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(71) Applicant: **FOOTJACKS LTD** [GB/GB]; 34D, Gills Hill Lane, Radlett Hertfordshire WD7 8DF (GB).

(72) Inventor: **STERN, Mark;** 34D, Gills Hill Lane, Radlett Hertfordshire WD7 8DF (GB).

(74) Agent: **MERRIFIELD, Sarah;** Verulam Gardens, 70 Gray's Inn Road, London, Greater London WC1X 8BT (GB).

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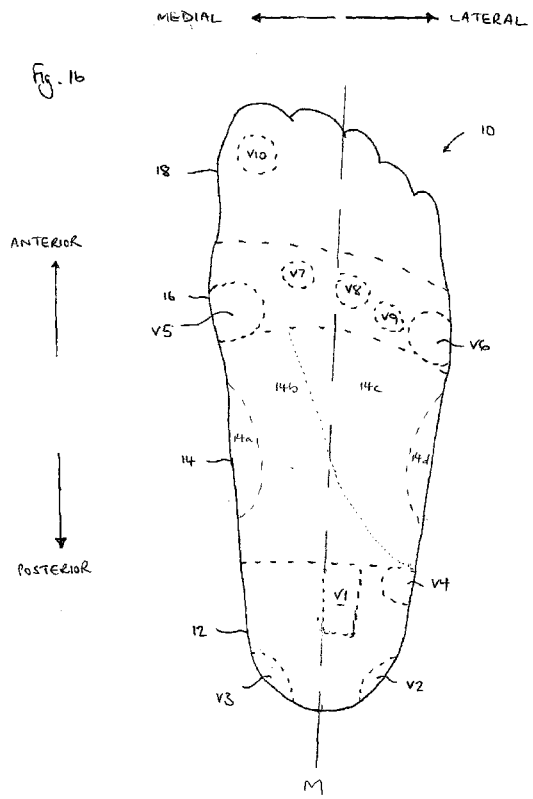

(57) Abstract: A footbed (20) for supporting a person's foot is formed with one or more voids which removes support beneath either at least part of the heel which is lateral to the midline of the heel and which does not extend medially of the midline, or beneath the medial process of the tuber calcanei, or a combination of the two. Such voids stabilise those parts of the heel which functionally form an abutment to support the medial and lateral longitudinal arches of the foot, in order to prevent pronation.

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FOOTWEAR/INSOLE FOR FOOTWEAR

The present invention relates to footwear for treating pronation. The invention may comprise an item such as an insole which is insertable into pre-existing footwear or it may be embodied as an integral part of an item of footwear itself .

Pronation is a common foot problem. It occurs particularly in people with flat feel (Pes Planus) . Pronation tends to occur in such people as they walk and refers to the condition where parts of the hind foot, mid foot and forefoot tend to lean medially (inwards) and the arch of the foot flattens and tips over medially. When this happens the soft tissues become stretched and the joint surfaces of the bones in the foot are placed at unnatural angles to one another. The tipping over of the arch leads to a decrease in the support of the structures supported by that foot.

Various insoles for treating over pronation are known. Some of these include a built up or raised area beneath the arch of the foot to contact and push upwardly on the arch. However, many people still find such insoles ineffective in treating the problem.

Insoles are also known which have parts of the arch area removed. However, this has been found to be ineffective in stopping pronation when a person walks and each step begins with a heel strike.

The present invention provides a footbed for supporting a person's foot, wherein the footbed is formed with one or more voids which remove support beneath either: at least part of the heel which is lateral to the midline of the heel and which does not extend medially of the midline, and with no other void in the part of the heel medial to the midline; or beneath the medial process of the tuber calcanei; or beneath both the lateral part of the heel and the medial process of the tuber calcanei thereby to stabilise those parts of the heel which functionally form abutments in the calcaneus to support the medial and lateral longitudinal arches of the foot.

In one embodiment, the footbed is formed with a void in the heel region, an area referred to herein as VI, positioned beneath the lateral aspect of the anterio-medial ground contact of the calcaneus, being lateral to a midline of the foot and aligned substantially with the 4th toe. Most text books on the subject provide that the anterior aspect of the calcaneus is not in ground contact. The writer has found, however, that this ground contact does occur in people with Pes Planus, and in conjunction with others, allows pronation to occur. The weight of the body reaches this point *before* the anterior arch abutments contact the ground. At this point the arches are formed loosely with flexibility between the joints. Once the posterior abutments at the Tuber Calcanei and the anterior abutments are in ground contact with the weight of the body acting through the arches, ground reaction forces 'firm up' the arches.

With pronation, the anterio-medial calcaneal ground contact functionally acts as an abutment to both medial and lateral long plantar arches. Instability at this contact point allows the arches to 'tip over' provided either the anterior or posterior medial calcaneal abutments are allowed to roll medially. This can be prevented in a flat shoe, with a void in the lateral heel which tips and holds the anterio-medial calcaneal contact laterally or with a void, beneath the medial process of the tuber calcanei (referred to herein as area V3)or a combination of voids in these areas.

A void directly beneath the lateral aspect of the anterio-medial calcaneal ground contact (VI) serves to prevent pronation at the talocalcaneonavicular (TCN) joint complex which occurs with a heel strike when the weight of the body reaches the ground contact point.

In alternative embodiments, the body may be formed with voids in those parts of the lateral heel which are not within the region VI described above and which indirectly prevent medial rolling at the anterio-medial calcaneal ground contact. For example, the body may be formed with voids under the lateral process of the tuber calcanei (V2), and under the anterio-lateral calcaneal ground contact (V4) occurring in people with collapsed arches.

In addition to the aforementioned, voids may be beneath any, a combination, or all of the metatarsal joints (V5-V9) and/or under the tuberosity beneath the distal phalanx of the hallux (V10) .

In a further embodiment, the footbed may also include a raised mound in the medial arch area of the midfoot and at least one void anywhere in the arch area of the midfoot. Alternatively, the footbed may be substantially flat and have at least one void formed in the medial longitudinal arch area, or in the lateral longitudinal arch area of the midfoot (i.e. regions 14b and 14c as described further below) .

The voids should preferably be separate and beneath each individual area described above as these increase the resistance to pronation.

The upper surface of the footbed may be arranged to support the foot with a slope downwardly from the heel region to the toe region at an angle of less than 20°, for flat or low-heeled footwear.

In another embodiment, for higher-heeled footwear, the footbed is arranged to support the foot so that it slopes down from the heel region to the toe region at an angle of or greater than 20°. At this angle there is no pronation permitted by the TCN joint complex through the mid foot. However, inversion and eversion of the foot occurs as a consequence of rolling medially or laterally across the metatarsal and phalangeal ground contacts and at the heel contact. To prevent this, the footbed may further comprise a void beneath the anterio-medial ground contact which extends both medially and laterally of the midline.

The or each void in the footbed may comprise a hole through the footbed or a depression in the footbed. Further, a thin, flexible layer may extend over the or each void to cover the void, but providing no support to the foot. The layer must be deformable into the or each void under the weight of a person standing on the footbed.

Preferably, the or each void has a minimum size of approximately 0.6 cm^2 to 1 cm^2, allowing the tissues in the sole of the foot to sink into the void.

The footbed may comprise a body made up of a plurality of separate bodies, which may be releasably connectable to each other. The footbed may be formed integrally with an item of footwear, and the item of footwear may comprise a flexible sock or stocking. Alternatively, the footbed may be releasably attachable to the sole of a foot. In a further alternative, the footbed may comprise an insole insertable into pre-existing footwear.

The footbed may comprise one or more optionally removable sections in order to create one or more voids.

The footbed may comprise a very thin layer of particulate material at least beneath those points which directly or indirectly stabilise the abutments to the medial and longitudinal arches of the foot. The layer should be thin enough so that the particulates do not compact into a hard surface. In this way, they create voids which act at the relevant points.

In another aspect of the invention there is provided a footbed for supporting a person's foot, wherein the footbed comprises a forefoot area receiving the parts of the foot beneath at least the heads of the first and fifth metatarsals, such that in use the heads of the first and fifth metatarsals are raised relative to the anterio-medial calcaneal ground contact of the heel by at least 0.5cm, and the toes are level with or lower than the heads of the first and fifth metatarsals.

The footbed may further comprise a toe area distal to the forefoot area for receiving the toes, wherein the toe area and forefoot area are generally flat and level with each other .

Alternatively, the footbed may further comprise a toe area distal to the forefoot area for receiving the toes, and a heel area for receiving at least part of the heel, wherein the toe area and heel area are generally flat and level with each other, and the forefoot area is raised relative to the heel area.

The footbed may also comprise a midfoot area between the forefoot area and the heel area, wherein part of the midfoot area beneath the medial arch of the foot comprises a raised mound .

The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings in which:

Figure la is a schematic medial view of the plantar arch of a foot;

Figure lb is a diagram illustrating the main regions of the sole of a foot;

Figure 2 illustrates a footbed in accordance with a first embodiment of the present invention;

Figure 3 illustrates a footbed in accordance with a second embodiment of the present invention;

Figure 4 illustrates a footbed in accordance with a third embodiment of the present invention;

Figure 5 illustrates a footbed in accordance with the present invention and formed of separate parts (with the voids omitted for clarity) ; and

Figure 6 illustrates a sock incorporating a footbed in accordance with the present invention (with the voids omitted for clarity) .

Figures 7a-c illustrate cross sections of a footbed in accordance with further embodiments of the invention.

The human foot is a complicated structure which has many functions. One function is to support the weight of the body so that all structures above the foot are maintained in their correct positions during movement and in the standing position .

The weight of the body is supported on two longitudinal arches in the foot, the medial and longitudinal plantar arches. These arches are bony in structure and maintained by ligamentous and muscular factors. These arches have abutments to support the arches.

Figure la shows a schematic medial view of a foot, with some of the bones removed for clarity. The foot should naturally assume an arched form as shown, with the weight of the body represented by arrow F acting downwardly and then being transmitted in directions Fl and F2 to the correct ground contact points, which act as abutments to the arches. The correct posterior abutments to the arches are the medial and lateral processes of the tuber calcanei. However, in a person whose foot tends to pronate, the arch tends to collapse in the direction of arrows PI and P2, flattening and reducing the size of the arch. Thus, with flat feet (Pes Planus), a functional abutment occurs when there is an anterio-medial and anterio-lateral calcaneal ground contact. These functional abutments have the effect of shortening the medial long plantar arch. It is the anterio-medial calcaneal ground contact which must be stabilised to prevent pronation and this can be done directly or indirectly.

Thus the abutments of the medial and lateral longitudinal arches are found in the calcaneus and under the heads of the metatarsals, although the 1St and 5th metatarsal heads bear most of the weight passing through the anterior aspect of the arches until the weight of the body moves into the mid foot .

Direct removal of support from beneath the lateral aspect of the anterio-medial ground contact forming a functional abutment stabilises the rear abutment at this contact and allows the longitudinal arches of the foot to firm up and function correctly during a heel strike. Indirectly stabilising the anterio-medial ground contact with a void at V3 or in the lateral heel other than in area VI stabilises the heel until the heel starts to lift at the position the void is placed so that it ceases to "act". A void in area V3 stabilises the midfoot whilst voids in the lateral heel area other than area VI only stabilise the midfoot in conjuction with one or more voids in the midfoot.

Figure lb illustrates schematically the sole of a foot 10 which has been divided up into various regions as defined below. In the following description the terms anterior and posterior are used to denote forward and backward directions as shown by the arrows in Figure lb, and terms medial and lateral are used to denote inner and outer directions, either side of the foot's midline, M, as shown by the arrows in Figure lb.

For the purpose of describing the present invention, the foot in a person with Pes Planus is considered as comprising the following general regions: the heel 12, the arch 14, the heads of the metatarsal joints 16 and the toes 18. The various parts of the foot can also be described as the fore-foot, consisting of the metatarsal joint region 16 and the toes 16, the mid-foot consisting of the arch 14, and the hind-foot consisting of the heel region 12. Although the

heel normally functions as part of the bony arch of the foot, with hind foot pronation the anterio-medial ground contact of the calcaneus forms a functional abutment and the arch is confined to the mid foot.

The arch 14 may be considered to consist of a medial strip 14a at the extreme medial edge of the arch 14, a medial longitudinal arch region 14b, a lateral longitudinal arch region 14c and a lateral strip 14d at the extreme lateral edge. In the area of the arch 14, the notional dividing line between the medial and lateral longitudinal arch regions is somewhat diagonal as illustrated, rather than strictly following the overall midline M of the foot.

For the purpose of describing the present invention, the foot is shown with those areas (V1-V10) in the heel, the midfoot and the forefoot which stabilise the medial and lateral longitudinal arches of the foot. The illustration is schematic and the precise locations will depend on the anatomy of an individual.

VI represents the area which stabilizes that part of the anterio-medial calcaneal ground contact which prevents pronation in the heel and through the midfoot. It is the part of the ground contact from the midline of the foot and lateral to the midline, substantially aligned with the 4th toe as shown in the diagram. The area VI is only lateral to the midline and must not extend across the midline into the medial side of the foot or have a balancing void in the medial aspect of the heel other than at V3 (defined below) .

V2 is under the lateral process of the tuber calcanei.

V3 is under the medial process of the tuber calcanei.

V4 is under the anterio-lateral ground contact of the calcaneus .

V5 is under the sesamoid bones under the head of the 1St metatarsal .

V6 is under the head of the 5th metatarsal.

V7, V8 and V9 are under the heads of the 2nd, 3rd and 4th metatarsals .

V10 is under the distal phalanx of the hallux.

What follows refers to the situation when the angle of the footbed, i.e. a surface on which the foot rests from hind foot to forefoot, is below approximately 20 degrees, when the foot is in the easy standing position. Below this angle the TCN joint complex is free to allow pronation through the hind and mid foot. Obviously, even with such a footbed, a slope of greater than 20 degrees occurs at push off as the heel is lifted off the ground.

The inventor has discovered that, in people whose feet pronate, the front of the calcaneus collapses anteriorly giving rise to two anterior calcaneal ground contacts. The more medial contact is roughly in line with the 3rd and 4th toes extending into the lateral half of the heel. The more

lateral ground contact is on the inferior surface of the anterio-lateral calcaneal process. It is the anterio-medial calcaneal ground contact which is largely responsible for pronation through the heel and needs to be stabilised.

If a void is at V3 and not VI, then voids at V2 and V4 prevent small amounts of pronation through the lateral heel. A void at VI itself will prevent pronation through the hindfoot with a heel strike and through the midfoot.

As mentioned, the front ground supports in the easy standing position are mainly on the tuberosities under the heads of the 1St and 5th metatarsals (V5 and V6) although the other metatarsal heads bear more weight once the weight of the body moves into the anterior mid foot. They represent the anterior abutments for the medial and lateral long plantar arches. The two sesamoid bones will bear the weight at the 1St metatarsal head support. The 1St and 5th ground supports should contact the ground together.

The inventor has discovered that removal of the footbed beneath these anterior ground contact points prevents medial rolling through the forefoot. Removal of the footbed beneath the 1St and 5th metatarsal head contact points V5 and V6 will substantially remove pronation through the forefoot. Combinations with the other metatarsal heads can improve the effect .

The degree to which pronation is resisted can be judged by the correct lifting of the arches of the foot, the correct simultaneous striking of the 1St and 5th metatarsal heads on

the footbed with no shifting of support towards the Ist metatarsal support. There should be no medial rolling through the heel, the midfoot or the forefoot. The knee should not collapse inwards and provided all joints are reasonably free, the pelvis and shoulders should be level.

The voids beneath the abutment ground contacts as described should be large enough for the tissues of the sole of the foot to sink into them and should provide a sufficient medial contact surface along the void's medial edge to resist medial roll and divert foot motion in an anterior direction. To this end, rectangular or square voids are much better than circular voids, which do not provide as great a surface area in contact with the tissues of the sole of the foot to resist medial roll and direct foot motion in an anterior direction. Circular voids can work if the sides of the void are vertical and made with a material that resists movement of the foot. Complete removal of the footbed beneath an entire region of the foot e.g. the entire midfoot of a strip across the entire foot, has a much reduced effect compared with separate individual voids. Thus, a rectangular void is ideal with the long edge of the rectangle placed in an anterior-posterior direction. Chamferred internal edges are not advised as these provide a surface for the foot to roll along. Hook and loop material is not advisable as its surface is too firm and destroys the effect. Individual small voids multiply the resistive effect.

In the following description of embodiments of the invention, the term footbed refers to a body of material with an upper surface on which a foot rests in use. The body

may constitute the base of a shoe or other item of footwear, and thus be formed as an integral part of the footwear, or it may take the form of a separate insole which can be inserted into a pre-existing item of footwear or directly attachable to the sole of the foot, for example by suction or releasable adhesive. The term insole encompasses a unitary item insertable into existing footwear to form at least part of the footbed, or a plurality of separate elements insertable into or attachable to an item of footwear to form at least part of the footbed. The separate elements may be releasably connectable to each other. The various areas of the footbed will be described using the same terms and reference numbers as the parts of the foot which overlie them in use. Thus, the heel region 12 of the footbed refers to the part which will be beneath the heel region 12 of the foot illustrated in Figure 1, and so on.

Figure 2 shows a plan view of a footbed 20 in accordance with a first embodiment of the present invention. The footbed 20 is generally flat, but has a portion removed to leave a void in the area VI. The void at VI is within the lateral heel region beneath the lateral part of the anterio-medial calcaneal ground contact which extends into the lateral half of the heel. The void at VI should have a minimum size of about 0.6 cm^2 but can be all or part of the region VI illustrated in Figure 2. In the direction across the footbed, the void at VI extends from the midline of the foot, laterally to a point which is substantially aligned with the lateral aspect of the 4^{th} phalange. Thus, the void at VI is substantially aligned with the 4^{th} phalange (4^{th} toe). In use the void at VI removes contact with that part

of the anterio-medial calcaneal contact which allows pronation. It is important that the void VI does not extend across the midline into the medial side, and that there is no balancing void to VI on the medial side of the calcaneus (other than at area V3) as such a void negates the effect of a void at VI. A void V3 will resist a balancing void placed in the medial heel which would otherwise negate the effect achieved by a void in area VI.

Without pronation the arch of the foot is able to properly firm up and the weight of the body is able to correctly move into the mid foot as the gait cycle progresses. A roughly equal contact with the footbed under the heads of the 1st and 5th metatarsal joints gives equal support to forward transferred weight; this does not occur with pronation.

The presence of void at VI controls pronation until weight reaches the middle of the mid foot and the heel starts to lift. At this point weight is transferred through the anterio aspect of the medial and lateral longitudinal arches and pronation can occur through the anterior abutments under the heads of the metatarsals. Voids in the footbed under areas V5 and any, or a combination, or all of areas V6, V7, V8, V9 will stop this occurring.

This is illustrated by the dotted lines in Figure 2 which shows optional voids at V5 beneath the sesamoid bones beneath the head of the 1st metatarsal, and beneath any, or a combination, or all of V6 (beneath the tuberosity under the head of the 5th metatarsal), V7, V8 and V9 (beneath the heads of the metatarsals 2, 3, and 4).

Voids under areas V7, V8 and V9 can be extended forwards to lower or remove the footbed beneath the 2nd to the 5th toes. This is helpful to remove pressure for people with hammer toes, while preserving a void under the 2nd to 4th metatarsals .

The void at VI (and voids in any of the other areas as described above and further below) may be formed by complete removal of material so that there is a hole all the way through the footbed 20 from top to bottom. Alternatively, the void VI may be formed as a depression in the upper surface 24 of the footbed 20, so that the upper surface 24 dips down in a certain area below the level of the remaining area. The tissues of the sole of the foot preferably should not be able to contact the floor of the void which can then provide a surface for the foot to roll upon depending on the sides of the void. The void can operate to tip the foot in a certain direction, to resist movement by contact of the tissues of the foot with an edge of the void, or by simply removing a surface upon which the tissues of the foot can roll .

In another alternative, the upper surface 24 comprises a thin, flexible layer which is continuous and extends over the void at VI (or any other void) so that the void is not visible, and in order to prevent dirt accumulating in the void. However, such a cover layer must be sufficiently thin and pliable so that it does not itself support the foot and the soft tissues of the foot are still able to deform into the void.

Figure 3 illustrates a plan view of a footbed 20 in accordance with another embodiment of the present invention. In this example, the footbed 20 is again generally flat and a void is provided at area V3 under the medial process of the tuber calcanei. In addition, there may be voids at any, or a combination, or all of the ground contacts at the following points: VI (see before), V2 (lateral process of the tuber calcanei), V4 (anterio-lateral calcaneal contact), V5, V6, V7, V8 and V9 (as described before) . These optional voids at VI, V2, and V4-V9 are shown in dotted lines.

Optionally a void may also be provided in a central distal portion V10 of the hallux 18a, which is shown in dotted lines, as the distal phalanx of the Hallux provides a proximal force helping to stabilise the anterior abutment of the medial longitudinal arch.

In a further embodiment where the footbed 20 is generally flat, in addition to voids in either or both of the lateral heel and in area V3, one or more further voids may be provided in the medial longitudinal arch area 14b or the lateral longitudinal arch area 14c. If the footbed 20 has a raised mound in the medial arch area, then one or more voids may be provided anywhere in the arch areas 14a-14d.

The various embodiments described above relate to a footbed where the supporting parts at the heel and the forefoot areas are substantially on a level with each other, or there is a downward slope from heel to forefoot of about 20° or less to the horizontal. Thus, this equates to substantially

flat or low-heeled footwear. In such footwear the mid tarsal joints are free and pronation can occur through the mid foot, unless prevented by the features of the present invention .

However, in footwear with higher heels, where the footbed slopes from the heel to the forefoot at an angle of above about 20°, or the footwear is shaped so as to support the foot at such an angle, the arch of the foot is fully firmed up and the mid tarsals are locked. Movement at the TCN joint complex allows rolling through the forefoot and hind foot. Such rolling occurs about three pivot points, that is where the forefoot contacts the footbed, at the contact of the heel with the footbed which in turn acts on the ground via the heel of the shoe, and upwardly at the person's hip. Movement about these three points can result in inversion, where the sole of the foot tends to move towards the median plane, and eversion, where the sole of the foot tends to move away from the median plane.

Since the arch of the foot is raised, the lateral longitudinal arch is unable to prevent excessive inversion through the mid foot making it much easier to "turn" the ankle. This is particularly true with stiletto heeled footwear where the pivoting of the heel of the shoe is on a very fine point. From full inversion to full eversion, the knee may be moving through nearly 180°, much more than when the footbed is substantially flat.

Thus with high heels the anterio-medial and lateral arch abutments must be stabilised. Any "rolling" of the foot at

footbed contact will cause a shift of body weight on the shoe. With a stiletto heel this will make it much more likely that a complete tipping over of the shoe will occur giving rise to a "turning" of the ankle medially or laterally.

Stabilisation of the anterior abutments requires voids at V5 (under the 1st metatarsal head under the sesamoid bones) and at V6 (under the tuberosity under the head of the 5th metatarsal) . Voids (V7, V8, V9) under heads of the metatarsals 2-4 also reduce rolling. Voids under the metatarsals should preferably be separate voids and not one joined up void unless the sides of the void are vertical.

The anterio-medial ground contact (VI plus ground contact crossing into the medial calcaneus) and areas V2 and V3 are the key calcaneal contact points which allow rolling at the heel as they are the posterior abutments, actual and functional. Voids beneath all three points provide maximal resistance to heel rolling. A void under the medial aspect of the anterio-medial calcaneal bony ground contact prevents medial rolling as it is on the medial half of the foot. A void under the lateral aspect of the same contact prevents lateral rolling being on the lateral half of the foot. A void under both aspects will reduce rolling both ways. Preferably the void should be not much bigger than the area of the ground contact as larger voids will permit a degree of rolling.

A void beneath the anterio-medial bony calcaneal ground contact substantially reduces medial and lateral rolling

whilst a void only at V3 will reduce rolling medially, one only at V2 will reduce rolling laterally.

Stabilising both anterior and posterior abutments has the maximum effect in reducing rolling. Stabilising either the front or the rear abutments separately will have some effect on reducing rolling at the other.

In the various embodiments described above, the footbed 20 may comprise a single body of material, or it may consist of a number of separate bodies of material. These separate bodies may be releasably connectable to one another. The bodies may be connectable directly to each other as shown in Figure 5, or spaced from each other but connected by means of straps or struts. The releasable connection may be by means of hook and loop fasteners or any other convenient fastening means. The releasable interconnection allows a footbed to be tailored to a particular user by combining and interchanging footbed parts of different configurations.

The footbed 20 may take the form of a separate insole which can be inserted into pre-existing footwear.

Alternatively, the footbed may be formed integrally into an item of footwear such as a shoe, boot or sandal. The footbed 20 may also be formed integrally with a flexible sock 28 or stocking as shown in Figure 6.

The user could then simply wear existing footwear over the sock 28. Alternatively, the sock itself could constitute an item of footwear in its own right. This could be worn

indoors in the manner of known "slipper socks" (which are simply socks with anti-slip material on the lower surface) or, if made from suitably durable, waterproof material it could be worn for outdoor use.

Figures 7a-c show alternatives (schematically and not to scale) of a footbed 20 in which at least part of the forefoot area is raised relative to the anterio-medial calcaneal ground contact of the heel area. In particular, the forefoot area 16 which in use will receive at least the parts of the foot beneath the 1St and 5th metatarsal heads is raised relative to the heel anterior-medial calcaneal ground contact of the area 12 by at least 0.5 cm. In its simplest form, the footbed may consist of two pads which in use receive the 1St and 5th metatarsal joints and thus raise these parts of the foot by at least 0.5cm relative to the anterio-medial calcaneal ground contact of the heel. In this case, the toes would also be lower than the 1St and 5th metatarsals .

However, the footbed may extend beyond the metatarsal area to include an area for receiving the toes and optionally also an area for receiving the heel.

For example, as in Figure 7a the toe and heel areas may be substantially flat and level with each other, while the metatarsal area at least beneath the 1St and 5th metatarsals is raised.

Alternatively, as in Figure 7b, the toe and metatarsal areas are substantially flat and level with each other, while the heel area is lowered.

In another alternative, the heel itself can be free to 'tip' forward and down. One method is to have a taper under the heel from back to front with a joint 26 between the heel and the rest of the footbed, allowing the heel part to tilt as indicated by the arrows in figure 7c. In this way, as the weight of the body reaches the medial anterior cancaneal ground contact, the front of the heel drops down below the rest of the footbed slightly. This both creates a void at VI and lowers the heel relative to the 1St and 5th metatarsal head ground contacts.

Further the outer sole of the shoe in contact with the ground at least in the mid foot (if present) and in the forefoot should preferably be generally flat with no form of "rocker" present. Such an arrangement has advantages over a footbed which slopes upward such that the distal phalanx of the hallux contacts the footbed at the same time as the 1St and 5th metatarsal heads as increased pressure is placed on the anterior aspect of the ankle. This is removed by the footbed under the distal phalanges being flat or level with or lower than the 1St and 5th metatarsal heads. If higher, the slope up should be no more than 5 degrees.

The absence of a rocker beneath the midfoot or forefoot is important as this increases stability in walking and a rocker action in the forefoot increases pressure on the ankle and knee during "toe off".

A footbed with support only under the Ist and 5th metatarsal heads, or under the forefoot, or under the forefoot and midfoot, also works leaving the heel to rest on the ground. Alternatively the footbed may support the whole foot but with the 1St and 5th metatarsal heads raised relative to the heel by at least 0.5cm. A footbed with support under the heel and under the forefoot without a midfoot also works. All of these options prevents pronation provided the relative difference in height between the anterio-medial ground contact and the 1St and 5th metatarsal heads is at least 0.5cm, the calcaneal ground contact being lower than the metatarsal. In this way the arches of the foot can "firm up" before rolling takes place.

Thus, the present invention provides an improved footbed which alters the support provided to a foot in order to halt pronation. It will be appreciated that the precise configuration of the footbed may take many forms and the details can be varied from those shown in the attached drawings without departing from the scope of the claims. Further optional features may also be provided.

For example, the footbed 20, whether separate or integrally formed with an item of footwear, may initially be provided with a continuous upper surface 24 with sections which are optionally removable to create one or more of the voids as discussed above so that the user, having purchased the footbed 20, can remove portions as required to give a choice of possible configurations.

It will also be appreciated that while a single void is illustrated in each of the various areas of V1-V10, each area may in fact include more than one void. The embodiments above also cover the situation where the footbed 20 is built up around the ground contact points described so as to leave a void at the claimed points, sufficient to prevent pronation .

The footbed can be formed by a very thin layer of particulate material, at least at the bony ground contact points in the heel and under the metatarsals as previously described. When a person stands on such a footbed, the particulate naturally moves under the person's weight in order to create voids in the necessary areas. The layer should be thin enough that it does not compact into a solid firm layer for the effect to work.

Claims

1. A footbed for supporting a person's foot, wherein the footbed is formed with one of more voids which remove support beneath either: at least part of the heel which is lateral to the midline of the heel and which does not extend medially of the midline, and with no other void in the part of the heel medial to the midline; or beneath the medial process of the tuber calcanei; or beneath both the lateral part of the heel and the medial process of the tuber calcanei, thereby to stabilise those parts of the heel which functionally form abutments in the calcaneus to support the medial and lateral longitudinal arches of the foot.

2. A footbed as claimed in claim 1, wherein the footbed is formed with a void (VI) to remove support from the heel beneath at least part of the anterio-medial calcaneal ground contact which is lateral to the midline of the heel and does not extend medially of the midline.

3. A footbed as claimed in claim 1 or claim 2, wherein the footbed is formed with a void (V2) so as to remove support from the heel beneath the lateral process of the tuber calcanei .

4. A footbed as claimed in any preceding claim wherein the footbed is formed with a void (V4) so as to remove support from the heel beneath the anterio-lateral ground contact of the calcaneous.

5. A footbed as claimed in any preceding claim, wherein the footbed is formed with at least one void (V5-V9) so as to remove support from the forefoot beneath the heads of one, a combination or all of the metatarsals.

6. A footbed as claimed in and preceding claim , wherein the footbed is formed with a void (V10) so as to remove support from the forefoot beneath the distal phalanx of the hallux .

7. A footbed as claimed in any preceding claim, further comprising a raised mound in the medial arch area of the midfoot and at least one void anywhere in the arch area of the midfoot .

8. A footbed as claimed in any of the claims 1-6, wherein the footbed is substantially flat and formed with at least one void in the medial longitudinal arch area or the lateral longitudinal arch area of the midfoot.

9. The footbed as claimed in any preceding claim wherein the footbed is arranged to support the foot with a downward slope from heel to forefoot at an angle of less than 20 degrees .

10. A footbed as claimed in any of claims 1-8, wherein the footbed is arranged to support the foot with a downward slope from heel to forefoot of or greater than 20 degrees and further comprises a void beneath the anterio-medial calcaneal ground contact which extends both medially and laterally of the midline.

11. A footbed for supporting a person's foot, wherein the footbed includes a forefoot area receiving the parts of the foot beneath at least the heads of the first and fifth metatarsals, such that in use the heads of the first and fifth metatarsals are raised relative to the anterior-medial calcaneal ground contact of the heel by at least 0.5cm, and the toes are level with or lower than the heads of the first and fifth metatarsals.

12. A footbed as claimed in claim 11 wherein the footbed further comprises a toe area distal to the forefoot area for receiving the toes, and the toe area and forefoot area are generally flat and level with each other.

13. A footbed as claimed in claim 11, wherein the footbed further comprises a toe area distal to the forefoot area for receiving the toes, and a heel area for receiving at least part of the heel, and the toe area and heel area are generally flat and level with each other, and the forefoot area is raised relative to the heel area.

14. A footbed as claimed in any of claims 11-13 further comprising a midfoot area between the forefoot area and the heel area, wherein part of the midfoot area beneath the medial arch of a foot comprises a raised mound.

15. A footbed as claimed in any preceding claim, wherein the footbed comprises a plurality of separate bodies.

16. A footbed as claimed in claim 15, wherein the separate bodies are releasably connectable to each other.

17. A footbed as claimed in any preceding claim, wherein the footbed is integral with an item of footwear.

18. A footbed as claimed in claim 17, wherein the item of footwear comprises a flexible sock or stocking.

19. A footbed as claimed in any of claims 1-18, wherein the footbed is releasably attachable to the sole of a foot.

20. A footbed as claimed in any of claims 1-18, wherein the footbed comprises an insole insertable into pre-existing footwear .

21. A footbed as claimed in any preceding claim, wherein the footbed comprises one or more optionally removal sections in order to create one or more voids.

22. A footbed as claimed in any preceding claim, wherein the or each void comprises one of: a hole through the footbed and a depression in the footbed.

23. A footbed as claimed in claim 22, further comprising a thin, flexible layer which extends over the or each void and is deformable into the or each void under the weight of a person standing on the footbed.

Fig. 1a

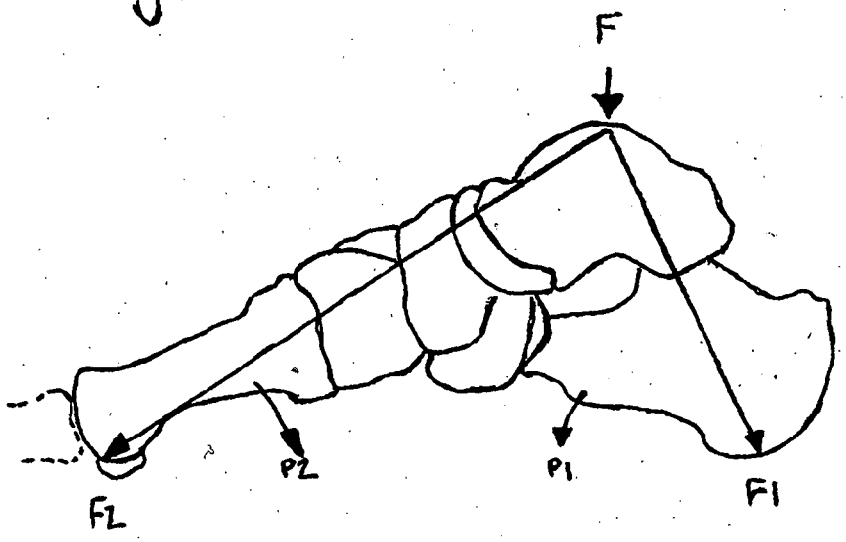


Fig. 16

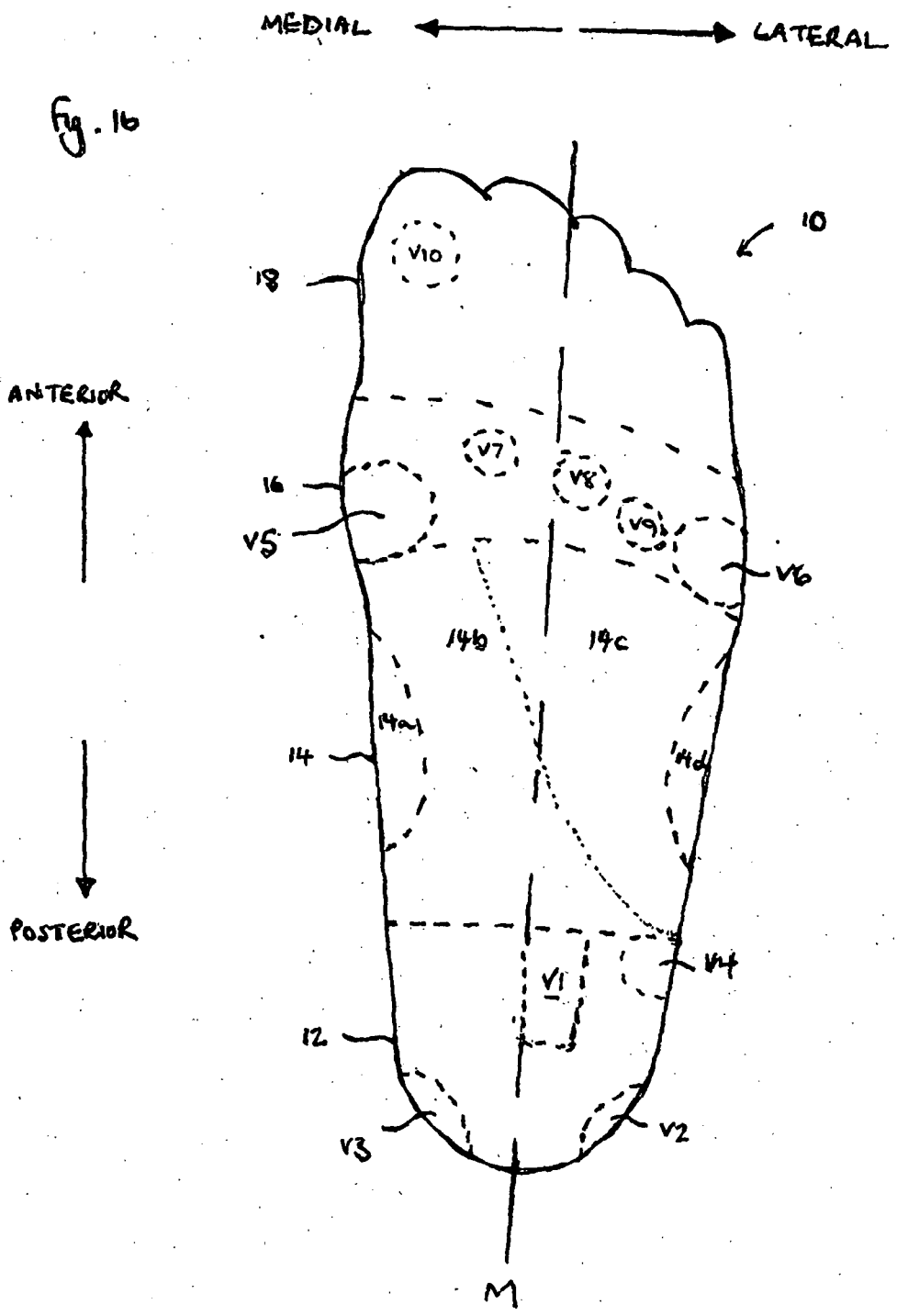

MEDIAL
LATERAL
ANTERIOR
POSTERIOR
10
18
16
14
12
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
14a
14b
14c
14d
M

Fig. 2

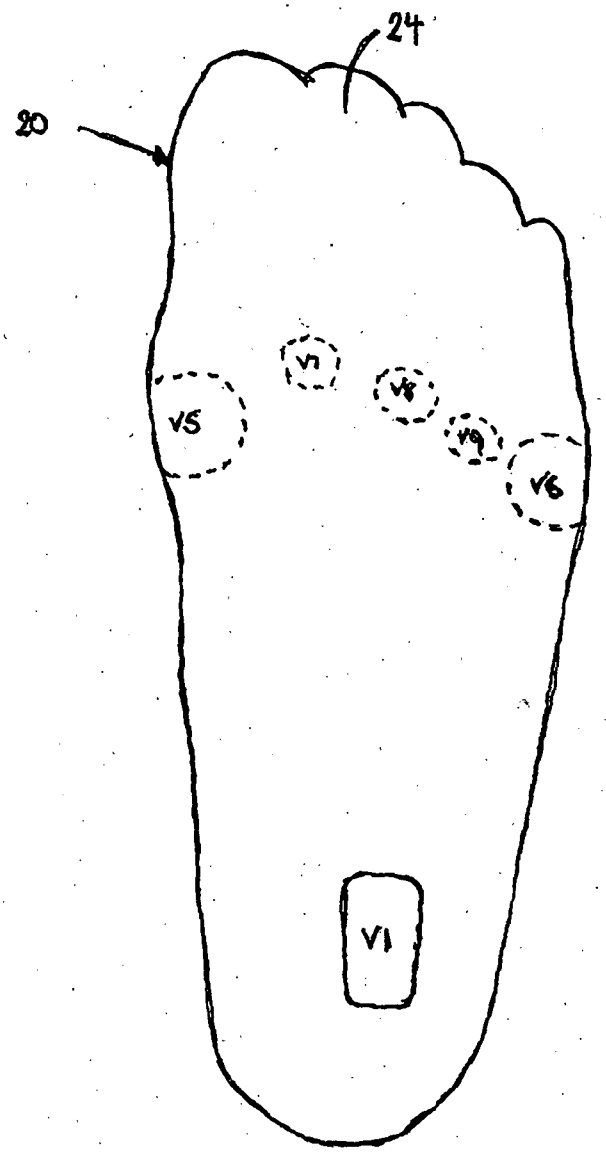


Fig. 3

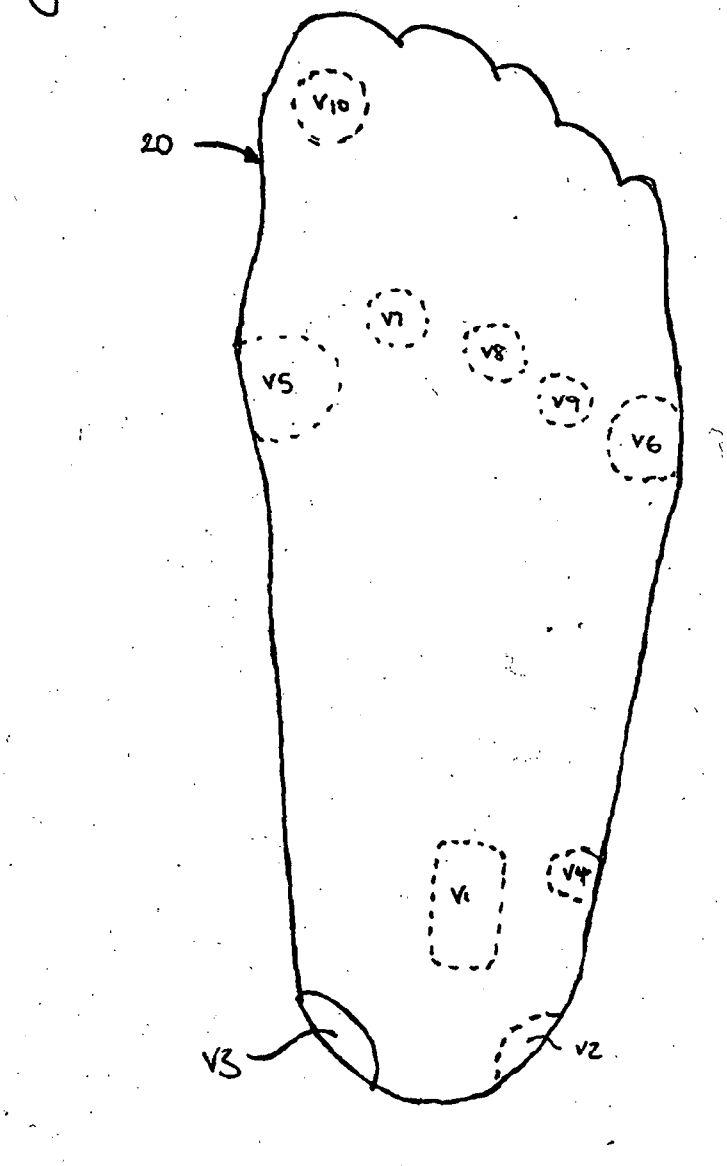


Fig. 4

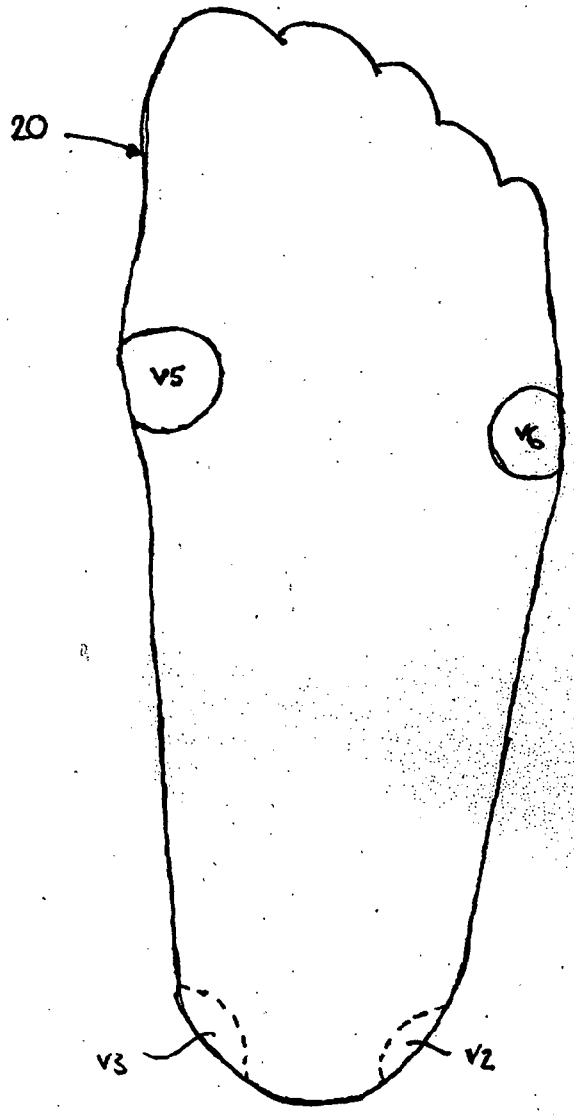


Fig. 5

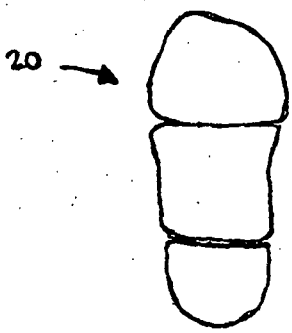
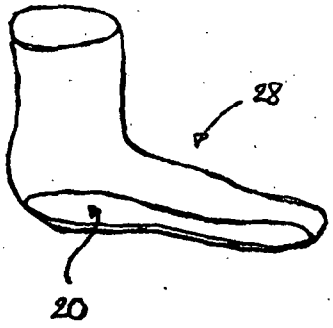


Fig. 6



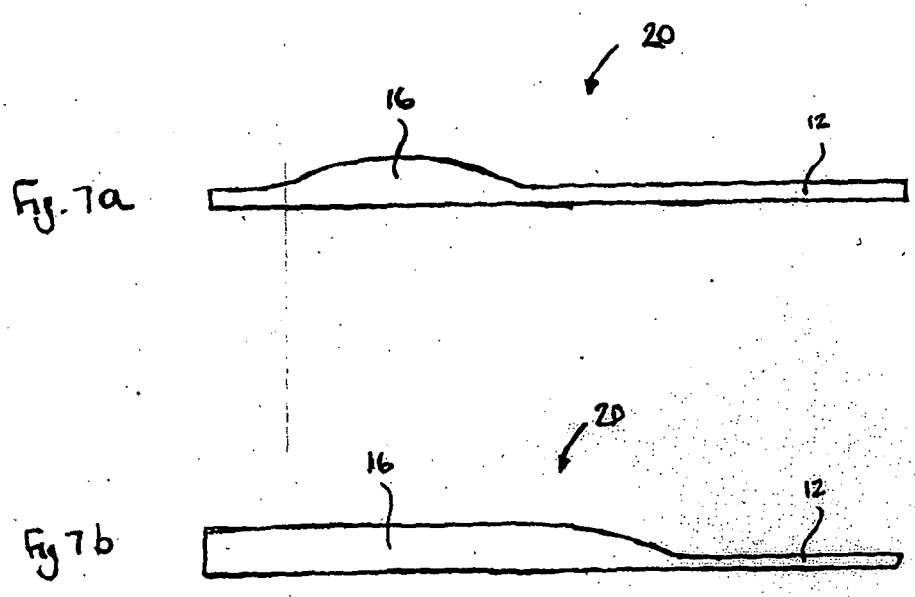


Fig. 7a

Fig 7b

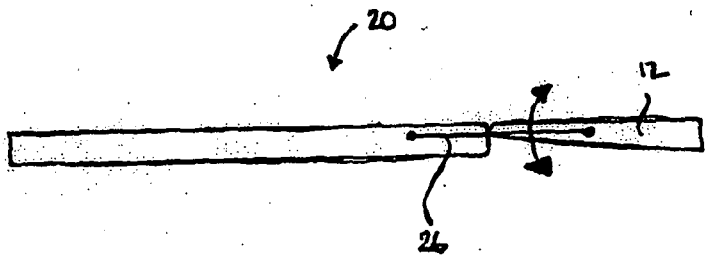


Fig. 7c

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/053073

A. CLASSIFICATION OF SUBJECT MATTER
INV. A43B17/00 A43B7/14
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A43B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 799 414 A (KELLERMAN DAVID [US]) 1 September 1998 (1998-09-01) column 4, lines 23-30; figures 1-22	1-17, 19-23
X	US 6 000 147 A (KELLERMAN DAVID [US]) 14 December 1999 (1999-12-14) column 3, lines 53-65; figures 2,3,5,6,7,9,11,12	1-17, 19-23
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" documentwhich may throw doubts on priority claim(s) orwhich is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 April 2013	18/04/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Duquenoy, Alain

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2012/053073

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [X] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

[X] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-10, 15-23

   a footbed with at least one void which removes support beneath a part of the foot

   ---

2. claims: 11-14

   a footbed with a raised forefoot area

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/053073

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	page 5, lines 8-26; figures 1-4	2-6
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3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2012/053073

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