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(54) **Shoe Soles.**

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## Description

This invention relates to footwear and particularly to a multidirectional toe-off shoe sole structure.

Shoe soles have had a variety of features imparted to them over the years, often for the purpose of accommodating the natural action of the foot structure during locomotion, and/or improving foot action that is defective in some respect. It is known that the human foot is a series of complex arrangements of bones, tendons, ligaments and muscles which produce a sequence of cooperative lateral and longitudinal movements during use. Although a great deal is presently known concerning these foot movements, understanding thereof is yet incomplete. Moreover, because each person's foot varies considerably from those of others, efforts are constantly made to improve footwear for optimizing locomotion action. Yet, because shoes must be mass produced for practical reasons, accommodating the variety of individual foot peculiarities is not totally possible. An object of this invention is to provide a special shoe structure which will aid in accommodating differing individual feet with a mass produced shoe and is directed to improving a shoe sole comprising an elongated sole having a bottom surface, an upper surface and a periphery including medial and lateral sides, the upper surface having a rear portion for engaging the heel of a foot, a narrow central portion to be beneath the instep of the foot, a wide portion to underlie and engage the metatarsal heads of the foot and a narrowing region forwardly of the wide portion.

There is described in US-A-4262435 an athletic shoe in which the bottom surface of the sole has a groove forwardly of the narrow central portion and extending from the medial side, forwardly and then rearwardly to the lateral side. In that athletic shoe the groove is formed of two intersections straight portions meeting at an angle of approximately  $145^\circ$ . The shoe is a running shoe which is specially designed to accommodate the unique movements of the foot bones and tendons occurring during running and which provides substantial flexure along only one of the two intersecting portions at a time. The actions which occur during walking and during the other activities in which the users of casual shoes engage such as rapidly changing direction, stooping, climbing and descending stairs, and flexing of an unweighted foot produce problems which are not the primary concern of the designer of a shoe for running and the shoe described in US-A-4262435 does not meet these requirements.

According to the present invention, the requirements of a sole for a casual shoe are met by a sole in which the narrowing portion is located to underlie

the inner space of the foot occurring just forwardly of the metatarsal heads and to engage the phalanges of the foot, the groove is curvilinear and is located at the narrowing region forwardly of the wide portion and the groove is configured and located to underlie the inner space of the foot forwardly of the metatarsal heads for enabling bending of the sole between the said wide portion and the said narrowina region in a range of directions which includes any characteristic individual's locomotion toeff direction.

This construction permits greatly increased flexure between the toe and mid portions of the shoe, not just along a single straight line, but rather along a plurality of lines disposed substantially perpendicular to the longitudinal axis of the arcuate groove. As a result, the individual toes and associated phalangeal bones therein can each bend or flex in a more natural fashion, which is along an arcuate pattern. Since each phalange of the foot can flex in a different direction, greater comfort is achieved during casual uses, such as walking, bending over, stooping, and the like.

The present invention provides a shoe having a novel sole structure for increasing accommodation of the shoe to the peculiarities of individual varying foot action by allowing toe-off for proper weight transfer through the gait cycle at any forward angle. The almost infinite number of directions of weight transfer from the shoe enables proper toe-off for the peculiarities of the particular foot. It accommodates individual variations in bone alignment of the forefoot structure, and aids in extension of the phalanges at toe-off. The radius of the flex groove addresses rotational shear in the forefoot encompassed during resupination of the foot.

Preferably, the arc of the groove has its forwardmost apex laterally off centre of the sole toward the medial side. The groove may have various crosssections, but preferably has in cross-sectional configuration a concave curved upper portion blending into convex curved junctures with the said bottom surface.

The invention also includes, according to another aspect, a shoe comprising an upper connected to a sole having the curvilinear groove referred to above.

The invention may be carried into practice in various ways but one shoe embodying the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a side elevational view of the shoe;

Figure 2 is a bottom view of the shoe in Figure 1;

Figure 3 is a photo reproduction of an ink blot footprint plus a dash-line diagrammatic indication of the shoe sole outline, a dash-line indication of the progressive line of contact of the foot

to the ground, and an indication of the location of the flex groove forwardly of the metatarsal heads and behind the ground engaging portions of the phalanges;

Figure 4 is a side elevational diagrammatic view of a foot showing the location of the inner space under which the flex groove lies; and

Figure 5 is a bottom view of a foot diagrammatically showing the location of the flex groove beneath the inner space.

The drawings show a casual shoe 10 which has an upper 12 secured around the periphery 26 of a sole member 14. This sole has a lower ground-engaging surface 14a and an upper foot-engaging surface 14b. An inner sole (not shown) or other conventional components may be employed as desired in conjunction with the upper surface 14b.

This sole has a conventional heel portion 16 to accommodate the area underlying the heel of a human foot F contained in the shoe, and a narrow intermediate portion 18 which underlies the instep of the foot. The sole then widens out in conventional fashion toward the front of the shoe to the widest portion 20 which underlies the metatarsal heads of the foot bone structure. The forwardmost portion 22 of the sole then narrows from this widest portion, and underlies the phalanges of the foot.

Beginning immediately forwardly of the widest portion 20, so as to be forward of the metatarsal heads, is a special curvilinear groove 24. Specifically, it is directly beneath the "inner space" of the foot existing between the metatarsal heads and the forward, ground-engaging portions of the phalanges. This curvilinear groove lies beneath the rearward phalangeal bones.

The groove extends between the lateral side 24a of sole periphery 26 and the medial side 24b, in an arcuate path projecting forwardly of the sole from these two sides. The forwardmost apex portion 24c of the groove is laterally offset from the centre of the sole, toward the medial side, so that it is slightly toward the centre of the sole from the great toe. This special groove 24 enables an almost infinite number of forward directions of flex and weight transfer upon toe-off during locomotion.

The cross-sectional configuration of the groove is preferably smoothly curved, having at its upper deepest portion a concave generally semicircular curvature (Figure 1), while merging gradually into two convex curved edge portions blending with the bottom surface 14a of the sole.

The curvilinear configuration of the groove from side to side adds volume to the groove to aid flexibility and enable further extension of the phalanges at toe-off. The ability of the curve of the flex groove to address an almost infinite number of forward directions of movement in a casual shoe

facilitates proper weight transfer through the entire gait cycle. The radius of the flex groove addresses rotational shear in the forefoot, encompassed during resupination of the foot. The depth of the groove may vary somewhat. Used in conjunction with a unitary type sole, the flex groove may be considerably deeper for more surface area in the groove, which in turn results in increased flexibility.

In use of the shoe sole for walking, the usual basic pattern of foot to ground engagement is depicted by the dash-line sequence 25 in Figure 3. As is known, it begins at 25a at the heel, proceeds toward the metatarsal head 25b at the lateral side of the foot, then across the metatarsal heads to the head 25c behind the great toe on the medial side. During subsequent toe-off, the fleshy material 27 forwardly of the metatarsal heads and then the forward ends of the toes provide the engagement area, with the phalanges being extended for a springing action in the forward direction. Toe-off for the particular person's foot may be directly ahead as per the arrows in Figure 5. Yet with different people and their own unique foot structures, toe-off direction can differ angularly from straight ahead. The novel sole readily accommodates any such individual locomotion toe-off direction characteristic because of the curvilinear groove which enables sole bending at that angular direction, for smooth comfortable action.

### Claims

1. A shoe sole (14) comprising an elongated sole having a bottom surface (14a), an upper surface (14b) and a periphery (26) including medial (24b) and lateral (24a) sides, the upper surface (14b) having a rear portion (16) for engaging the heel of a foot, a narrow central portion (18) to be beneath the instep of the foot, a wide portion (20) to underlie and engage the metatarsal heads of the foot and a narrowing region (22) forwardly of the wide portion, the bottom surface of the sole (14) having a groove (24) forwardly of the narrow central portion (18) and extending from the medial side (24b), forwardly and then rearwardly to the lateral side (24a), characterised in that the shoe sole is a casual shoe sole, the narrowing portion is located to underlie the inner space of the foot occurring just forwardly of the metatarsal heads and to engage the phalanges of the foot, the groove (24) is curvilinear and is located at the narrowing region (22) forwardly of the wide portion (20) and the groove is configured and located to underlie the inner space of the foot forwardly of the metatarsal heads for enabling bending of the sole between the said wide portion and the

said narrowing region in a range of directions which includes any characteristic individual's locomotion toe-off direction.

2. A shoe sole according to claim 1 in which the arc of the groove (24) has its forwardmost apex (24c) laterally off centre of the sole toward the medial side (24b).
3. A shoe sole according to claim 1 or claim 2 in which the groove (26) has in cross sectional configuration a concave curved upper portion blending into convex curved junctures with the said bottom surface (14a).
4. A shoe (10) comprising a sole (14) and an upper (12) connected thereto, the sole being according to Claim 1 or Claim 2 or Claim 3.

#### Patentansprüche

1. Schuhsohle (14), umfassend eine längliche Sohle mit einer Bodenfläche (14a), einer oberen Fläche (14b) und einem Rand (26), und mit mittigen (24b) und äußeren (24a) Seiten, wobei die obere Fläche (14b) einen hinteren Abschnitt (16) für die Ferse eines Fußes, einen schmalen Mittelabschnitt (18) unterhalb des Rists des Fußes, einen breiten Abschnitt (20) für die Fußballen und einen vor dem breiten Abschnitt gelegenen und sich verengenden Bereich (22) aufweist, und wobei die Bodenfläche der Sohle (14) eine Rille (24) aufweist, welche vor dem engen Mittelabschnitt (18) ausgebildet ist und sich von dem Mittenteil (24b) nach vorne und dann nach hinten zu dem Seitenteil (24a) erstreckt, dadurch gekennzeichnet, daß die Schuhsohle eine gewöhnliche Schuhsohle ist; daß der sich verengende Bereich unterhalb der Fußunterseite direkt vor den Fußballen gelegen ist und so die Zehenglieder aufnehmen kann; daß die Rille (24) krummlinig verläuft und in dem sich verengenden Bereich (22) vor den, breiten Abschnitt (20) gelegen ist; und daß der Verlauf und die Ausbildung der Rille so gewählt sind, daß diese unterhalb der Fußunterseite und vor den Fußballen gelegen ist, damit zwischen dem breiten Abschnitt und dem sich verengenden Bereich ein Abbiegen der Sohle in einem Richtungsbereich ermöglicht wird, welcher alle möglichen Zehenabwinkelungsrichtungen beinhaltet, wie sie typischerweise bei der Fortbewegung einer Person auftreten.
2. Schuhsohle nach Anspruch 1, bei der die Rille (24) einen Bogen beschreibt, dessen vorderster Abschnitt (24c) vom Zentralbereich der

Sohle in Richtung zur mittigen Seite (24b) hin versetzt ist.

3. Schuhsohle nach Anspruch 1 oder Anspruch 2; bei der die Rille (24) im Querschnitt betrachtet einen konkav gekrümmten oberen Abschnitt aufweist, welcher über konvex gekrümmte Verbindungsabschnitte in die Bodenfläche (14a) übergeht.
4. Schuh (10), umfassend eine Sohle (14) und ein damit verbundenes Oberleder (12), wobei die Sohle nach Anspruch 1 oder Anspruch 2 oder Anspruch 3 ausgebildet ist.

#### Revendications

1. Semelle de chaussure (14) comprenant une semelle allongée présentant une surface inférieure (14a), une surface supérieure (14b) et une périphérie (26) comprenant un côté médian (24b) et un côté latéral (24a), la surface supérieure (14b) comportant une partie postérieure (16) destinée à engager le talon d'un pied, une partie centrale étroite (18) destinée à être placée sous le cou-de-pied, une partie large (20) destinée à être placée en dessous des têtes des métatarsiens du pied et à les engager et une partie qui va en se resserrant (22) vers l'avant de la partie large, la surface inférieure de la semelle (14) étant dotée d'une rainure (24) à l'avant de la partie centrale étroite (18) qui part du côté médian (24b), s'étend vers l'avant puis vers l'arrière pour aboutir au côté latéral (24a), caractérisée en ce qu'il s'agit d'une semelle de chaussure de loisirs, dont la partie qui va en se resserrant est disposée de manière à se situer en dessous de l'espace interne du pied qui se trouve juste devant les têtes des métatarsiens et à engager les phalanges du pied, la rainure (24) est curviligne et est située dans la région qui va en se resserrant (22) vers l'avant de la partie large (20), et ladite rainure est configurée et disposée pour se trouver sous l'espace interne du pied, en avant des têtes des métatarsiens, afin de permettre la flexion de la semelle entre ladite partie large et ladite partie qui va en se resserrant dans une gamme de directions qui inclut toute direction de décollage des orteils pour la locomotion caractéristique d'un individu.
2. Semelle de chaussure suivant la revendication 1, dans laquelle le sommet antérieur (24c) de l'arc de la rainure (24) est décentré latéralement de la semelle vers le côté médian (24b).

3. Semelle de chaussure suivant la revendication 1 ou 2, dans laquelle la rainure (26) comporte, en coupe transversale, une partie supérieure à courbure concave qui se fond dans des jonctions à courbure convexe à ladite surface inférieure (14a). 5
4. Chaussure (10) comprenant une semelle (14) et une empeigne (12) qui y est reliée, la semelle étant conforme à la revendication 1, à la revendication 2 ou à la revendication 3. 10

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