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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A43B 13/14

A1

(11) International Publication Number: **WO 97/41749**

(43) International Publication Date: 13 November 1997 (13.11.97)

(21) International Application Number: PCT/US97/07822

(22) International Filing Date: 6 May 1997 (06.05.97)

(30) Priority Data:
08/643,789 6 May 1996 (06.05.96) US

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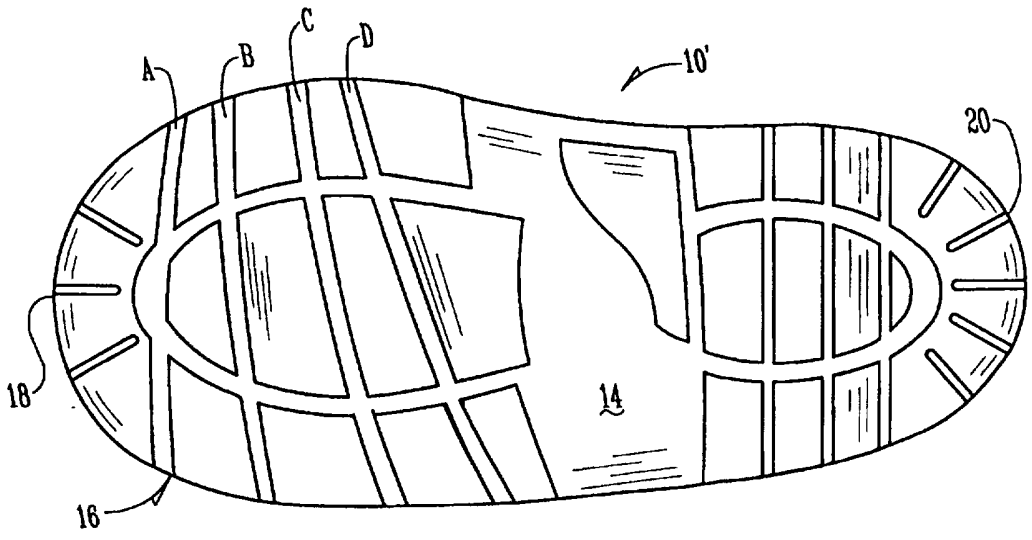
(81) Designated States: AU, BR, CA, CN, MX, VN, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: COMBINED INSOLE/OUTSOLE



(57) Abstract

A unitary insole/outsole (10) for attachment to footwear includes an upper surface (12) and a lower surface (14). The upper surface is contoured to conform generally to the natural countours of the sole of a wearer's foot, and the lower surface has formed areas of flexion to permit the insole/outsole (10) to flex.

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TITLE: COMBINED INSOLE/OUTSOLE

FIELD OF THE INVENTION

The present invention relates generally to footwear and, more specifically, to a combined or "unitary" insole/outsole for footwear, especially for children's footwear, which insole/outsole improves upon the contoured insole of U.S. Patent No. 4,272,899 by incorporating features thereof with an outsole bottom that enhances foot function during growth of the foot by specifically placed lines of flexion on the outsole.

BACKGROUND AND SUMMARY OF THE INVENTION

Although children are usually born with normal arches, as a child begins to learn to walk and the body weight is applied to the foot on a support surface, the foot structure necessarily tends to flatten out under the inherent stresses. When walking only on natural surfaces, i.e., the ground, the normal age for the child to be able to stand without the need of external support for the foot is generally considered to be approximately eight years. Unfortunately, for purposes of improved appearance, convenience, or endurance, man-made products are applied to the surfaces on which we walk; but these same surfaces are detrimental to the human musculoskeletal structures, especially during the developmental stages, when the foot structure is "soft" and incompletely formed.

Because of these negative environmental influences on the human foot structure, shoes which provide proper support and shock attenuation should be worn for protection and prevention of structural injury thoughout most of a person's life. Conventional children's shoes do not provide an insole design which controls and reduces stresses which the growing foot encounters due to modern environmental conditions, i.e., hard walking surfaces such as tile, concrete, and asphalt. Rather, the conventional child's shoe insole is usually flat, without contours, except when an arch pad or "cookie" is placed under the shoe lining to attempt to lift up the arch.

In order to compensate for the above-mentioned environmental conditions, as well as to compensate for foot deficiencies, such as high arches or flat-footedness, foot specialists often custom design removable orthoses to be placed from shoe to shoe. Of course, with children, growth of the foot requires new orthoses at frequent intervals, to fit the new, larger shoes. This entails

considerable expense which can be avoided by eliminating the need for such orthotic appliances, except with extreme deformities.

Ideally, for proper function and comfort, a shoe should only bend in the region of the ball of the foot, and the shoe should not need to be "broken in" to be comfortable and to function properly. The deficiencies found in presently available children's shoes are: 1) a majority of the children's shoes are inflexible in the ball of the foot; 2) as the child's foot growth takes place through one shoe size and into the next, any flexion which has been obtained in the child's shoes through the usual breaking-in process does not readily shift forwardly with the distal change in the transverse axis (of the metatarsal joints 1-5) along which the foot naturally flexes, thus inhibiting the foot from bending at the appropriate point and thereby interfering with proper growth and function of the foot. This restriction of the foot structure and function is particularly detrimental in children who are just learning to walk.

As explained in further detail hereafter, the ability of the new insole/outsole to flex in the correct location, so as to enable the first metatarsal to plantar flex during growth is a key element of the new insole/outsole which has never been previously available in any children's shoe. Rather, known children's shoes make no allowance for this requirement, but instead inhibit flexion entirely, (especially in toddler's shoes which have stiff, flat bottoms), and/or fail to adapt the flexion area of the outsole to accommodate growth of the foot and a change in the natural area of foot flexion.

The Known Art:

One of the inventors herein, Dr. Jeffrey S. Brooks, received U.S. Patent No. 4,272,899 for a contoured insole structure which when applied to children's shoes is the first contoured insole to reduce abnormal stress applied to the child's foot by placing the foot in a more advantageous position with regard to making the foot stable during walking. This stability reduces stress from the heel to the metatarsal during the foot's development. The contoured insole design, which is incorporated into the present combined insole/outsole, specifically supports the heel, arch, and forefoot. By so reducing stress placed upon the medial column of the foot, which stress comes with lack of proper support, body weight is distributed more evenly on the sole of the foot as explained in U.S. Patent No. 4,272,899, and as further supported, especially with regard to toddlers, by comprehensive analyses known in the art as "F-scan" studies.

The new outsole features described hereafter complement the insole design of U.S. Patent No. 4,272,899 by providing an area for the first "ray" of the foot to plantar flex as it passes from mid-stance to the propulsive phase of gait. This allows the transverse axis of the first through fifth metatarsals to move forwardly, shifting the secondary lever distally (to a more distal fulcrum) as the foot grows, developing into the next size shoe.

Although the foot stops its growth before almost any other part of the skeleton, in the young child the foot bones grow very rapidly. The normal growth from size to size is a 9 mm change per year, which encompasses two or three shoe sizes per year. One inch is approximately three sizes, or about 5 mm for each 1/2 size, based on a U.S. sizing scale. Feet increase in length on an average of less than 2% of stature from 1-18 years of age. It takes four years to double the length of the foot at birth and seven years to double the length it is at six months. At 10 years of age girls have reached 90% of foot development and boys 82%.

The average length of the mature male foot is about 1 inch longer than that of a mature female foot. In girls there is a growth spurt between 10 and 11 years of age of 1.1 cm. Feet increase in length 0.9 cm per year in girls from 5-12 years of age, and in boys from 5-14 years of age. The foot reaches one half its final size in girls at 1 year of age and boys at 1 1/2 years of age. No known children's shoes make accommodation for this rapid growth with respect to proper flexion of the foot.

Some examples of known patented shoe soles which may have attempted to address some of the above problems are addressed herein, as follows:

U.S. Patent No. 4,924,606 discloses a split sole shoe and emphasizes that most people need to break in shoes and discusses the difficulty in so doing. In fact, in the past shoes were so rigid that they were effectively worn out before they were broken-in. The shoe of this patent was designed with a toe buttress to protect the front part of the shoe from breaking down and it includes one flex line incorporated in the bottom part, an overlain split usage of materials not found in the present unitary design. The present device uses only one component to accomplish the necessary flexion.

U.S. patent No. 4,667,423 requires use of different molded components formed of EVA. Only one material component is necessary in making the new footwear device.

U.S. Patent No. 4,507,879 discloses a design with multiple air holes within the properties of the footwear component, but does not address flex lines of the shoe.

U.S. Patent No. 4,364,190 discloses an outer sole for an athletic shoe having lines in inappropriate positions for flexion, so they were going in a counterproductive direction relative to ambulation of the foot.

Patent No. 2,236,278 had only tread components, no flexion components.

U.S. Patent No. 4,854,459 discloses a component shoe with a flex line, but which is inappropriate and counterproductive in the use of the new insole/outsole.

U.S. Des. 366,354 discloses an ornamental design, wherein lines on the sole bottom initially appear similar, but are not drawn in any specific mechanical fashion, and are not used as with the present flexion concept because they do not incorporate a contoured top sole that allows support of the foot. Elevation of the sides provided protection on the sides of the shoe.

U.S. Design Patent No. 356,438 discloses three ornamental lines on the bottom of a shoe which do not extend entirely to the side edges of the sole bottom, and thus do not affect flexibility, as in the present case; and there are no depressions or cutouts whatsoever, to accommodate the metatarsal phalangeal joints.

U.S. Design Patent No. 349,391 illustrates different lines than presented herein.

U.S. Design Patent No. 343,726 discloses an ornamental design having no attributes to the top part of the shoe sole having any ability to control the foot, and there is no assessment to where they put the creases throughout the bottom. The lines shown are merely ornamental without any measurements or any impact on functionality.

U.S. Design Patent No. 343,050 illustrates lines that do not cross the entire sole of the shoe.

U.S. Design Patent No. 340,797 shows completely transverse type cuts throughout the shoe which are angled inappropriately for allowing flexion of the foot and may actually impede function of the foot.

U.S. Design Patent No. 322,158 is an ornamental design with distinctively different lines from those of the present sole. They do not go the outer side edge of the shoe and are not really to be implemented in functionality.

U.S. Design Patent No. 292,540 includes inappropriately marked lines for functionality, actually placed in the wrong position for function.

U.S. Design Patent No. 266,797 shows multiple marked lines for flexion for a deformed foot, which lines are inappropriately placed for a normal foot with a straight last.

U.S. Patent No. 4,924,606 has overlapping portions not comprehended by the new structure because the art patent is a composition outsole having only one flex line, not two, and does not allow for the growth of the foot. None of the components of the art shoe allow that.

The related U.S. Design Patent 327,570 also has an inappropriately placed line for flexion of the foot.

The commercially available Toddler University shoes have a "flex zone", which allows the foot to flex as if barefoot, no stiffness, no breaking-in. However, that would be inappropriate because we have designated the fact that the child's foot becomes flattened and flexes at the wrong area unless it is stabilized by the heel, midfoot and forefoot before flexion occurs. The known design does not offer that stability before flexion.

It should be understood that there must be stability before proper flexion can occur at the ball of the foot, and none of the designs or structures disclosed in the above-referenced patents approach that concept in theory or fact.

U.S. Patent No. 5,344,973 cites the above-referenced Brooks patent, but designates two different patterns in the metatarsal region of the sole for providing a stable foot, such as the normal adult foot, which allows flexion at the first metatarsal joints separate from those of the lesser metatarsal joints, and has allowed for a static flexion point which is appropriate for an adult foot, but does not allow for any growth of the structure of the foot within a particular shoe. Instead, the components designated for flexion in the referenced patent are too far forward (as compared to where the critical flexion lines are placed in new insole/outsole 10), to permit the proper positioning of the axis of the joint.

The Present Invention:

During the process of normal human walking, when the heel lifts off the ground, and the leg externally rotates, the metatarsal phalangeal joints begin to dorsiflex (the proximal phalangeal bones rotate about the transverse metatarsal axis) with the heel no longer in contact with the ground. The excursion of the joint may range from 15 degrees of dorsal excursion to 90

degrees depending on the speed of which the child is moving. This may only be accomplished if the foot is stable at mid-stance. This stability can be acquired with use of the contoured insole of U.S. Patent No. 4,272,899, which is designed to accurately accommodate the foot's anatomy. Other shoes lack this contoured insole feature and therefore the foot in other shoe gear is unstable at the mid-stance point of gait. Thus, in contrast to known sole structures for children's footwear, the foot flexion area is able to move distally with foot growth with the new insole/outsole combined design.

The transverse axis of the metatarsal phalangeal joints, from any proximal segment growth, moves forward during development. Metatarsal and tarsal longitudinal growth continues from size to size. To accommodate proper dorsiflexion at the metatarsal phalangeal joints the axis through these joints and the apex of this second degree lever must move distally to accommodate this growth. The present unitary insole/outsole structure accommodates this change of anatomical position of the transverse metatarsal joint axes until the next size shoe is required by the distal toe length. The new insole/outsole allows distal fulcrum movement and flexion to be 10 mm distally, without hindering the dorsiflexion of the toes against the metatarsals as required during normal phases of gait.

The new combined insole/outsole is effective due to the fact that dorsiflexion of the toes during the propulsive phase of gait may be appropriately applied following stability of all the proximal segments. This is accomplished by the controlling frontal plane rotation with a heel seat in the insole (placed at 2 degrees of varus), the sagittal plane with accurately placed arch support, forefoot balance allowing support of the metatarsals 2-5, and a first metatarsal phalangeal joint ("mpj") transverse axis "cut out" or depression of 1/32 inch, allowing plantar flexion of the first metatarsal for 10 mm of distal growth. This allows the foot to function normally until the next digital length requires a larger shoe. (The end of the longest toe requiring a finger's breadth, or about a half inch from the end of the shoe for proper fit).

Dorsiflexion of the metatarsal phalangeal joints 1-5 (mpjs) is not inhibited, but rather is enhanced by the new insole/outsole structure, as necessary for forward progression, and for the outsole to permit the digits to dorsiflex efficiently by having a flexible material offered in the outsole. As far as the prior art goes, flexion components disclosed therein may consist of one randomly placed flex line, or a combination of one component of the shoe overlapping the other component, but none of the known footwear allows for

the growth of the foot within the 5 mm that it takes to grow into the next half size. The new insole/outsole accommodates up to about 10 mm of growth, although the end of the toes would be damaged against the nails if the wearer were to grow to the next shoe size without changing to the next larger shoe. (Conventionally, 1 inch is actually considered in some shoe companies as the equivalent of 3 shoe sizes, and in other companies, every 5 mm or about a fifth of an inch is equivalent to a half size).

The new insole/outsole structural design provides stability to the rear and mid foot regions, and simultaneously provides the transverse plane of the forefoot with uninhibited, enhanced motion, accomplished at the metatarsal phalangeal joints, even as the foot grows from one shoe size to the next, by moving the dorsiflexion axis distally with foot development. This is accomplished through addition of two specifically placed flex lines on the new outsole, as described further hereafter with reference to the enclosed figures.

Thus, with the above background considerations in mind, it is among the various goals and objects of the present invention to provide an improved sole structure for footwear, and especially for children's footwear, which structure drastically reduces or completely eliminates the need for a breaking-in period for the footwear in which the sole is incorporated, to make the footwear more comfortable, less likely to cause blisters, cramping, etc., and to generally cause the footwear to be more useful.

It is further among the objects of the present invention, having the features mentioned, that the new insole/outsole be unitary and thus simple to manufacture, as by molding, and economical, thus making it attractive for use in children's shoes which must necessarily be replaced at frequent intervals due to the rapid rates of foot growth.

it is also among the objects of the present invention, having the features enumerated, that the new unitary insole/outsole be amenable for use on may types of footwear, including, for example only, tennis-type shoes, boots, sandals and oxford-type shoes.

It is still further among the goals of the present invention to provide a new insole/outsole which does not inhibit the natural functioning of the foot structure during the normal phases of gait, and especially in the growing foots.

Accordingly, in keeping with the above objects and goals, the present invention is, briefly, a unitary insole/outsole for attachment to an upper of an article of footwear. The insole/outsole includes an upper surface and a lower surface. The upper surface is contoured to conform generally to the natural

contours of the sole of a wearer's foot, and the lower surface has formed areas of flexion which permit the insole/outsole to readily flex at areas which correspond to areas of the wearer's foot which normally flex as the foot passes through normal phases of gait, to thereby enhance the wearer's foot comfort and decrease irritation and structural harm occurring to the wearer's foot from footwear having the unitary insole/outsole.

These and other objects and advantages of the invention will be in part apparent and in part pointed out hereinbelow.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic illustration, bottom plan view, showing the bottom surface of a combined insole/outsole (for a left shoe) constructed in accordance with the invention.

Fig. 2 is a reduced schematic view of the insole/outsole of Fig. 1, indicating specific angles for proper placement of the lines of weakness.

Fig. 3 is a top plan view of the insole/outsole of Fig. 1 (left shoe).

Fig. 4 is a perspective view of the insole/outsole of Fig. 3.

Fig. 5 is a bottom plan view of another embodiment of the outsole of Fig. 1 (Right boot).

Fig. 6 is a side elevational view of the outsole of Fig. 5, shown flexed, as in normal walking, with some of the bones of the foot shown in phantom.

Fig. 7 is a schematic illustration, showing an outline of the insole/outsole of Fig. 1, in top plan view and illustrating the proper position of the distal metatarsal ends (left foot), in relation to the top of the sole.

Fig. 8 is a vertical sectional view taken on line 8 - 8 of Fig. 7.

Fig. 9 is a vertical sectional view taken on line 9 - 9 of Fig. 7.

Fig. 10 is a vertical sectional view taken on line 10 - 10 of Fig. 7.

Fig. 11 is a schematic side elevational illustration of the mate to the insole/outsole of Fig. 7, with a right foot shown positioned thereon.

Fig. 12 is a vertical sectional view taken on line 12 - 12 of Fig. 7, but reversed, as for the left foot.

Fig. 13 is a rear elevational view of the insole/outsole and foot shown in Fig. 7, to illustrate the placement of the heel in the heel cup area, the shoe upper being shown in phantom.

Fig. 14 is a side elevational view of a further embodiment of the new insole/outsole (right shoe, without the shoe upper, for clarity) showing the position of the bones of the foot and flexion of the sole, in relation to each

other, during normal walking gait, the first mpj depressed area and arch of the sole indicated in phantom.

Fig. 15 is a side elevational view of the same foot and the same unitary insole/outsole shown in Fig. 14, except that the first mpj of the foot is moved forwardly and the insole/outsole has flexed more distally, as occurs with growth of the foot to the next shoe half size.

Fig. 16 is a top perspective view of a unitary insole/outsole having certain top surface contour features in keeping with the invention, some other inventive structures being omitted for clarity.

Fig. 17 is a top plan view of the insole/outsole of Fig. 16, showing the position of the mpj depressed area on line 20 - 20.

Fig. 18 is an engineer's sectional view taken on line 18 - 18 of Fig. 17.

Fig. 19 is an engineer's sectional view taken on line 19 - 19 of Fig. 17.

Fig. 20 is an engineer's sectional view taken on line 20 - 20 of Fig. 17.

Fig. 21 is an engineer's sectional view taken on line 21 - 21 of Fig. 17.

Fig. 22 is an engineer's sectional view taken on line 22 - 22 of Fig. 17.

Throughout the drawings, like parts are indicated by like element numbers.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Structure of the new unitary insole/outsole:

With references to the drawings, 10 generally designates a unitary insole/outsole constructed in accordance with the present invention. For brevity, the new insole/outsole will sometimes be referred to herein as the shoe or footwear "sole", which sole 10 is preferably formed as a single molded unit, rather than as separate, independent insole and outsole placed in overlapping relationship to one another in the conventional manner. For simplicity and clarity of the drawings, not all elements are shown in all figures. However, those elements which are essential and those which are optional or alterable will be made clear throughout the following description.

Although it can be conceived that the purposes of sole 10 could with some difficulty be accomplished through a carefully manufactured footwear sole formed of an independent outsole and insole, and thus be considered an equivalent of sole 10 if certain structural requirements to be described are included, such a device would reduce or eliminate certain of the advantages obtained by sole 10 being a single, unitary structure; among these advantages

being economy of manufacture, durability and structural and functional integrity.

Figs. 3, 4, 7 - 12, and 16 - 22 illustrate that sole 10 includes a contoured top, or insole surface 12, for comfortable, stable support of the wearer's foot, and Figs. 1, 2 and 5 show a bottom, outsole surface 14 which contacts the floor or other support surface during use of footwear incorporating the new combined insole/outsole 10.

If desired, a plurality of small weight reduction holes, such as those indicated in Fig. 4 at 13, for example, may be formed into the top surface 12 of insole/outsole 10. Weight reduction holes 13 may be varied as desired in shape, number and location, as is well known in the industry. Similarly, many aspects of the structure and appearance of the bottom sole surface 14 can be varied as is known and as with many new designs which may be conceived for ornamental and structural purposes, and not prevent the subject sole from being in keeping with the invention. For example, the number, arrangement and design of the lugs formed in the heel area of the sole 10 shown in Fig. 5 could vary substantially without affecting other structural features which are considered part of the present invention.

A common sole perimeter 16 defines the limits of both the top surface 12 and bottom surface 14, taking any of the usual shoe sole shapes (although not limited thereto), and includes portions defined for purposes of reference herein as the toe edge 18, heel edge 20, medial side edge 22 and lateral side edge 24. Although more than one style of footwear sole is shown in the figures herein, as will become apparent, all styles are intended to include the same key features of the invention (although every one of these features is not necessarily all shown in every view) and thus the sole is in each embodiment referred to by the same element numeral 10.

Length and width of combined insole/outsole 10 vary as is customary, depending upon the size of the footwear to which the sole is attached. The depth or thickness of sole 10 can also vary considerably overall, depending upon the style of footwear into which the new sole is incorporated. Also, at certain specific sites on sole 10 the depth will vary crucially, as will be later described and seen. Although illustrated uncovered, for example in Fig. 3, insole or top surface 12 can be overlayered for style and/or comfort with a thin fabric layer (not shown) or other pliable sheet-like material, although such fabric or other material is not constructed as an insole per se, but rather

merely serves to separate the sole of the wearer's foot from direct contact with surface 12.

The material from which unitary insole/outsole 10 is molded or otherwise formed is preferably a pliable vinyl or other synthetic substance, for example, such as those referred to as EVA (ethylene vinyl alcohol), PVA (polyvinyl alcohol), PU (polyurethane) or latex foam, polypropylene, etc., or other readily moldable substances which yield a relatively soft, pliable form once cured or "set". The material selected should be one which is relatively durable with long use in contact with abrasive material such as concrete and asphalt walking surfaces and should further, preferably be one that is relatively inert and not commonly the cause of allergic reactions when in contact with skin.

With reference to Figs. 1, 2 and 5 it will be seen that the bottom or outsole surface 14 has incorporated therein preferably four spaced apart lines indicated at A, B, C, D, in the order shown, from the distal or toe end 18 of insole/outsole 10 toward the proximal or heel end 20 thereof. It will be noted in the figures that each line A, B, C, D extends substantially transversely in a very gentle arc (convex side directed distally) entirely from the inside (medial) edge 22 to the outside (lateral) edge 24 of sole 10. This is the preferred arrangement.

For reasons that will become clear, it is especially preferred that the two central lines, indicated at B and C so extend across the sole. Lines A and D, however, may be discontinued prior to reaching perimeter 16. Lines A and D can be effectively ornamental, more or less painted on the sole, actually engraved into sole surface 14, or even omitted altogether, although this latter option is not preferred.

With reference to Fig. 2 it can be seen that lines A and D at least serve to some extent to assist with proper positioning of lines B and C. When engraved into sole surface 20, lines A and D may also enhance sole flexion, which is primarily the function of central lines B and C.

Although lines B and C are shown in Fig. 1 to be continuous and unbroken, they can also be broken lines, shown in the boot sole of Figs. 5 and 6, as long as they extend entirely across the sole and interrupt perimeter edge 16, as indicated, at both the medial and lateral sides; for example, as in the side views shown in Figs. 4 and 6. This feature, of breaking the perimeter, is necessary in order to provide the optimal degree of flexibility to sole 10 along flex lines B and C.

Also, although flex lines B and C are shown as thin lines, they can be broader than shown, especially if warranted for a large size shoe, and may in some cases be formed as broader flex "areas", more than as "lines" per se. However, it is expected that, especially in small children's shoes, flex lines B and C, at least, will be just that, narrow "lines" formed as grooves or channels in bottom surface 14. Lines A and D, if present at all, may be only decorative, if desired, whereas flex lines B and C are more accurately referred to as grooves or channels because they must, to function according to the invention, actually extend into the body of sole 10, beyond the lower surface thereof.

Fig. 2 illustrates a bottom shoe pattern for determining the precise angles and spaced-apart placement of flexion lines A, B, C and D on bottom surface 14. As will be further seen and described hereafter, the specific positions of the flex areas, or lines B and C, is critical for appropriate foot flexion in footwear having unitary insole/outsole 10.

With further reference to Fig. 2, four straight dashed lines A', B', C', and D' correspond respectively to flexion lines or areas A, B, C, and D. Positioning lines A' and B' extend medially and intersect at point X, medially of sole 10. Likewise, positioning lines C' and D' extend medially and intersect at point Y, also medially.

Two other straight lines, shown in Fig. 2, the bottom pattern center line G and the heel tread center line H both extend substantially longitudinally and pass through a central heel point Z. The angles between longitudinal line G and positioning lines A' - D', and between line H and lines A' - D' are used in determining the proper placement of flexion lines A, B, C and D. Although it is understood that the spacing between the lines will necessarily vary proportionately with increases or decreases in shoe size, as a specific example, in a children's size seven shoe having the new unitary insole/outsole 10, the angles shown in the figure are as follows:

Angle M, between lines G and A' is 93 degrees, 30 minutes.
Angle N, between lines G and B' is 100 degrees, 0 minutes.
Angle O, between lines G and C' is 106 degrees, 30 minutes.
Angle P, between lines G and D' is 113 degrees, 0 minutes.
Angle Q, between lines H and A' is 86 degrees, 30 seconds.
Angle R, between lines H and B' is 92 degrees, 30 seconds.
Angle S, between lines H and C' is 99 degrees, 30 seconds.
Angle T, between lines H and D' is 106 degrees, 0 seconds.

Figs. 5 and 6 illustrate insole/outsole 10 formed as a thick sole for heavy footwear such as a boot. Regardless of the heavy, lugged nature of such a sole, it will be noted that critical flex lines B and C can still be appropriately placed and formed into surface 14, entirely to perimeter 16. In the example shown, lines A and D are also so formed. Although a boot is shown here as one example of the type of footwear to which sole 10 can be attached, clearly, sole 10 can also be just as readily incorporated into sandals, sports shoes of all types, oxford-style shoes, etc. Conceivable, even women's pumps and other shoes with higher heels can also be modified with the new unitary insole/outsole 10, as shown, or as required to be modified by the specific shoe style and shape.

Figs. 3, 4, 7, 10 and 12 illustrate a depression or cutout area 26, previously discussed in the background of this document, which permits the first metatarsal-phalangeal joint ("mpj") to move vertically downwardly in walking, in conjunction with the flex line action described to permit proper foot flexion in walking. Cutout 26 is preferably about 1/32 of an inch deep, approximately 10 mm in diameter, and is formed in top surface 12 at the position shown in the figures, just below the first mpj. As illustrated in Fig. 12, cutout 26 accommodates the paired sesamoid bones 28 beneath the mpj, at the distal end of the first metatarsal M1.

Preferably, cutout 26 is at least 10 mm in diameter and may be circular, as shown, or have an alternative, broad, relatively flat shape. For example, cutout 26 may be rectangular, triangular, oval, etc., as long as it is broad enough, in the distal to proximal (longitudinal) direction to accommodate the forward shifting of the transverse axis of the first mpj, as the foot grows, and in normal walking.

Figs. 14 and 15 further illustrate the flexion features of insole/outsole 10, and advantages thereof, as foot structure grows and shifts position relative to sole 10 the distal most line of flexion permits sole 10 to still flex properly with the flexion of the foot, especially the growing foot, at the axis through the mpjs. Thus, it will be seen that in Fig. 14, as foot F flexes at the transverse axis through the first mpj, sole 10 bends along flex line C. Thereafter, as the foot grows toward and into the next half shoe size, the axis through the first mpj necessarily shifts forwardly (distally), in the direction indicated by arrow I in Fig. 14, until reaching a position closer to that shown in Fig. 15, wherein it shown that sole 10 then flexes more distally, along flex line B. In both cases, as shown in Figs. 14 and 15, depressed area, cutout 26 is broad enough and

deep enough to accommodate the necessary downward movement of the joint to enhance sole 10 flexion along the corresponding line.

Appropriate contours for sole 10 top or insole surface 12, in order to provide optimal foot stability are shown in Figs. 16 - 22, as one example, and those illustrated in Figs. 8 - 13, as another, similar example, and in keeping with the disclosure of U.S. Patent No. 4,272,899, which issued to one of the inventors herein, like parts being indicated by like element numbers.

Thus, it will be seen that the important areas of the contoured upper surface 12 of insole/outsole 10 are cutout 26 for the first mpj, an integral arch support area 32 (shown clearly in the cross-sectional Figs. 10 and 21, and in the side elevational view, Fig. 11 under foot F), and in integral heel cup or large molded depression 30, for stably seating the heel (as shown in rear elevational view in Fig. 13, and in sections in Figs. 8 and 22). As explained further herein, these top surface contour features of sole 10 permit the foot to be as secure and stable as is necessary for appropriate flexing and movement of the bone structure thoughout the phases of gait.

As an additional, optional feature of top surface 12, another small depression 27 or some other appropriate structure already known for shock absorption may optionally be added in the heel cup area 30 of insole surface 12, as shown for example in Fig. 3.

Function and advantages of the new unitary insole/outsole:

The progressive phases of gait are heel strike, when the heel hits the ground; midstance, when the arch is stable; and propulsive phase, as the heel lifts off the ground and the body weight shifts onto the ball of the foot. Unitary insole/outsole 10 is the first shoe sole that allows stability of first metatarsal M1, because of the facts that the heel is stable, the arch is stable, and the metatarsal/phalangeal joint is allowed to move vertically downwardly with the sesamoid apparatus which is underneath the metatarsal distal end to allow proper, natural flexion at the joint, despite the foot being confined to an article of footwear.

Flexion of the metatarsal phalangeal joint (the first "mpj"), i.e., the great toe joint, is approximately 15 degrees in a dorsiflex position to the metatarsal at the joint when standing, and increases to 90 degrees of motion when just about to come off the ground. The two small bones underneath the big toe joint called sesamoids, the tibial and fibular sesamoids, need to move downwardly with the first "mp" joint in order for the toe to move appropriately upwardly during the described downward "excursion of the mpj". The

relationship among the foot bones is such that the first metatarsal bone and the two sesamoids underneath it are pushed downwardly during walking.

The present unitary insole/outsole design accommodates this structural motion by including in surface 12 the cutout area that has a depth, preferably of 1/32 inch, and as the joint movement is a pivotal or rotational arthrodial joint movement, the joint pushes downwardly as the foot leaves the ground in the "push off" phase of walking.

The present invention represents the first time the great toe joint is allowed by footwear to actually move in its normal ("natural") anatomical functional position, downwardly as the heel lifts from the ground. As the first "mp" joint shifts downwardly and is stabilized in so doing by the peroneus longus tendon (which inserts into the base of the first metatarsal and lies in the calcaneal cuboid sulcus, and pulls down the first metatarsal) the mpj stabilizes, as it must before the foot leaves the ground.

Once the joint is stabilized, the first metatarsal M1 is permitted by the new insole/outsole appropriately, to push downwardly, to become stable before the heel lifts from the ground. The first metatarsal M1 remains stable throughout this phase of gait. In other words, from heel strike, when the heel hits the ground, to the intermediate point where the arch is supported (mid-stride) by area 32 and the first joint is on the ground, the foot must be stable before the heel lifts. The reason the foot is so unusually stable in insole/outsole 10 is because the contoured insole structure allows the heel to be stable, the arch to be stable, and the first metatarsal to be stable before the heel leaves the ground and through the point at which the first metatarsal leaves the ground (or other support surface).

Also, as the heel lifts off the ground, the additional component, the new flexible outsole surface, allows the joint to actually go downwardly. The novel outsole structure allows the present combined insole/outsole to permit the first metatarsal to move downwardly to become stabilized, so the foot actually works properly during the entire course of the gait.

In conventional children's shoes the insole is flat, or has a "cookie" in the arch. However, as described in U.S. Patent No. 4,272,899, control of the foot must begin in the heel, proceed to the arch, and then include stability of the forefoot as well, in order for the foot to function properly through a normal gait. So, all the factors necessary to stabilize the foot are appropriately made in the insole surface 12, and by combining the new outsole surface 14 structure with the insole contour features (such as those of U.S. Patent No.

4,272,899), in one, unitary insole/outsole structure, the foot can function maximally within the confines of the shoe, by continuing to let the joint travel downwardly to become stabilized, and to allow the foot to appropriately flex at the ball of the foot without the forward foot slippage that ordinarily occurs known shoes lacking the cutout 26 and contour features of insole surface 12. This is particularly important when the foot is growing, and thus subject to being deformed by stresses imposed by hard walking surfaces and ill-fitting shoes.

The reason for that is that the normal foot structure at birth tends to flatten with standing. The new insole/outsole construction allows the foot to be in a normal healthy non-deforming position through growth development and gait; whereas, when the heel lifts off the ground in other known insole structures, the foot slides forward and is not able to be stabilized, resulting in flexing in the wrong anatomical position.

As the foot grows approximately 5 mm in length at the metatarsal phalangeal joints (regardless of whether the growth comes from the mid-part of the foot or the heel of the foot), the axis through which the foot bends is along a line from where the first metatarsal begins, through the lesser metatarsal joints. The new top surface 12 depression component 26 of the insole/outsole combination allows the foot to be stable and then to bend as the foot is fit into a shoe and as it grows approximately 5 mm (which allows the foot to go into the next half size) without causing a detriment or an inappropriate elevation of the metatarsal phalangeal joints during the motion from mid-stance to the propulsive phase of gait.

To reiterate, as shown in the figures, there are four anatomically appropriate flexion lines that are formed on the bottom of insole/outsole 10 starting from proximal (near the heel) toward distal (near the toe), the first one is optionally ornamental, the second one is functional, the third one is functional, and the fourth one is optionally ornamental.

What happens during the gait in footwear having insole/outsole 10, is that in combination with the downward movement allowed by the depressed area 26 that is formed within the top part 12 of the insole/outsole construction, lines B and C also assist in permitting the first mpj to move downwardly. The described flexion lines or areas also allow the flexion initially to be in flexion point C during gait, but as the joint moves forwardly with foot growth toward and into the next size shoe, the cutout allows 5 to 10 mm of forward excursion

of the joint and allows the lever of the foot to be participating at the flex line B, instead of flex line C.

Thus, the lever action wherein the apex of the second degree lever system actually moves from flex line C to flex line B, as the joints move distally during foot growth, is a property that is completely unique in the new insole/outsole.

In other words, insole/outsole 10 allows for normal growth of the foot and the flexibility changes from its secondary lever and the fulcrum of that secondary lever changes from line C forwardly (distally) to line B without any destructive elevation of the first joint. This feature of insole/outsole 10 allows proper motion of the mp joint throughout the phases of gait from midstance to propulsion. Insole/outsole 10 permits downward excursion of this great toe joint to about 9 mm in combination with our circular cutout component because this circular area is approximately 10 to 20 mm in diameter. So, the new insole/outsole allows for more than ample amounts of motion of the mpj to take place downwardly as the joint advances distally with normal foot growth.

However, it should be understood that if the heel is not stable and the fore and the mid-part of the foot are not stable, then the flexible outsole component of the invention is of much less value. A valuable feature of insole/outsole 10 is that it includes additional features that when applied to the contoured insole structure of U.S. Patent No. 4,272,899 (the disclosures and teachings of which are incorporated herein by reference) on the top surface allows the outsole bottom to act as an advantageous component in letting the foot move naturally and properly, letting the first joint plantar flex, and allowing the axis through the first metatarsal and lesser metatarsals to move forwardly and still allow proper foot motion to take place without any hinderance from the shoe.

The "cutout" area 26 complements the outsole flex area, lines B and C, by providing space for the required downward motion of the mpj. Preferably at least 1/32 inch is provided in area 26 of insole/outsole 10, allowing for that whole joint structure to actually go plantarward, and because it is not a solid construction, even further, if necessary.

When the novel structure of insole/outsole 10 is also applied to the boot, or sandal, as well as to the enclosed shoe styles, the flex lines do not have to be, but can be, altered by the fact that a different ornamental construction is added to the shoe. Thus, the flex lines can also work in a boot with treads as shown, in which the great toe joint is stable as it fits into the shoe. Regardless

of what the ornamental designs are, even if the design is a sandal sole 10 can be incorporated in any particular shoe as long as the outsole flex lines B or C start at the point of the first metatarsal, which should shift distally 5 mm so that it can bend with allowing the lever on the fulcrum of that secondary lever to go from proximal to distal without any distortion of the foot during growth.

Thus, the properties of this unitary insole/outsole vary from any other insole or outsole (alone or in combination) presently known, to such an extent that it is considered to be unique. As Fig. 12 shows in the section through the metatarsals and it can be seen that the top sole area is cut out, at 26, for the first metatarsal and the phalangeal area. The lesser phalangeal joints are stabilized because of the contour of the insole and the cutout portion for the first metatarsal joint. Because this area is stable the joint can move forward with growth of the foot and still remain stable in the shoe, thoughout gait rather than slipping or sliding within the shoe, throughout gait rather than slipping or sliding within the shoe as is normal.

Insole/outsole 10 includes paired and specifically positioned flex lines. Although some known shoes allow for one flex line; the present footwear sole has two flex lines to which can be attributed the ability of the foot to continue to flex properly in the same shoe as the bone structure grows. None of the other patented structures allow for growth of the foot within the shoe because 1) they do not have an insole that allows for structural stability or anatomical stability in a normal fashion; and/or 2) they do not allow for flexion which accommodates growth of the foot relative to the shoe. Some known shoes have one flex line which may allow for the flexion of the foot from midstance to propulsive phase of gait in a static foot (non-growing). However, during a given stride, when the shoe heel lifts from the ground to the point where the shoe toe actually lifts from the ground the excursion at the mp joints can be anywhere from 15 to 90 degrees of the first toe joint and the lesser joints, depending on the activity. In other words, when a child runs, there needs to be more motion available in the shoe to accommodate joint movement than when the child is walking. If the child is just picking up the foot and putting it down, such excessive mpj motion is unnecessary because the foot does not have to flex as much. Known shoes even having one flex line do not provide the control and growth accommodating features found in the present combined insole/outsole.

In view of the foregoing, it will be seen that the several objects of the invention are achieved and other advantages are obtained.

Although the foregoing includes a description of the best mode contemplated for carrying out the invention, various modifications are contemplated.

As various modifications could be made in the constructions herein described and illustrated without departing from the scope of the invention, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative rather than limiting.

What is claimed is:

1. A unitary insole/outsole for attachment to footwear, the unitary insole/outsole comprising an upper surface and a lower surface, the upper surface being contoured to conform generally to the natural contours of the sole of a wearer's foot, and the lower surface having formed areas of flexion which permit the insole/outsole to readily flex at areas which correspond to areas of the wearer's foot which normally flex as the foot passes through normal phases of gait, to thereby enhance the wearer's foot comfort and decrease irritation and structural harm occurring to the wearer's foot from footwear having the unitary insole/outsole

2. The unitary insole/outsole of Claim 1, wherein the formed areas of flexion comprise at least first and second paired lines formed into the lower surface of the unitary insole/outsole, the paired lines disposed substantially transversely, adjacent and substantially parallel to each other and positioned at a point beneath the ball of the wearer's foot.

3. The unitary insole/outsole of Claim 1, and further comprising a depressed area formed into the upper surface at a position beneath the ball of the wearer's foot.

4. The unitary insole/outsole of Claim 3, wherein the depressed area is at least 10 mm in diameter.

5. The unitary insole/outsole of Claim 3, wherein the depressed area is at least 1/32 inch deep.

6. Children's footwear comprising a unitary insole/outsole having a upper surface and a lower surface, the upper surface being contoured to conform generally to the natural contours of the sole of a child's foot, and the lower surface having formed areas of flexion which permit the insole/outsole to readily flex at areas which correspond to areas of the child's foot which normally flex as the foot passes through normal phases of gait, to thereby enhance the child's foot comfort and decrease irritation and structural harm occurring to the child's foot from footwear having the unitary insole/outsole, as the child's foot grows from one size into the next size.

7. An improved sole for footwear having a contoured top sole surface, the contours being formed to provide uniform support for the foot and to cause a wearer's body weight to be relatively evenly distributed, as compared to a conventional sole, and to thereby stabilize the wearer's foot through the normal phases of gait, wherein the improvement comprises a bottom sole surface having formed flexion areas which cause the sole to flex along an area substantially beneath and coextensive with a line formed through the mpjs of the foot as the foot passes through such normal phases of gait.

8. The sole of Claim 7, wherein the improvement further comprises an area of the sole which is reduced in thickness and located on the formed flexion area directly beneath the position of the mpj of the first metatarsal phalangeal joint, to further enhance flexibility of the sole along the formed flexion areas.

9. The sole of Claim 7, wherein there are two formed flexion areas disposed spacedly in relation to one another and extending entirely across a width of the sole from an inside edge of the sole to an outside edge of the sole, the first formed flexion area being disposed along a line beneath the mpjs and the second formed flexion area being spaced forwardly of the first formed flexion area by a distance sufficient to accommodate growth of the foot by approximately one half of a shoe size.

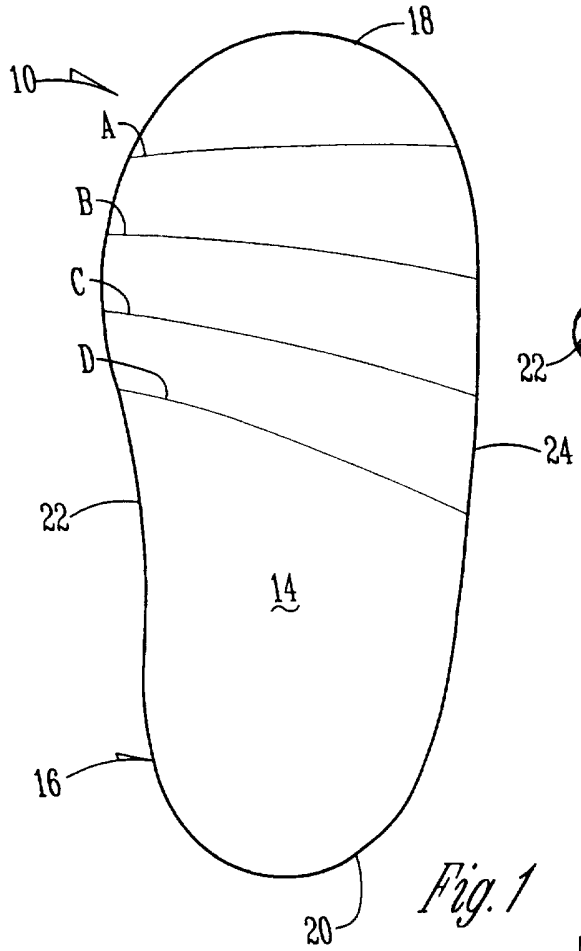

Fig. 1

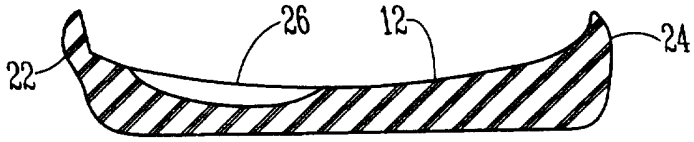

Fig. 20

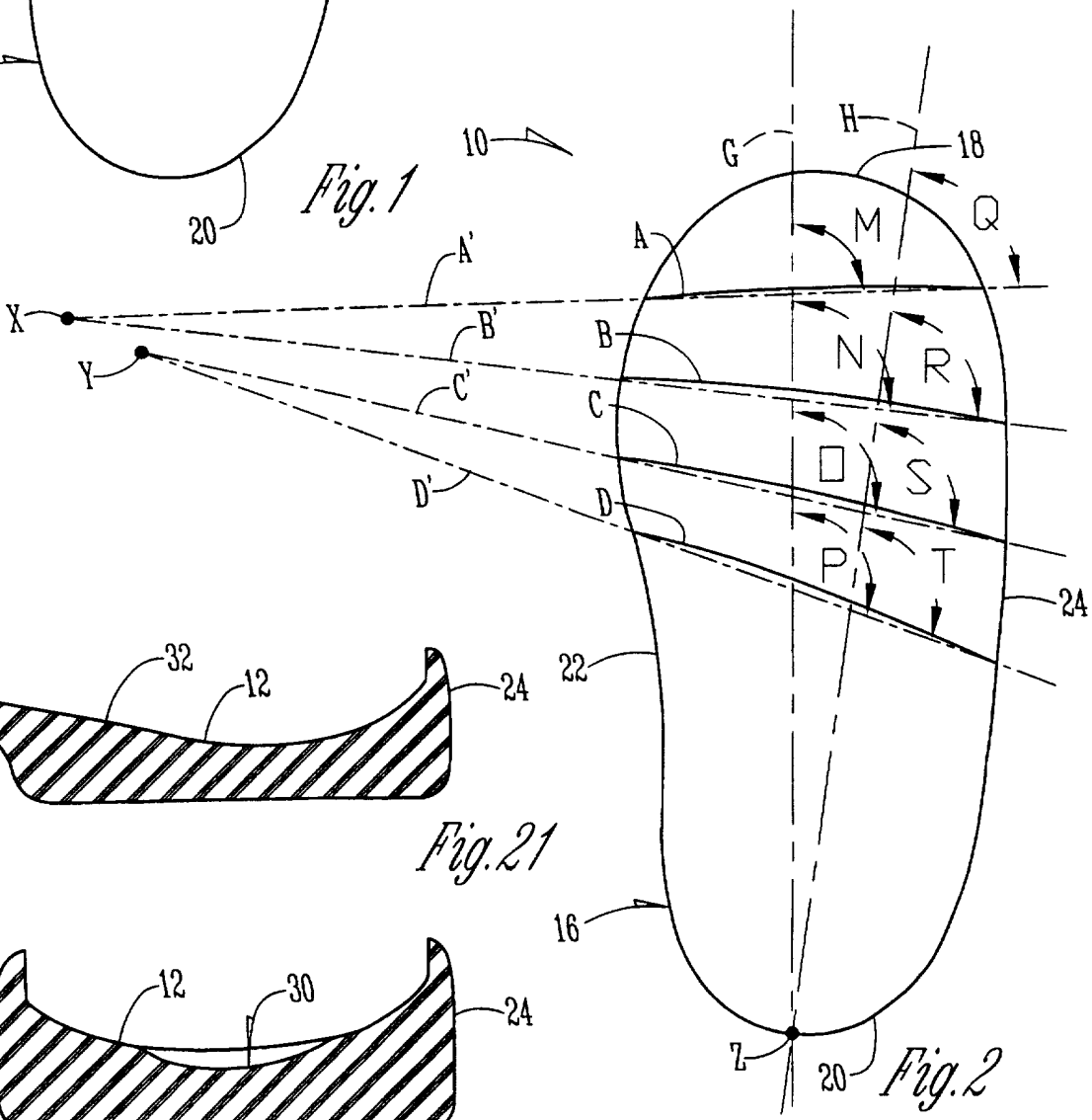

Fig. 2

Fig. 21

Fig. 22

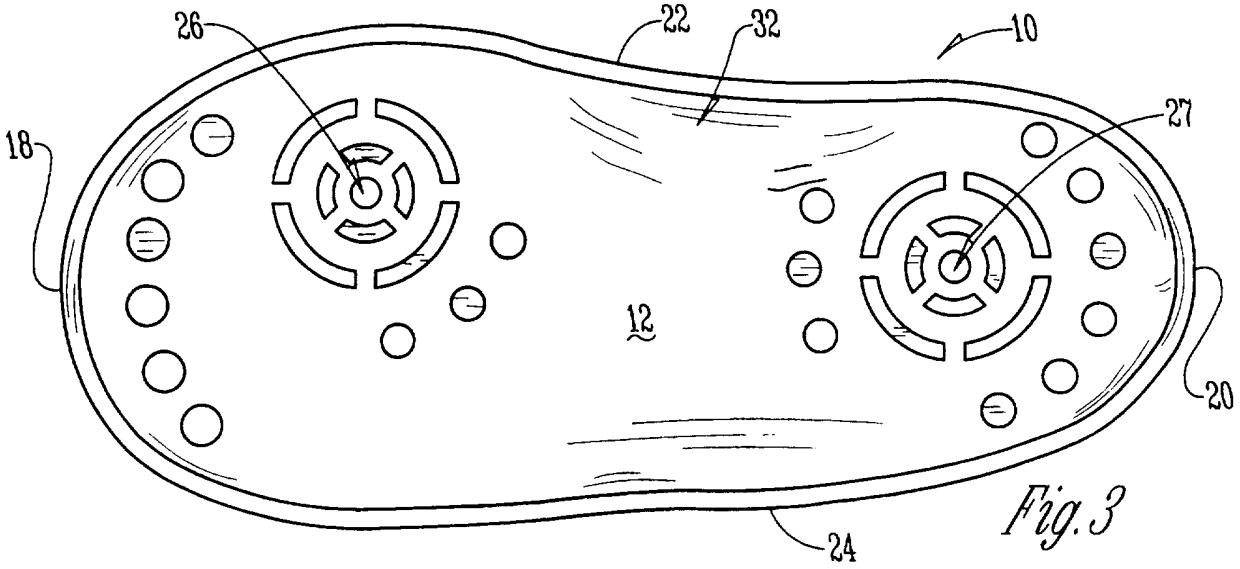

Fig. 3

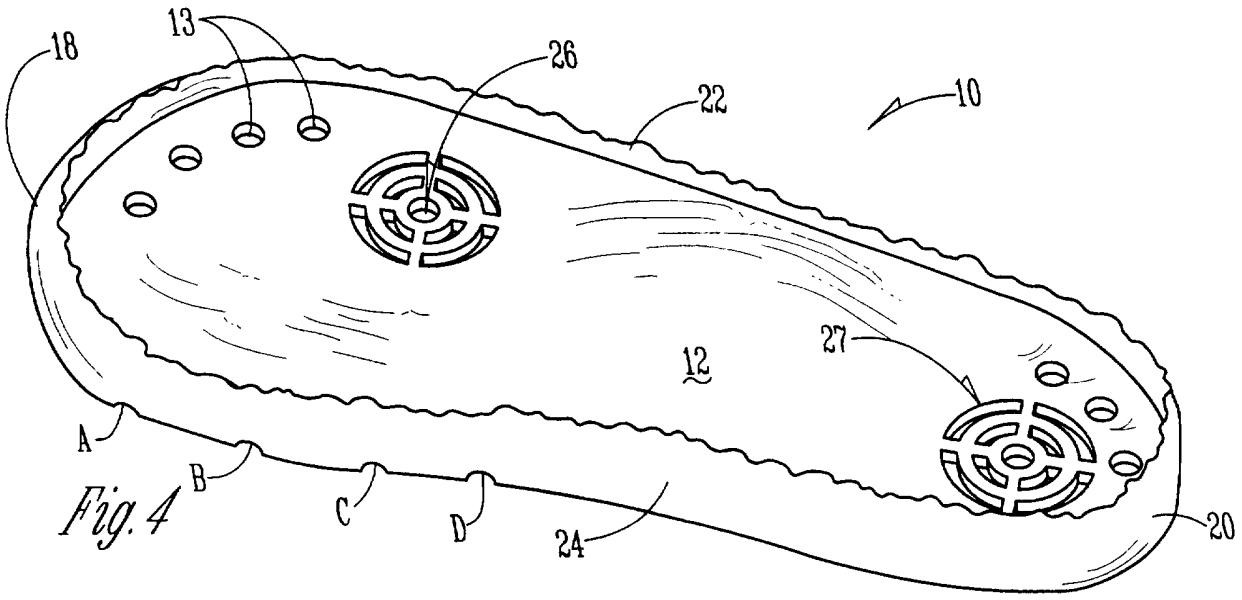

Fig. 4

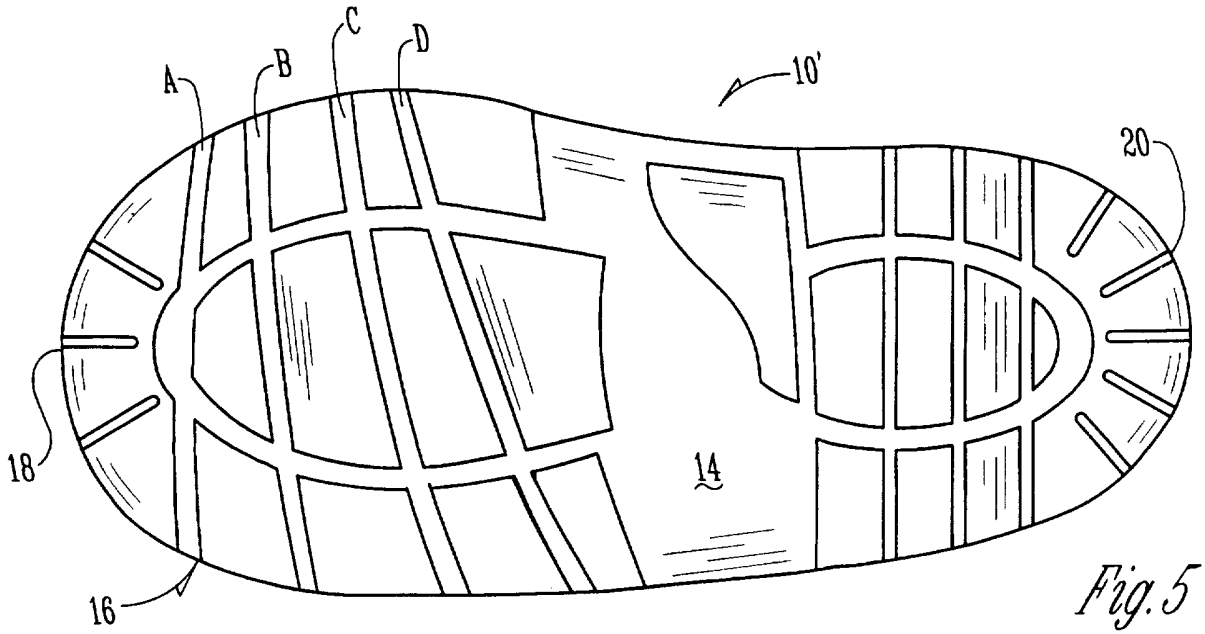

Fig. 5

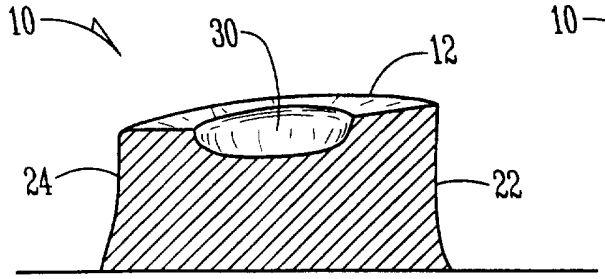

Fig. 8

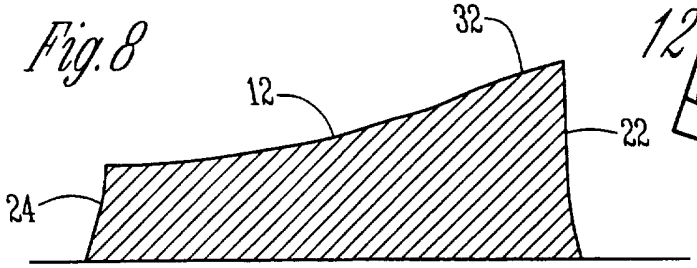

Fig. 9

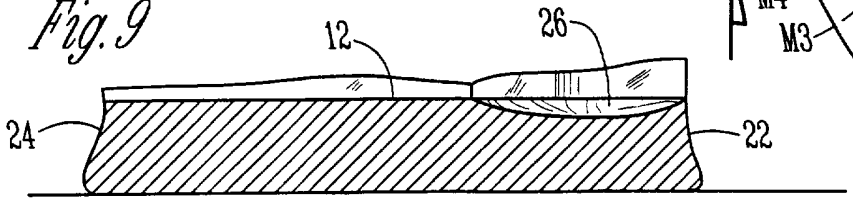

Fig. 10

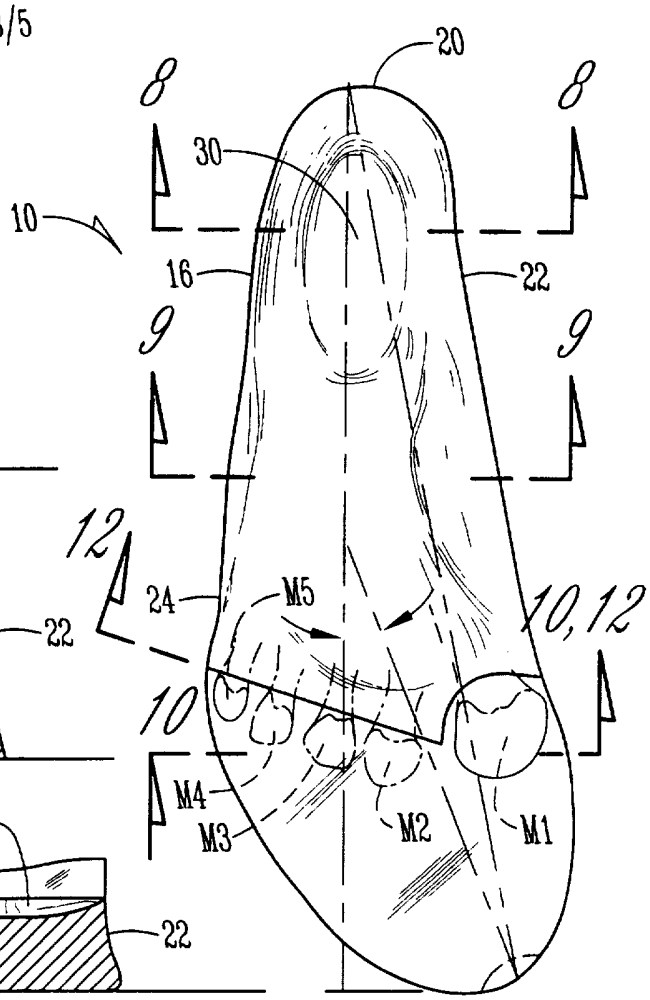

Fig. 7

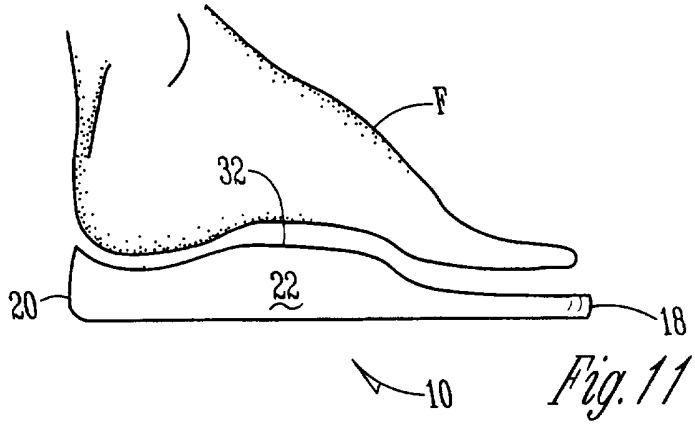

Fig. 11

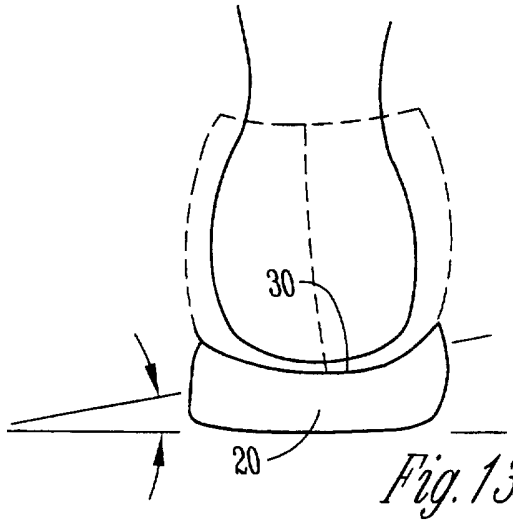

Fig. 13

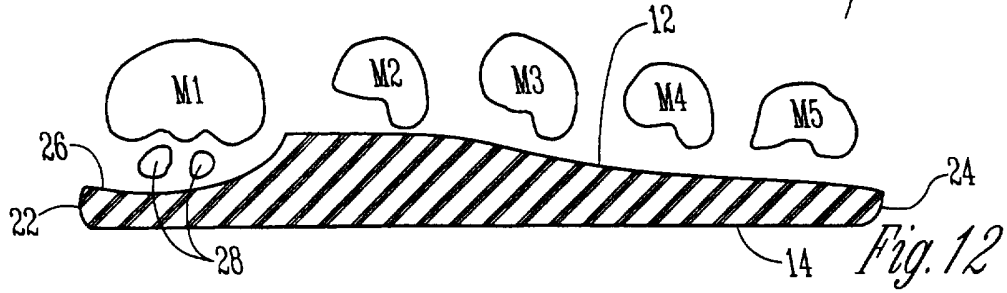

Fig. 12

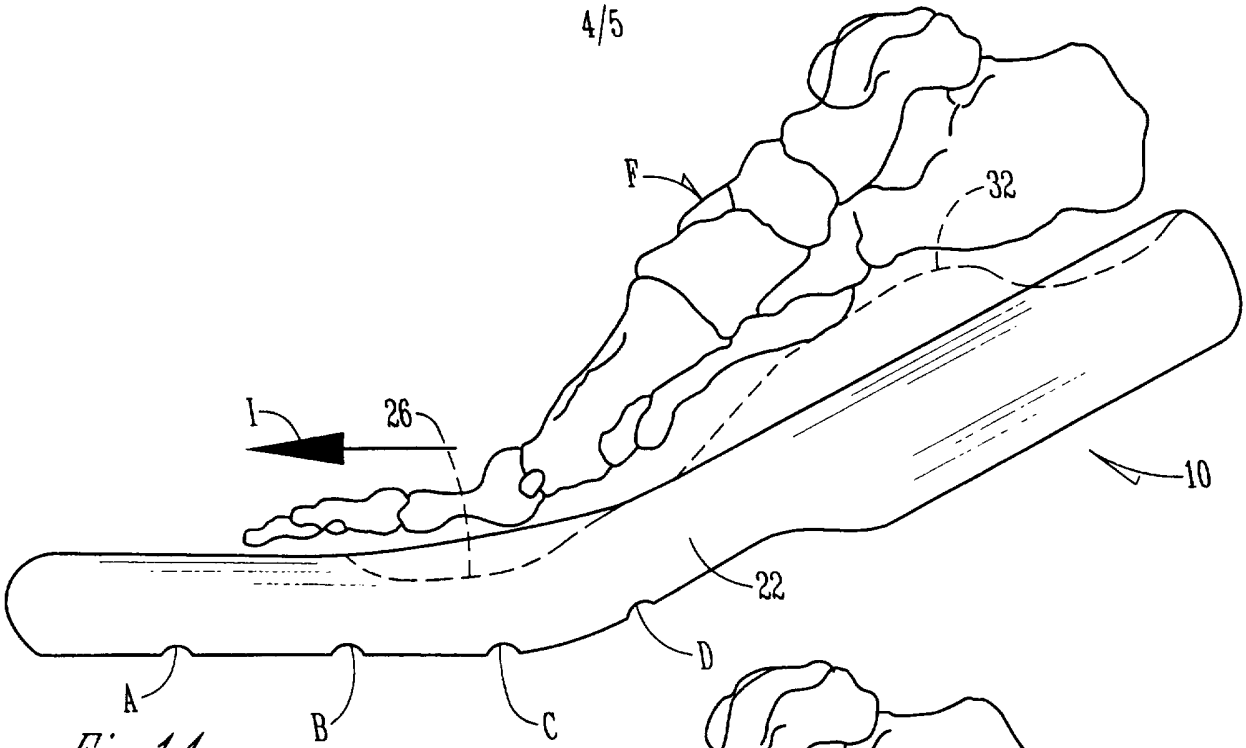

Fig. 14

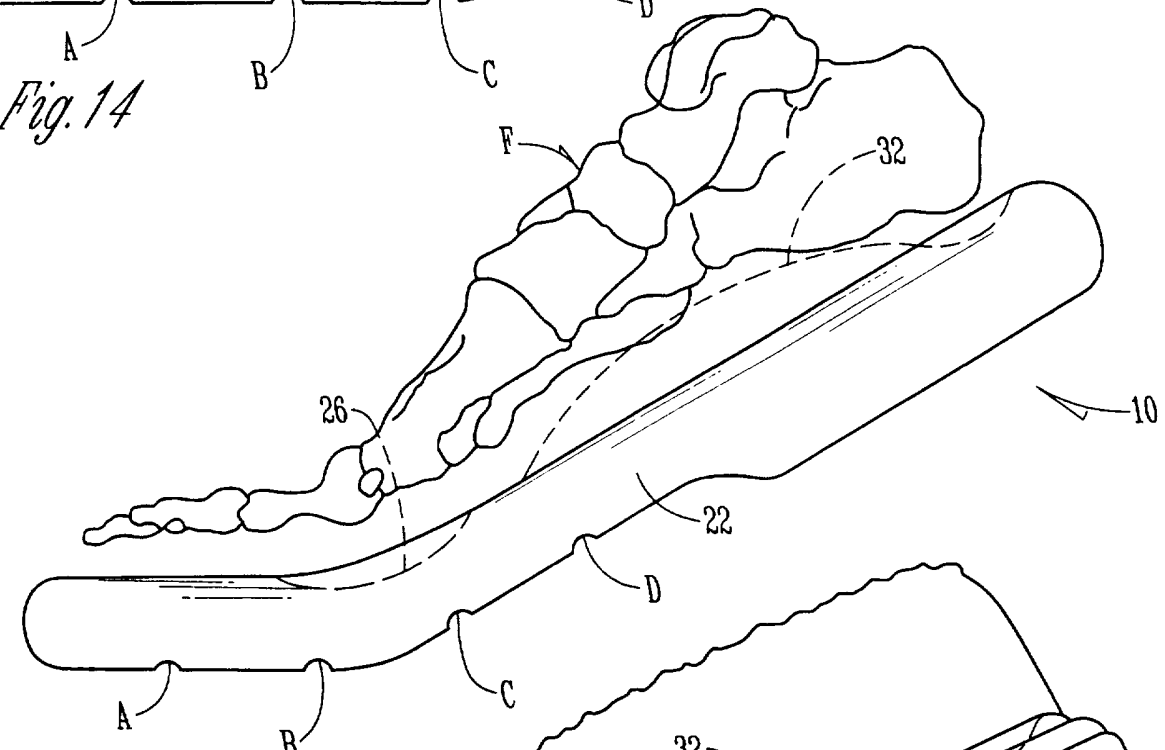

Fig. 15

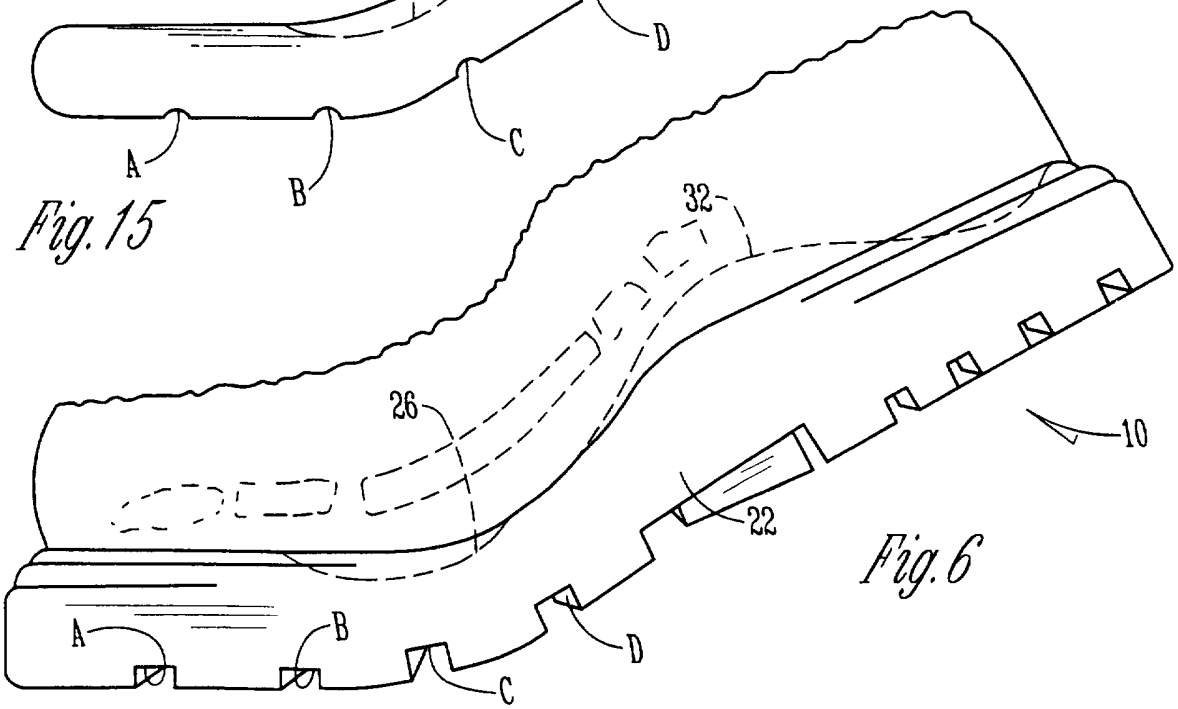

Fig. 6

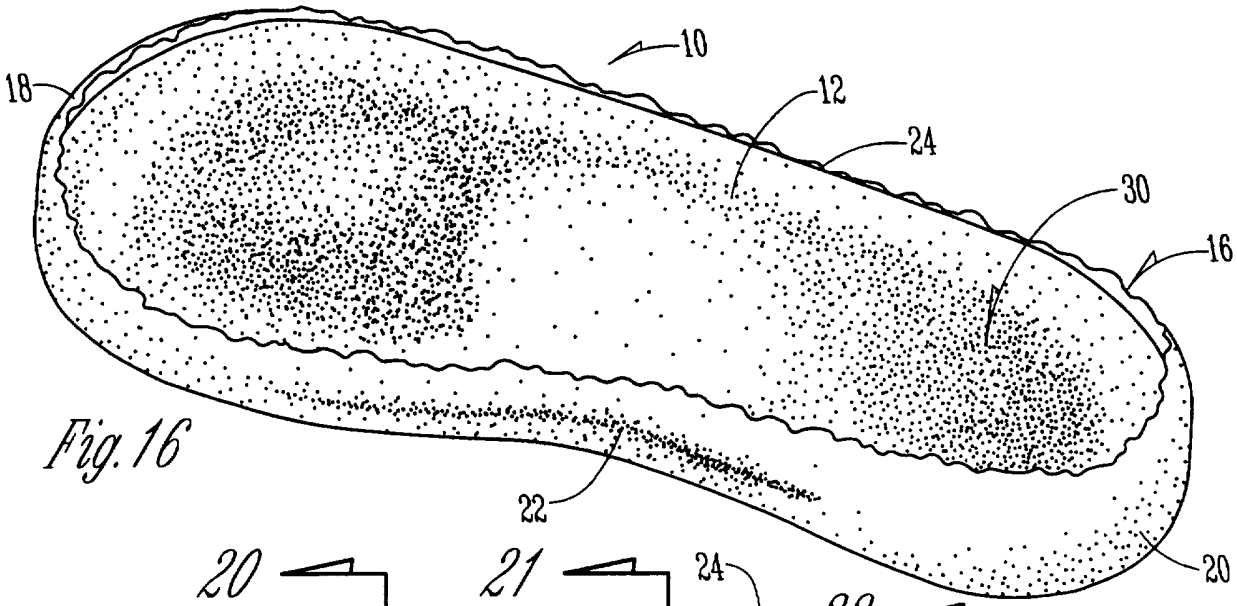

Fig. 16

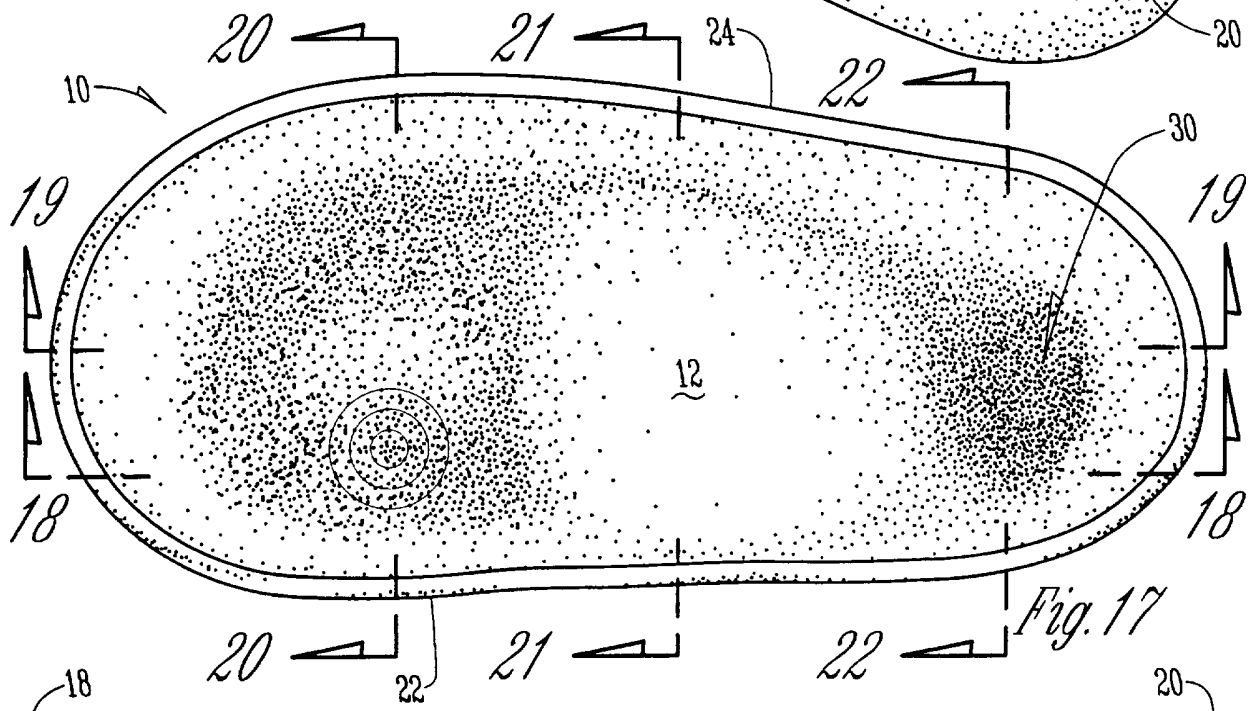

Fig. 17

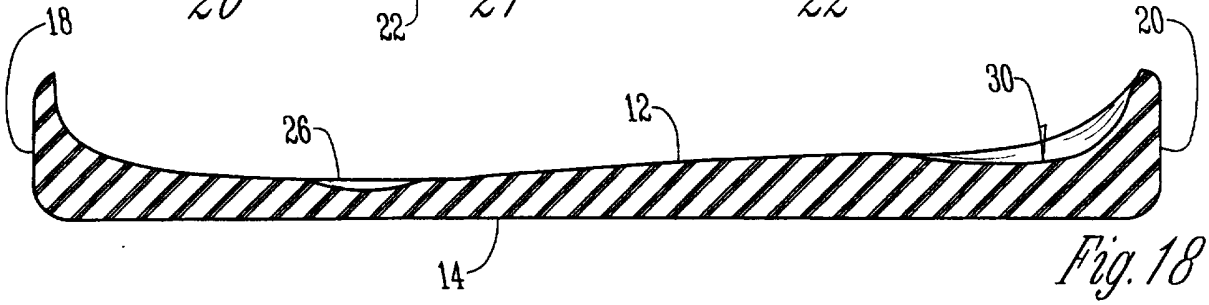

Fig. 18

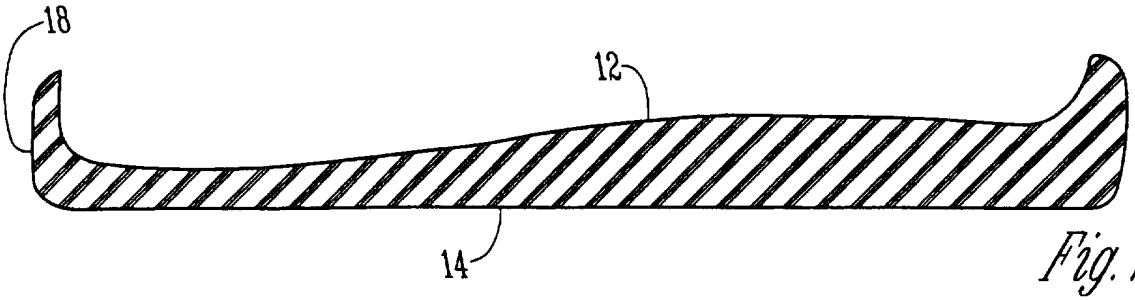

Fig. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/07822

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A43B 13/14
US CL :36/25R

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)

U.S. : 36/25R,80,173,174,176,180,182

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,879,821 A (GRAHAM ET AL) 14 NOVEMBER 1989, SEE THE ENTIRE DOCUMENT	1,2,6,7 --- 1-9
Y	US 2,828,555 A (LEDOS) 01 APRIL 1958, SEE THE ENTIRE DOCUMENT	1-9
Y	GB 217,833 A (FLEMING) 26 JUNE 1924, SEE THE ENTIRE DOCUMENT.	1-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be of particular relevance	"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
"E"	earlier document published on or after the international filing date	"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
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 15 JULY 1997	Date of mailing of the international search report 18 AUG 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer For TED KAVANAUGH Telephone No. (703) 308-1148

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