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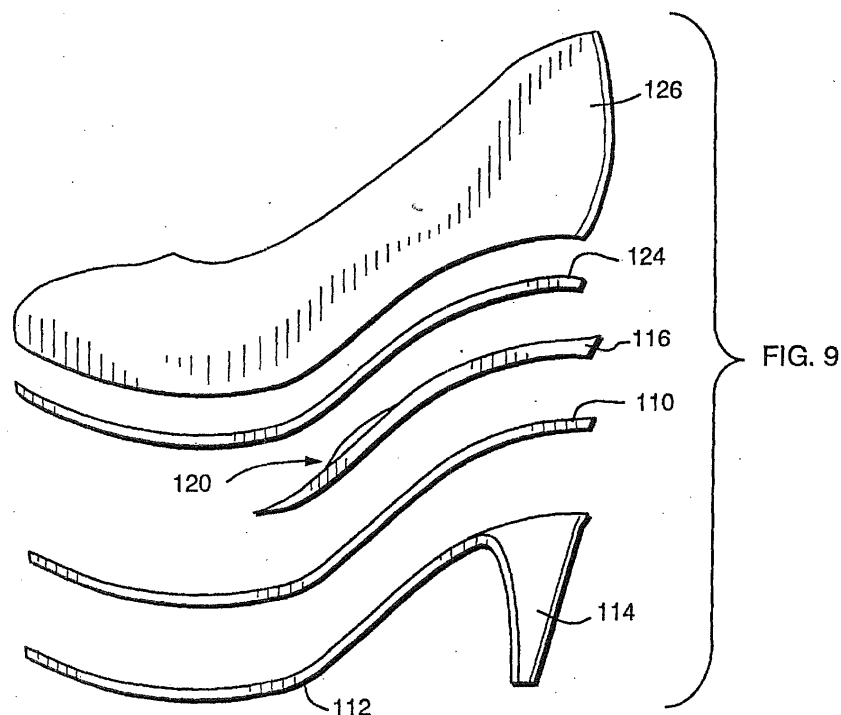
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(54) **Shoe and method of making same**

(57) A foot construction comprising a rigid molded
 device (116) comprising a heel cup (118) and an ana-
 tomically shaped arch appliance (120) extending for-
 wardly from the heel cup to just proximal to the metatar-

sal heads, causes the foot of the wearer to assume an
 anatomically correct position in the shoe, provides tor-
 sional stability and contributes to shoe structure integ-
 rity.



Description

[0001] The present invention relates, in general, to footwear, and more particularly to a footwear construction for walking and other active use. The invention has particular utility in connection with high heel shoes, and will be particularly described in connection with such utility, although other utilities are contemplated.

[0002] Prior art high heel shoes in current use have a reputation of being extremely uncomfortable and there is survey information indicating that as many as 20% of the users of such shoes experience foot pain related to the shoes immediately and the majority of users experience such pain after as little as four hours of use. This discomfort results primarily from the wearer's foot sliding forwards in the shoe with the consequence that the wearer's toes are jammed in the toe portion of the shoe.

[0003] With reference to Figure 1 there is shown in ghost the bone structure of a foot in a conventional high heel shoe. The foot structure comprises the heel bones 10 (also known as tarsus), including the talus and calcaneus, the arch including the cuneiform 11 and the metatarsus 12, and the toe bones or phalanges 13. The heel bones 10 are supported by the heel seat 19, while the arch extends over the shank-reinforced midsole region 15 of the shoe to the ball of the foot 16 where the metatarsus joins the base of the phalanges 13. The ball of the foot underlying the heads of the metatarsals, forming the metatarsus, and the phalanges are supported by the toe region 9 of the shoe.

[0004] The shoe illustrated in Figure 1 has a heel height of approximately 2 inches. The particular shoe illustrated is based on a U.S. standard ladies' shoe size 7. The shoe is shown on a ground plane 18 from which the heel height " α " to the heel seat 19 is measured. The heel seat 19 is inclined upwardly at an angle of approximately 12-15 degrees relative to the ground plane. This angle is referenced "x" in Figures 1 and 3. The shank-reinforced midsole region 15 is angled downwardly and forwardly of the shoe from the heel seat at an angle of approximately 30 degrees relative to the ground plane. This angle is referenced "y" in Figures 1 and 3. In the toe region of the shoe the great toe is essentially parallel to the ground plane, but may be inclined upwardly and forwardly by the upward and forward inclination of the toe region at an angle of 2-3 degrees relatively to the ground plane 18. This angle is referenced "z" in Figures 1 and 3.

[0005] As will be appreciated, a conventional high heel shoe such as shown in Fig. 1 places the wearer's foot essentially on an inclined plane, whereupon the foot is urged forward into the toe box in standing or walking. This results in pressure on the ball or forefoot regions and toe jamming which often gives rise to a burning sensation in these areas of the foot, as well as fatigue and discomfort.

[0006] Traditionally, shoes have been made with either one of two basic techniques, slip lasting or board lasting. In slip lasting, an upper typically is stitched together and then either glued or sewn onto a mid-sole and/or outsole. In board lasting, the upper is either stitched or glued onto a flat or pre-shaped board, which in turn is attached to a sole and/or outsole. In order to properly carry the weight of the wearer without the footwear collapsing, a reinforcement, known as a shank, typically made of metal, wood, leather, fiberboard or plastic, is cemented and/or stitched between the midsole and/or insole board and an outsole. Some shoe constructions also employ a molded sock liner, and/or a cushioning insole is provided for cushioning the foot in the shoe. However, while cushioning the foot in the shoe may provide an initial perception of comfort, cushioning actually compromises biomechanical properties of the shoe and does little to stabilize the foot in the shoe or support the foot in an anatomically correct position.

[0007] It is therefore an object of the invention to provide a shoe having a construction which is comfortable to wear, but which also supports the wearer's foot in the shoe in an anatomically correct position.

[0008] Another object of the present invention is to provide a shoe construction method which provides a shoe construction which is comfortable to wear, but which also supports the wearer's foot in the shoe in an anatomically correct position.

[0009] Yet another object of the present invention is to provide a means for altering the angle of inclination of the heel in relation to the ground plane. This is applicable in a variety of shoe heel heights and would permit the ability to retain the heel in a near parallel relationship to the ground plane as the heel height increases as in women's high heeled dress shoes.

[0010] Still another object of the invention is to provide a shoe construction which supports the longitudinal axis of the foot but, permits flexibility in the oblique axis orientation. This would be applicable in the design, e.g. of golf shoes where flexibility during swing motion could be permitted but collapse of the longitudinal arch of the foot during walking prevented. In such application, the area underlying the medial longitudinal arch of the foot would be either thinned down or completely removed to permit for raising and lowering of the arch of the foot during the swing motion while the central portion would retain its rigid construction to prevent long axis breakdown.

[0011] Briefly, the present invention in one aspect accomplishes the foregoing and other objects, by providing a shoe construction in which a rigid shaped orthotic device comprising a heel cup and an anatomically shaped appliance running distally to just proximal to the metatarsal heads, is rigidly affixed as a structural element to the top surface of the last/insole board. The shaped device includes a deep conformal heel cup, and runs from the heel of the shoe to the point just behind the metatarsal head area, and is molded and/or machined to conform to the underside of the foot

whereby to cause the foot to assume an anatomically correct position within the shoe. As thus described, the shaped device of the present invention is similar to a conventional foot orthotic device; however, unlike conventional foot orthotic devices, the shaped device of the present invention comprises an integral structural element of the shoe, whereby to better stabilize the wearer's foot in the shoe, and preferably eliminate the need for a separate shank, and thus may serve a dual purpose.

[0012] As applied to high heel shoes in accordance with a preferred embodiment of the invention, the rigid shaped device includes a heel seat having a slightly downwardly inclined angle (relative to the shoe's imaginary shank plane), and an arch support extending forward from the heel seat and having a first portion which supports the head of the navicular of the wearer. The shoe also includes a last/insole board extending downwardly and forwardly from the first portion of the arch support, and a toe support region which extends at an inclination upwardly and forwardly from the last/insole board whereupon the first metatarsal of the wearer is buttressed by the phalanges of the wearer to prevent forward sliding of the foot of the wearer relative to the shoe, thereby preventing jamming of the human digits into the toe portion of the shoe, while an increase of about 16% or more of the wearer's weight is borne by the heel seat, as compared to standard high heel dress shoes.

[0013] Still other objects and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings in which like numerals depict like parts, and wherein:

Fig. 1 is diagrammatic cross sectional view of a conventional high heel shoe made in accordance with the prior art; Fig. 2 is a diagrammatic cross sectional view of a high heel shoe made in accordance with the present invention; Fig. 3 is a diagrammatic representation showing a comparison of relevant angles to the ground plane of a shoe made according to the present invention such as that shown in Fig. 2, and a conventional high heel shoe having similar heel heights, i.e. such as shown in Fig. 1;

Figures 4-7 are views, similar to Figure 2, of high heel shoes made in accordance with the present invention, and illustrating the application of the invention to shoes with varying heel heights;

Fig 8 is a side elevational view, in partial cross-section, of a shoe made in accordance with one embodiment of the present invention;

Fig. 9 is an exploded view of the shoe of Fig. 8;

Fig. 10 is a perspective view, in partial cross-section, of the shoe of Fig. 8;

Fig. 11 is a perspective view of an element of the shoe of Fig. 8;

Fig. 12 is a view, similar to Fig. 8, and showing an alternative embodiment of the invention;

Fig: 13 is a cross-sectional view taken along lines 13-13 of Fig. 12; and

Fig. 14 is a side elevational view showing placement and support of the left foot by the present invention.

[0014] Referring to Figure 2, there is shown a preferred embodiment of the present invention. As in the case of the shoe of Figure 1, the shoe shown in Figure 2 has a heel height of approximately two inches. However, unlike the conventional shoe shown in Figure 1, in the Figure 2 shoe, the heel seat 20 is rotated clockwise, i.e., in the direction of arrow CL, relative to the shank plane at an angle "H", relative to ground plane 18, in accordance with the following formula:

$$H = 5^{\circ} + (\infty \times 1.25^{\circ})$$

where ∞ = the heel height in nearest $\frac{1}{2}$ " segments in excess of 1".

[0015] An arch support 22 extends forward from the forward edge of the heel seat 20 to underlie the arch of the foot of the wearer, at least in part. Arch support 22 has a contour with a high point 23 which forms a barrier which prevents forward sliding of the calcaneus of the wearer forward in the shoe. The arch support 22 then curves downwardly from the high point 23 to join the shank 24 which then runs to the toe region 26 of the shoe.

[0016] Shank 24 is inclined at an angle "M" perpendicular to the ground plane in accordance with the following formula:

$$M = 18^{\circ} + (\infty \times 3.5^{\circ})$$

where ∞ = the heel height in nearest $\frac{1}{2}$ " segments in excess of 1".

[0017] Maintaining the aforesaid relationships of "M" and "H" relative to heel height is critical to the present invention in order to prevent excessive height at point 23 which would be uncomfortable to the wearer. Thus, altering the M/H relationship as heel height ∞ increases, results in a shift of the weight of the wearer onto the heel seat, thus preventing forwarding sliding in the shoe, but without creating a painful stress point under the arch of the wearer.

[0018] The toe region of the shoe is inclined upwardly and forwardly by the upward and forward inclination at an angle "T" of approximately 2-3° plus/minus 1° relative to the ground plane.

[0019] The combination of the downward inclination of the heel seat, the contour of the arch support 22 as an extension of the heel seat, the incline of the shank, and the upward inclination of the toe region of the shoe, i.e. in accordance with the present invention, results in higher percentage of the weight of the wearer being carried by and supported by the heel seat than in the case of a conventional high heel shoe. Pressure measurements taken within the shoe under the wearer's heel seat and balls of the foot, respectively, of a high heel shoe made in accordance with the present invention, and a conventional high heel shoe of equal heel height, show a shoe made in accordance with the present invention provides an increase in the weight carried by the wearer's heel of approximately 16 -18%, with a corresponding decrease in the weight carried by the ball of the foot of the wearer, during walking. Thus, as a consequence of a design of the shoe of the present invention, a greater portion of the weight of the wearer is borne by the heel seat rather than being transferred by the sloping shank of the shoe to the ball of the foot, toe jamming is prevented, and comfort assured.

[0020] Referring to Figure 3 the line in ghost illustrates the heel seat angle H, the inclination M of the first metatarsal and of the great toe T in the toe region relative to the ground plane 18 of a high heel shoe made in accordance with the present invention. Dimension ∞ represents the heel height. The solid line in Figure 3 represents the corresponding set of angles and inclination for currently available high heel shoes having similar heel heights such as shown in Figure 1 to that of the present invention. In these current shoes the inclination of the heel seat is upward towards the rear of the shoe at an angle x of approximately 8 degrees, the inclination of the first metatarsal downwardly and forward is at an angle y of about 27 degrees and the great toe is inclined upwardly and forwardly at an angle z of approximately 1 ½ degrees. These angles are also relative to the ground plane 18, and relate to a shoe of similar size.

[0021] A brief explanation of the mechanics of the foot may be helpful to facilitate an understanding of the function of the shoe of the present invention. The foot is capable of functioning in two separate mechanical fashions so as to support the body above. Primarily, the foot functions as a beam and supports the body by bending strain. This mechanism of support is effective when the force in acting on the arch (arch flattening force) is relatively low. This occurs at such times in the step when the center of body weight falls posterior (behind) the ankle joint. As the center of weight passes ahead of the ankle joint, as occurs in a normal step forward, the forces present begin to cause arch flattening. To counter this, the foot initiates a basic change in the mechanism of support to a truss form of support and is then capable of supporting via compression strain. Since the bones of the foot have been shown to be extremely strong in terms of compression strength, the greater the compression strain, the better the arch support ability. In order for the foot to achieve this change in support mechanism, the metatarsals must be buttressed by the bending of the toes. This buttress effect prevents the metatarsals from sliding forward and thus permits the switch from bending to compression support.

[0022] It is the combination of this effect and the shape and inclination of the heel seat and arch support in the shoe design of the present invention that provides the advantages of the present invention. By creating a particular platform surface for the foot, a buttress effect is initiated in a more effective fashion preventing the forward sliding of the metatarsal bones and, as a result, eliminating the subsequent jamming of the toes into the pointed front of the shoes.

[0023] Increasing the angle of bending, dorsiflexion of the toes in the shoes can be accomplished in one of two ways. The tip of the shoes may be lifted upwards creating a "genie" type shoe. Although this would be effective, it would not be particularly stylish. A more effective mechanism entails increasing the angle at which the metatarsals themselves approach the sole of the shoe. This has the effect of increasing the bending of the toes without creating a "genie" type shoe. This increase in the angle of the metatarsals relative to the ground plane is accomplished by the change in the rear construction of the shoe, specifically the angle of the heel seat, and by extending the arch support under the navicular of the wearer as previously discussed. Since the foot is jointed in a variety of locations, the plane that the heel bone (calcaneus) takes with the ground will be compensated for by the pitch of the metatarsals as they approach the ball of the foot. This angular relationship is inversely proportional. The closer the calcaneus comes to parallel with the ground (provided there is adequate heel height present), the closer the metatarsals approach a perpendicular attitude. Thus, by providing a heel seat with a low slope to increase the descent angle of the metatarsal, the desired buttressing effect is achieved.

[0024] In the present invention, the heel seat is maintained downwardly inclined with respect to the shank irrespective of the heel height, and the navicular of the wearer is supported by an arch support extending forward from the heel seat. In prior art shoe designs, the higher the heel of the shoe, the closer the heel seat angle approaches the shank angle. This relative relationship in prior art shoe designs created an inclined platform of the foot toward the floor. This increased angle in turn forced the foot to slide forward and be pinched in the toe portion of the shoes. The present invention creates a shoe in which the heel seat is downwardly inclined relative to the shank regardless of heel height, and provides an arch support which underlies and supports the navicular of the wearer, thereby creating a surface which causes a greater percentage of the wearer's weight is carried by the heel seat. The metatarsal angle (corresponding to the shank of the shoe) -increases proportionally to the heel height, e.g. the higher the heel, the greater

the metatarsal angle to the floor. In a shoe with a heel height over 2 inches, the advantage is not of increased metatarsal inclination, but rather the resulting biomechanical change in metatarsal inclination due to the maintenance of heel seat more closely aligned to parallel to the ground plane.

[0025] This effect is emphasized when the toe region is angled as specified above in order to increase the spring angle of the toes. As a consequence of this particular design, the load distribution between the foot and the shoe is effected whereby when the wearer is at rest a greater proportion of the weight of the wearer is borne by the heel seat rather than being transferred by the sloping surface of the prior art shoes to the ball of the foot with consequent problems as referred to above. Thus, with the design of the present invention, toe jamming is prevented and comfort assured.

[0026] While the description above has been made with respect to a U.S. standard ladies' shoe size 7, having a 2 inch heel height, the invention is specifically designed to be applicable to the whole usual range of U.S. standard ladies' shoe sizes and particularly to those in the range having from size 5 to size 10, and having various heel heights and particularly to those heel heights that range from 1 to 3 inches. With different shoe sizes and heel heights, the metatarsal inclination will vary within the range of about 18-22 degrees in the case of a 1 inch heel height to about 33 - 36 degrees in the case of a 3 inch heel height. Figures 2 and 4-7 and the following Table I illustrate high heel shoes made in accordance with the present invention, and having heel heights of 1 inch (Figure 4), 1 ½ inches (Figure 5), 2 inches (Figure 2), 2 ½ inches (Figure 6), and 3 inches (Figure 7.)

TABLE I

Heel Height (H)	Heel Seat Inclination (H)	Metatarsal Angle (M)	Toe Angle (T)
1"	5-6%	18-22%	1-2%
1½"	6-7%	20-23%	2-3%
2"	7-8%	24-28%	2-3%
2½"	8-9%	30-33%	2-3%
3"	9-10%	33-36%	3-4%

[0027] In Figs.8-11, the primary elements of a shoe made in accordance with another and preferred embodiment of the present invention are shown. The shoe comprises a last/insole board 100 formed of a dimensionally stable, flexible material such as leather, fiberboard, a non-woven material, or the like. Below the last board 110 is an outsole 112 and a heel 114. Located above the last board 110 is a rigid device 116 comprising an heel cup 118 and an anatomically shaped arch appliance 120 extending forwardly from the heel cup 118 to just behind the metatarsal head area 122. Device 116 is molded and/or machined to conform to the underside of the foot whereby to locate and stabilize the heel of the wearer in the shoe, and is raked downwardly from the heel cup 16, i.e. at about 5-10°, depending on the heel height, so as to cause the foot to assume an anatomically correct position in the shoe, while the heel of the wearer is retained in a near parallel relationship to the ground plane, whereby to buttress the phalanges of the wearer to prevent forward sliding of the foot of the wearer relative to the shoe, i.e. as described in detail above. Device 116 is adhesively and/or mechanically, e.g. riveted or fixed to last/insole board 110.

[0028] Device 116 can be formed of a lightweight, rigid material compatible with shoe construction. Thus molded device 116 preferably is formed of ABS plastic; however, device 116 may be formed of other rigid plastic molding materials or a composite material such as a fiber reinforced plastic or a metal such as foamed aluminum. Device 116 serves the dual purpose of locating and stabilizing the wearer's foot in the shoe, whereby to support the foot in an anatomically correct position and provide torsional stability, and also serves to stiffen the shoe from the heel forward to just behind the metatarsal head area, and support the weight of the user. Thus, the requirement for a separate reinforcing shank may be eliminated. However, the shoe also may incorporate a reinforcing shank, if desired. Also, because device 116 is an integral part of the shoe, its exact location in the shoe, and thus the location of the wearer's foot in the shoe is assured:

[0029] Completing the shoe is an insole or sock 124 which is placed over molded device 116, and a shoe upper indicated generally at 126. Heel 114 is attached to the outsole 112 by means of adhesive and/or mechanical fasteners in known manner, while upper 126 is affixed to the bottom of last/insole board 110 and outsole 112 by means of stitching, adhesives, staples, rivets, or combinations thereof using one of several well known shoe construction techniques.

[0030] The invention is susceptible to modification. For example, outsole 112 and heel 114 may be formed as a single unit, as shown in Fig. 9. Also, as shown in Fig. 12, the device 116 advantageously may be employed in a low heel shoe 130 or boot. For such application, device 116 will be raked only slightly downwardly from the heel cup 116 so as to accommodate the lower heel height, while the heel is retained in a near parallel relationship to the ground plane. Also, device 116 could be adjusted for different user applications, e.g. golf shoes, so as to provide the desired degree of torsional stability as well as anatomically holding the foot in position, while maintaining shoe structural integrity. For

example, as applied to golf shoes, the area 132 underlying the medial longitudinal arch of the foot may be thinned so as to permit for raising and lowering of the arch of the foot during the swing motion, while the central portion would retain its rigid construction to prevent long axis breakdown. Device 116 also advantageously may be employed in men's, women's and children's walking and running shoes, tennis shoes, hiking boots, cross-training shoes, sandals and other active footwear in which torsional stability is desired.

[0031] Although the present invention has been illustrated in terms of a preferred embodiment, numerous modifications may be made without departing from the spirit and scope of the invention. For example, as shown in phantom in Fig. 11, a cut-out area 140 may be removed from device 116 underlying approximately the distal 1/3 of the first metatarsal head. Therefore, the scope of the invention is to be limited only by the appended claims.

Claims

1. A shoe construction comprising a flexible last board (110) overlying an outsole (112), a heel (114) and a rigid shank, **characterized in that** the shank comprises a rigid device (116) comprising a heel cup (118) and having an anatomically shaped arch appliance (120) extending forwardly from said heel cup to just proximal to the metatarsal heads of the wearer, said rigid device (116) being permanently affixed to said last board (110) as an integral part of said shoe, said rigid device serving to locate and stabilize the heel of the wearer in the shoe, and to support the heel of the wearer above the toes of the wearer, relative to the ground plane, such that the heel of the wearer is supported in a near parallel relationship to the ground plane, the foot of the wearer is caused to assume an anatomically correct position in the shoe, and to provide torsional stability, said device also contributing to shoe structure integrity.
2. A shoe construction according to claim 1, **characterized in that** said rigid device comprises acrylonitrile-butadiene styrene copolymer (ABS) plastic.
3. An improved shoe construction according to claim 1, wherein the heel seat is inclined at an overall angle H drawn along an imaginary line between the proximal and distal ends of the seat is at an angle of 5-10° relative to the ground plane.
4. A shoe construction according to claim 1, wherein said shoe comprises a cleated shoe, **characterized in that** the area of said rigid device (116) underlying the medial longitudinal arch of the foot of the wearer is thinned down relative to the remaining areas of said device so as to permit for raising and lowering of the arch of the foot during walking.
5. A shoe construction according to claim 1, **characterized in that** said rigid device (116) comprises a one-piece molded construction.
6. A shoe construction according to claim 1, **characterized in that** said rigid device (116) comprises a one-piece machined construction.
7. A shoe construction according to claim 1, **characterized in that** said rigid device (116) is adhesively affixed to said last board.
8. A shoe construction according to claim 1, **characterized in that** said rigid device (116) is mechanically affixed to said last board.
9. A shoe construction according to claim 1, **characterized in that** a cut-out area (114) is provided in the device underlying the distal end of the first metatarsal head of the wearer.
10. A method of making shoes in which an upper and an outsole are affixed to a last board, **characterized by** permanently affixing a rigid device comprising a heel cup and an anatomically shaped arch appliance as claimed in claim 1, to the top side of the last board, as an integral part of the shoe, whereby to stiffen the board from the heel forward to just proximal to the metatarsal heads, prior to affixing the upper and/or outsole on the last, said rigid device serving to locate and stabilize the heel of the wearer to the finished shoe, and to support the heel of the wearer above the toes of the wearer, relative to the ground plane, such that the heel of the wearer will be supported in a near parallel relationship to the ground plane when wearing the finished shoes.

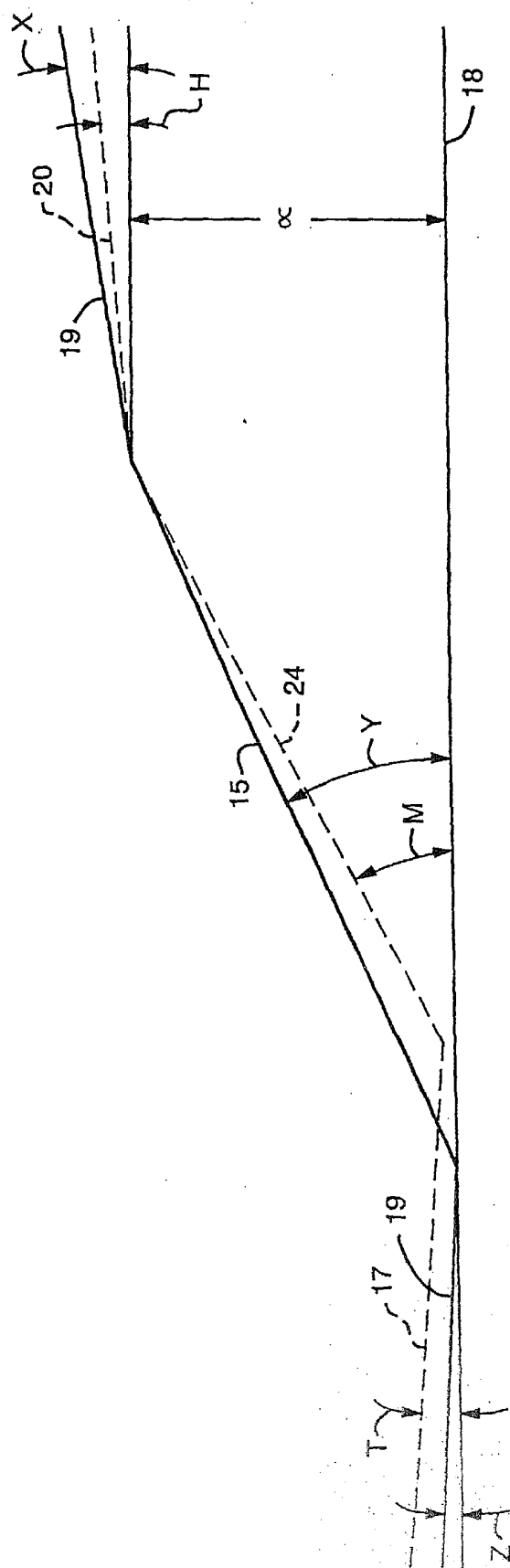


FIG. 3

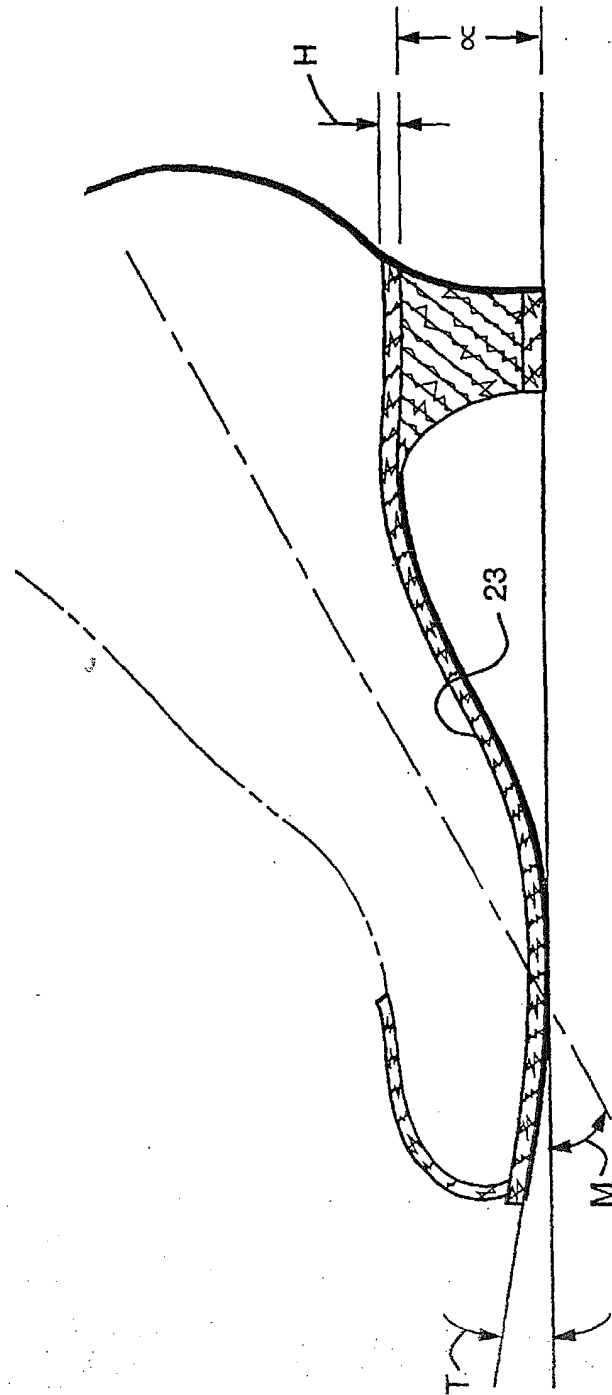


FIG. 4

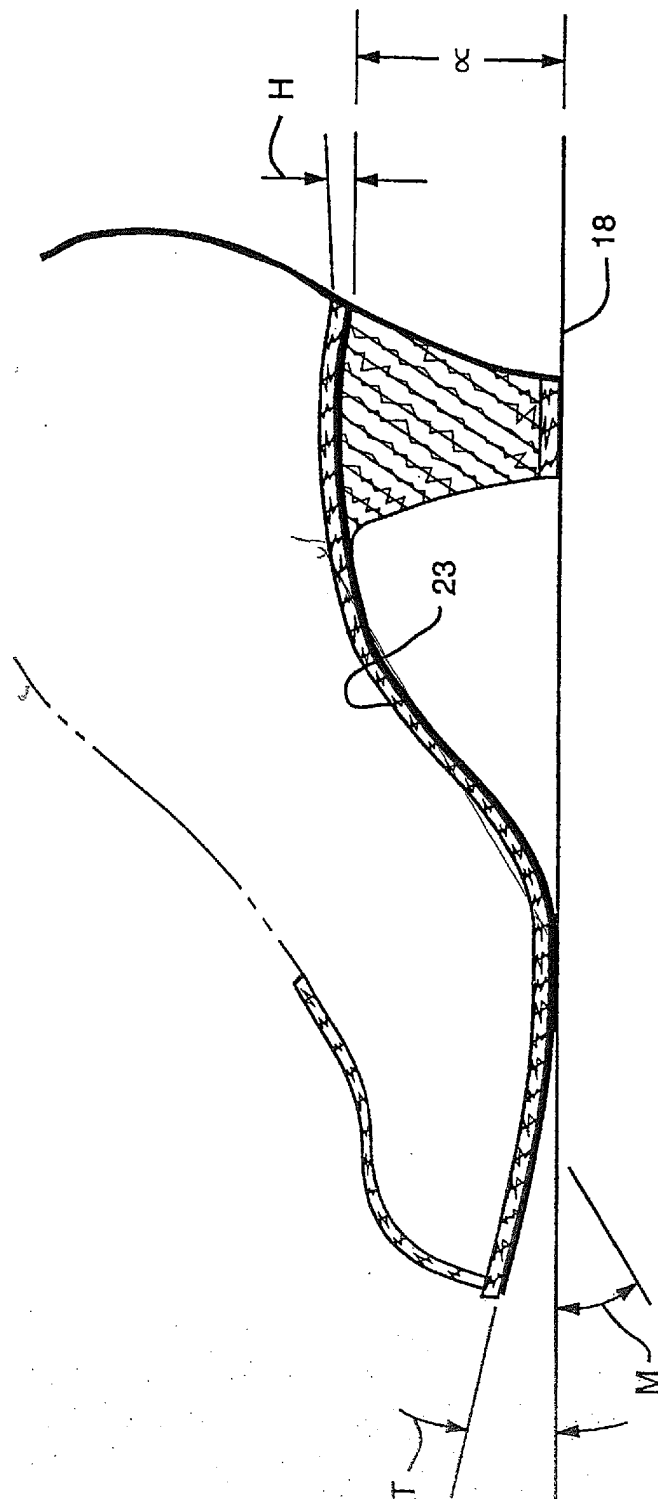


FIG. 5

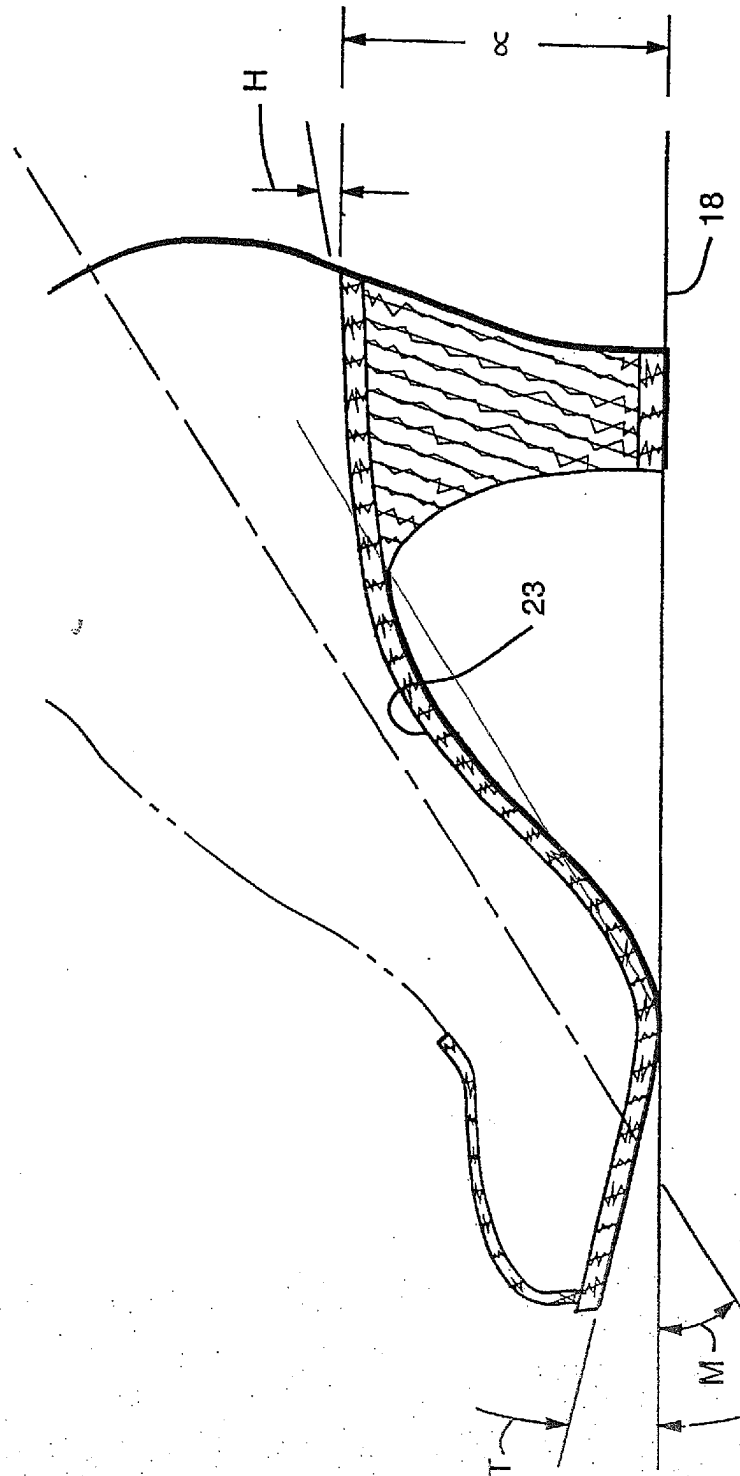
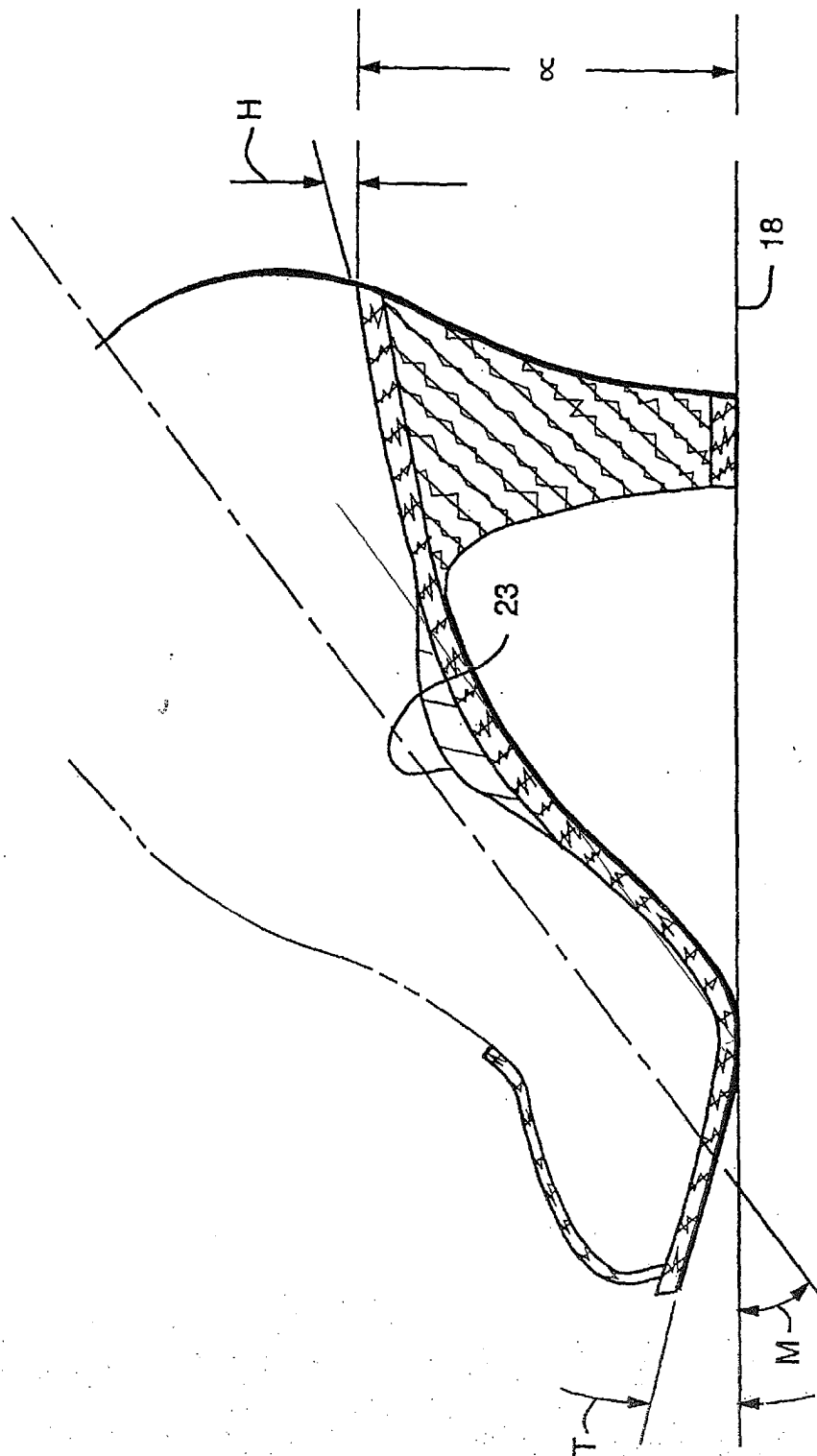


FIG. 6



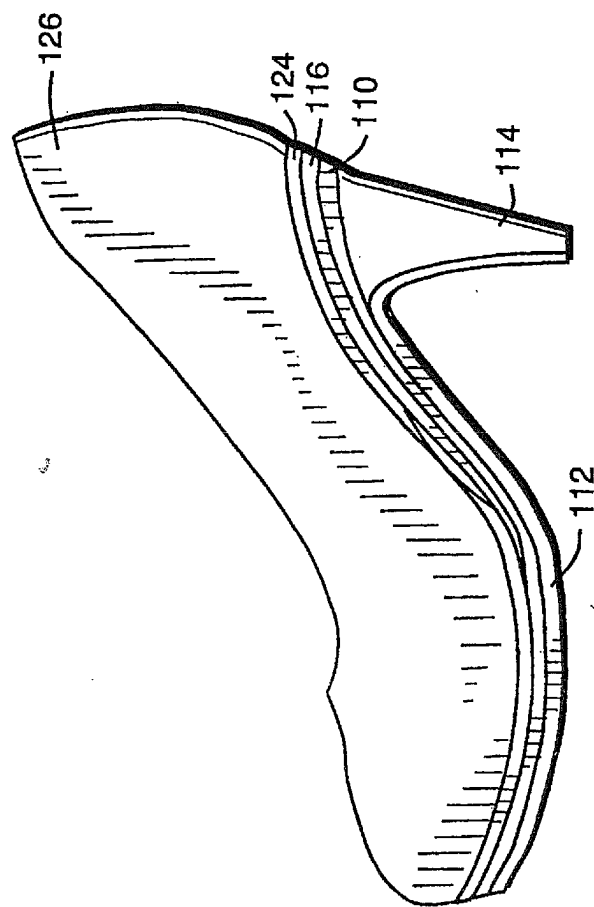
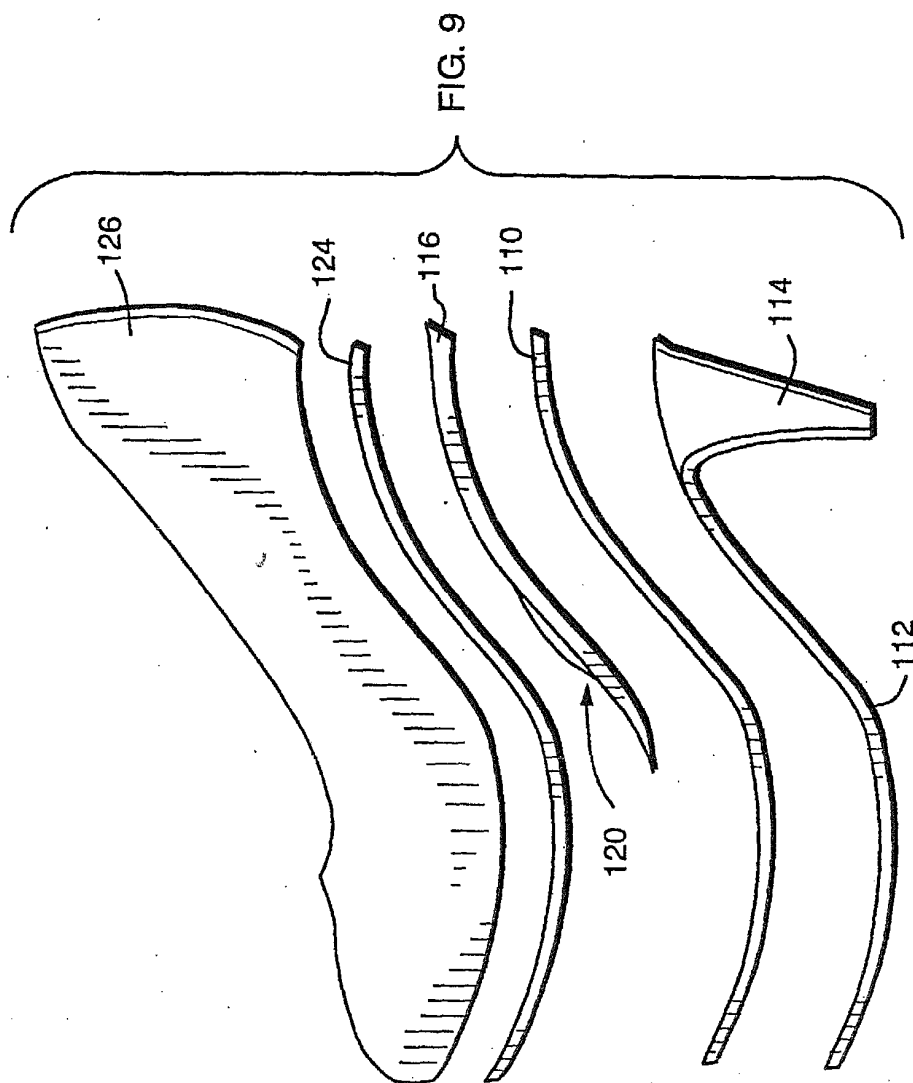


FIG. 8



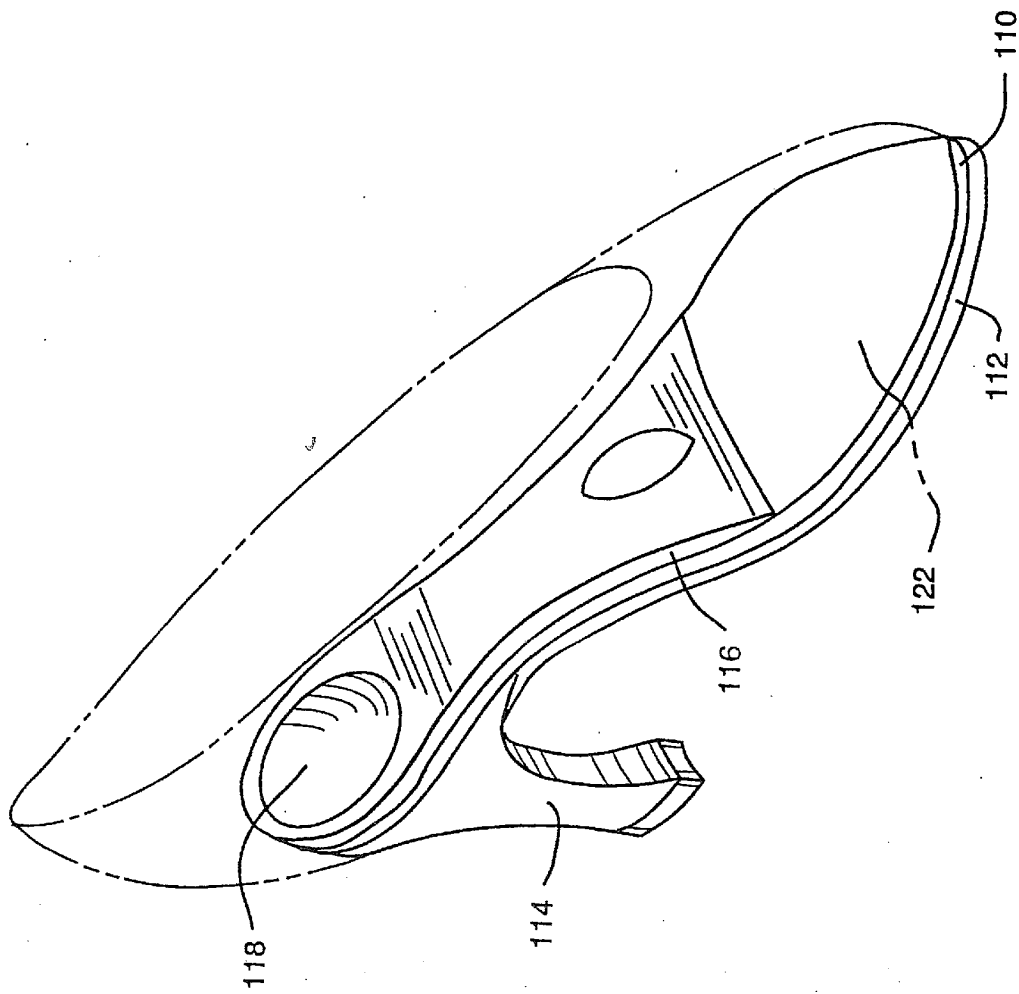


FIG. 10

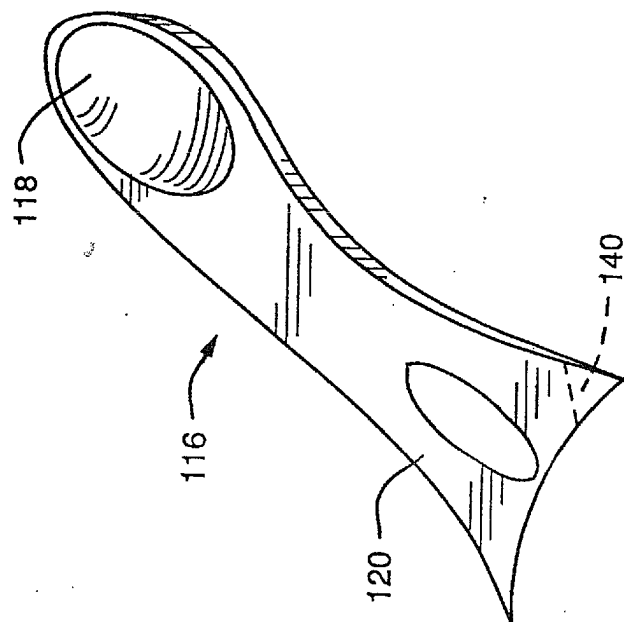


FIG. 11

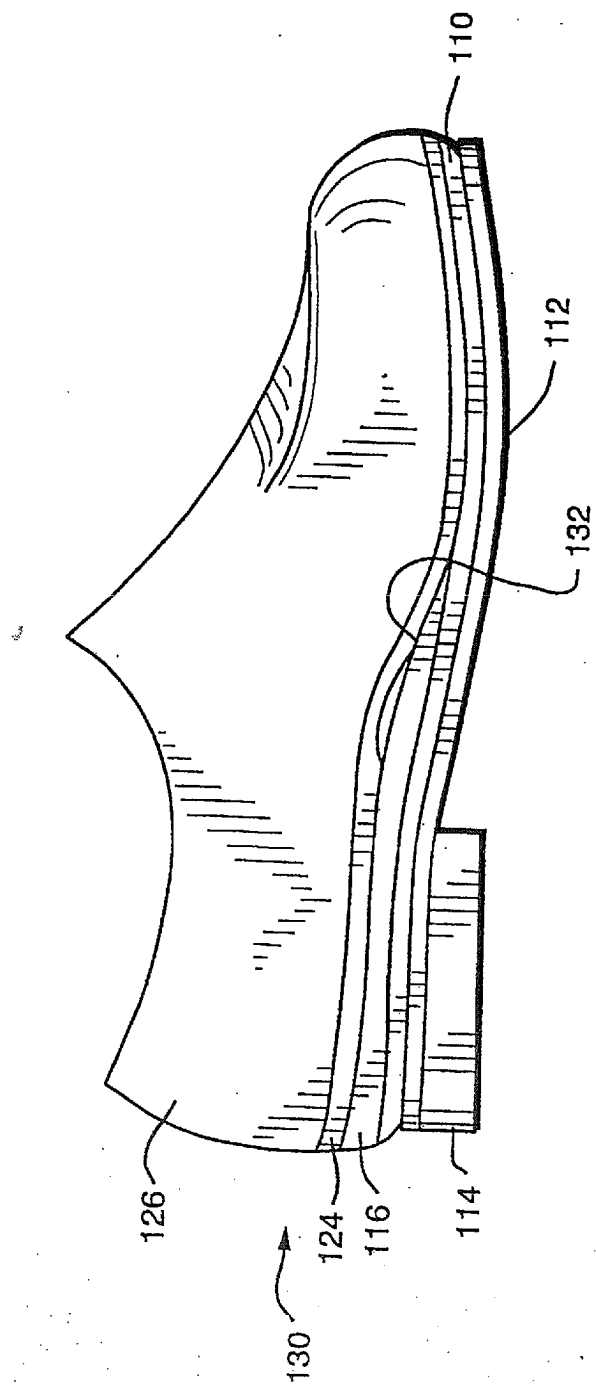


FIG. 12

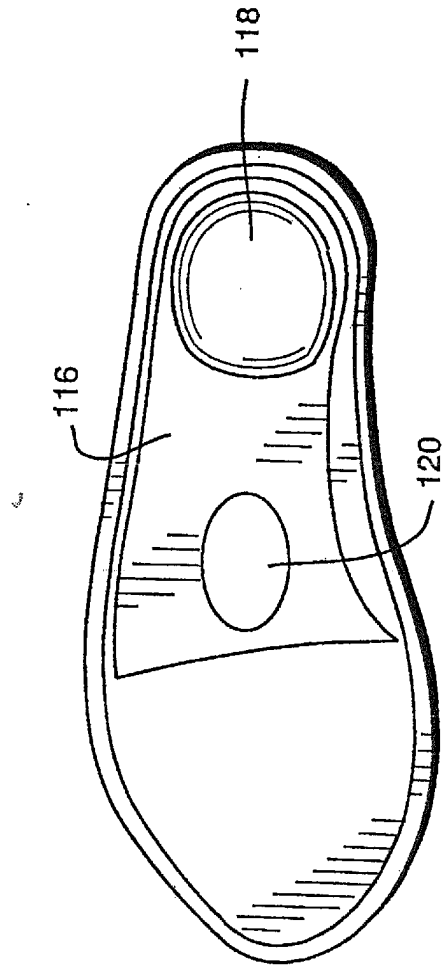


FIG. 13

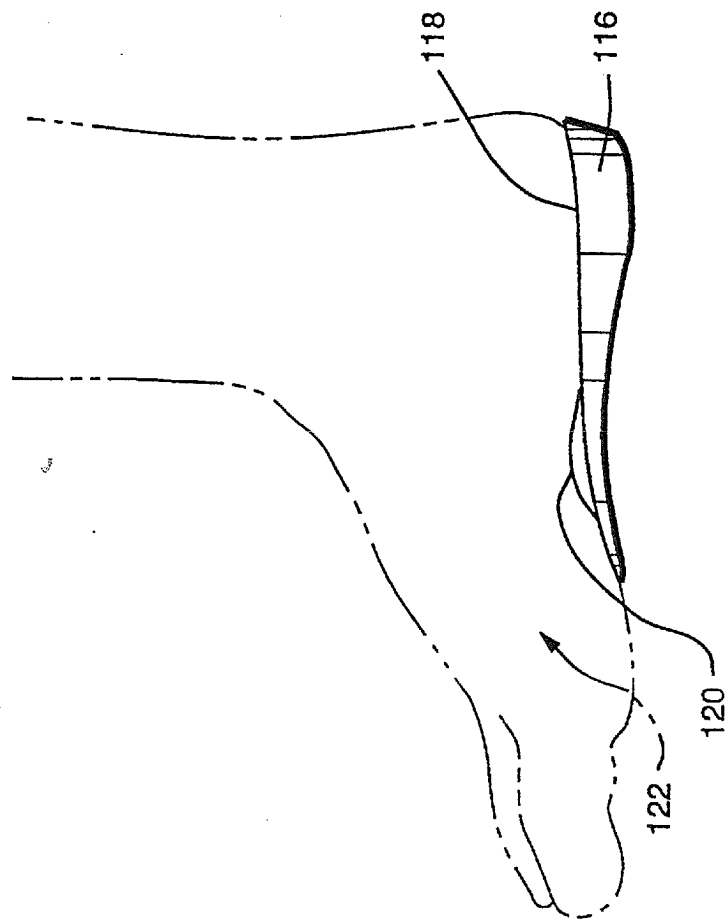


FIG. 14



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 10 1303

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 10 May 2004	Examiner Claudel, B
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

EPO FORM 1503 03 82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 04 10 1303

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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