead of the pivot line 10. The weight of the body stressing the grooved plate as a beam like structure has a similar mechanism as an athlete leaning on a pole vault at the first part of the pole vault action. After the maximum stress on the plate, energy from the plate is released and assists the wearer 4 to move upwards and forwards. The up and forward acceleration is also assisted by the push off on the metatarsal heads 25 and 26 against the plate 6 when the plate has tilted over the pivot 10. This then has a similar mechanism as a sprinter starting his running race pushing off against a starting block.

In various embodiments of the present invention, in use, when the shoe is resting on ground 5, but no weight is applied on to the sole, as illustrated in Figure 6, there is a space between the bottom of the sole directly below the first distal phalange 38 and the ground 5, that is greater than 14 mm for a shoe of shoe size UK 9 / EU43. In an embodiment of the present invention this dimension is 16 – 18 mm. In another embodiment this dimension is 18 – 20 mm. In another embodiment it is greater than 20mm.

In various embodiments of the present invention a third pivot 11 is provided as illustrated in Figure 3, 6, 7 and 8. At the very end of the stance phase of running and walking the wearer 4 can give an extra flick forward pushing back on plate member 6 to assist the forward propulsion of the body.

According to another embodiment of the present invention there is provided an insert for a sports shoe, the insert being adapted to lie, in use, between a compressible portion of the sole arrangement of a sports shoe and the foot of a wearer of the shoe, the insert including a rigid portion, in use, is shaped so as to lie beneath the heel bone 20, cuboid bone 21 and the fifth metatarsal 22 of the wearer. The rigid portion may fully comprise the insert. Alternatively, the rigid portion may be incorporated into the insert such that portions of the insert extend beyond the bounds of the rigid portion.

In an alternative embodiment of the present invention the relatively rigid sole member is a plate like structure with a marked curvature which is convex on the ground facing side. In this embodiment there is only a thin sole part which is made of compressible material and therefore the rigid sole member provides all, or almost all of the footwear’s shock absorption and energy return.

CLAIMS

Footwear with plantar fascia reinforcement

Claim 1.

There is provided a shoe sole that includes a hard and rigid reinforced plate situated directly underneath all foot bones of the foot of the wearer, and is reinforced by longitudinal grooves and long fibres running from the heel to the forefoot, and is situated above, and is attached to a compressible midsole with recesses to provide shock absorption, energy return and stability to fast walking, running and jumping.

Intellectual Property Office

Application No:	GB2005661.0	**Examiner:**	Damien Huxley
Claims searched:	1	**Date of search:**	16 September 2020

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1	WO2015/175605 A1 (ARIAT INTERNATIONAL INC) See lines 2 to 13 of page 2, lines 10 to 33 of page 4, the text from line 22 of page 8 to line 14 of page 9 and the figures
X	1	US2012/246969 A1 (BAUM ET AL) See paragraphs [0004] to [0007], [0013], [0066], [0084] and the figures
X	1	US2010/122471 A1 (CONVERSE INC) See paragraphs [0002], [0003], [0008] to [0010], [0056] to [0082] and the figures
X	1	US2014/075778 A1 (NIKE INC) See paragraph [0001], [0025] to [0028], [0053] to [0059] and the figures. See also US2014075777 by the same applicant.
X	1	US2014/115925 A1 (NIKE INC) See paragraphs [0001] to [0003], [0029] to [0032], [0052], [0053] and the figures
X	1	US2009/300943 A1 (HSEIH) See paragraphs [0002], [0006], [0013] and the figures
X	1	EP2277401 A1 (JORGENSEN) See paragraphs [0001] to [0010], [0013], [0021] to [0026] and the figures
X	1	EP0990397 A1 (MZUNO CORPORATION) See paragraphs [0001] to [0003], [0069], [0070] and the figures
X	1	WO2007/010253 A1 (INOVEIGHT LTD) See the text of page 1 to line 27 of page 2 and the figures

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A43B; A61F

The following online and other databases have been used in the preparation of this search report

WPI, EPODOC

International Classification:

Subclass	Subgroup	Valid From
A43B	0007/14	01/01/2006
A61F	0005/01	01/01/2006