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(54) **SHOE WITH ELASTIC SOLE INSERT.**

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No further relevant documents have been disclosed.

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Description

The present invention relates to the field of footwear and particularly to footwear having an elastic sole insert.

BACKGROUND OF INVENTION

Sporadically over the last 100 years, there have been various attempts to fabricate shoe soles or insoles having internal springs. Early such devices are shown in U.S. Patents 413,693, 507,490, 968,120, and 1,088,324. These early patents, like the more recent counterpart, U.S. Patent 4,322,893, utilize helically wound coil springs as shock absorbing energy storage devices. A drawback with coil springs is their height relative to their diameter and their limited range. In order to minimize the collapsed height, conically wound coil springs have been utilized. The most significant problem of prior art coil springs is their limited energy storage capacity. Additionally, coil springs of conventional design are difficult to retain as their free ends cause load concentrations requiring rigid retainer plates as reinforcement structures, as shown in U.S. Patent 2,668,374. U.S. Patent, 4,267,648 (Weisz) suggests several alternatives to coil springs, such as flat disk springs and belleville washer springs. In order to maintain a low profile, a large number of small springs are utilized.

In G.B. 105409A a shoe is provided with a plate located inside the shoe and located in the area of the heel of the wearer. The plate is hinged to the shoe at its forward end and springs are trapped between the plate and the sole. The springs may be in the form of a pair of comb-like parts with interdigitated fingers, the springs being riveted to the plate and the fingers contacting the sole below the plate. Spring action in this case involves the foot moving within the envelope formed by the upper part of the shoe and may result in the foot being rubbed by the lateral of the shoe upper. In addition, the springs also rub on the inside of the sole during the spring movement.

It is known from US-A-3602490 to make a spring for a seismometer out of a circular plate with a complex pattern of cut-outs so that the spring can form the equivalent of a spirally wound wire spring and flatten to the thickness of the plate under load.

OBJECTS, FEATURES AND ADVANTAGES OF INVENTION

It is an object of the present invention to provide an elastic sole insert which is compact and provides high energy storage capability.

A feature of the present invention is that the insert has a large diameter relative to its height and presents a large load bearing surface.

An advantage of the present invention is the elastic insert is relatively easy to retain within the shoe, and has a relatively low weight and size when compared to prior art devices having comparable energy storage capacity.

These and other objects, features and advantages of the present invention will become apparent from the following specification.

SUMMARY OF THE INVENTION

According to the invention a shoe to be worn on the foot of a person comprises a generally planar sole member having an exterior and interior surface, an original height (h) and a peripheral edge; an upper member affixed to the sole periphery to generally surround the foot of the wearer; an insole conforming with the sole interior surface for cooperation with the foot; an elastic insert oriented between the sole interior surface and the insole and arranged to elastically deform along an axis generally perpendicular to the sole member, and characterised in that said insert is provided with a continuous generally planar outer ring having a cut-out region formed therein defining a leaf projecting in a free state out of the plane of the ring, said leaf elastically deflecting towards said plane and the sole member being compressed upon the exertion of a load along said axis, and the leaf returning when the sole member expands to its original height.

BRIEF DESCRIPTION OF DRAWINGS

FIGURE 1 is a plan view of an elastic insert;
FIGURE 2 is a side elevational view of the insert of Figure 1;
FIGURE 3 is a partially cut-away side elevation of a shoe with a wearer's foot shown in outline;
FIGURE 4 is a cross sectional end view taken along line 4-4 of Figure 3;
FIGURE 5 is a plan view of the outline of a shoe showing the insert orientation;
FIGURE 6 is a plan view of an alternative elastic insert design;
FIGURE 7 is a side elevation of the insert in Figure 6 in its free state;
FIGURE 8 is a side elevation of the insert shown in Figure 6 in its fully compressed state;
FIGURE 9 is a plan view of a third embodiment of the elastic insert, the side elevation in the free and compressed states being substantially equivalent to Figures 7 and 8, respectively;
FIGURE 10 is a plan view of a fourth embodiment of the elastic insert;

FIGURE 11 is a side elevation of the Figure 10 elastic insert;
 FIGURE 12 is a load versus deflection graph;
 and
 FIGURE 13 is a schematic diagram of a cantilevered beam.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, several preferred embodiments of the invention are disclosed. Figures 1-5 show a first embodiment of the elastic insert 20 shown in an athletic shoe 22. In the preferred embodiment, the elastic insert 20 consists of upper and lower elements 24 and 26 shown in Figure 4 oriented in stacked alignment along a common axis. Upper and lower elements 24 and 26 are substantially identical to one another and are centrally attached to one another using a rivet 28 or the like which acts as a fastener means for attaching the upper and lower elements together. Each of the upper and lower elements are formed of an elastically deformable material such as a spring steel sheet or the like. Each element has a continuous and generally planar outer ring 30 having a cutout region 32 formed therein which defines a leaf 34. The leaf extends inwardly from the outer ring 30 and is preferably of a spiral shape, as shown in the Figure 1 plan view. The leaf terminates in an enlarged boss 36 having a central hole 38 for receiving rivet 28.

As shown in the Figure 2 side elevation, outer ring 30 is generally planar. Leaf 34 projects out of the plane of the ring in the free state. The sheet material forming the element 26 has a thickness T, and the element has a free height H as shown. The maximum deflection is the difference between the free height H and thickness T. The elastic element may be compressed repeatedly from its free height to the totally flat position without fatigue.

Leaf 34 acts as a cantilever beam fixed at one end and loaded at the other. The leaf is affixed to the outer ring and extends inwardly therefrom. The leaf has an uniform thickness T and a varying width. The leaf width is greatest adjacent the outer ring 30, and tapers to a minimum width adjacent the central boss 36. By utilizing a spiral design, a greater beam length can be achieved. The spiral design causes the leaf to be loaded in torsion, as well as simply in sheer and bending, as would be the case in a straight beam cantileveredly affixed to a rigid body at one end. Where the elastic insert is made up of an upper and lower element as shown in Figure 4, the free height, compressed thickness, and useful range will be twice that of the single element.

Shoe 22 is made up of a sole member 40, an upper member 42 and an insole 44. Sole 40 has an exterior surface 46 and an interior surface 48. The upper member 42 is affixed to the periphery of the sole and generally surrounds the foot of the wearer in a conventional manner. Insole 44 conforms to the sole interior surface and cooperates with the foot of the shoe wearer in a typical fashion. Between the sole interior and the insole is a cavity 50 in which the elastic insert 20 is installed. As the foot of the shoe wearer exerts a load along the insert axis, leaf 34 will elastically deflect toward the plane of the outer ring. As the shoe wearer runs or jumps, the load exerted upon the insert will cause the insert to compress and expand, storing and releasing energy. In the preferred embodiment of the invention shown in Figure 4, a thin insole reinforcement 52 is provided to prevent the soft foam insole 44 from deforming into the element cutout region 32.

The elastic insert is particularly beneficial in an athletic shoe used in jumping sports, such as basketball and volleyball. The inserts are also helpful in running shoes. During a running or jumping step, the load is transmitted from the wearer's foot to the ground through the shoe sole. In a typical shoe during a jumping maneuver, the sole is compressed during initiation of the jump and expands to the original height once the shoe is separated from the ground. A typical shoe sole is relatively inelastic and is very inefficient at releasing energy during the jumping maneuver due to high hysteresis. Inserts of a present size are very elastic with relatively little hysteresis thereby releasing the maximum amount of energy during a jumping maneuver.

Preferably, each shoe is provided with two elastic inserts, as shown in Figures 3 and 5. One insert 20 located in the shoe sole adjacent the wearer's heel and the other insert 20' oriented below the ball of the wearer's foot.

Initial testing has indicated that the elastic element having a compression range of .27 inches and a spring rate of 175 pounds per inch performs satisfactorily in a shoe worn by a 160 pound person. Ideally, an insert will be selected which has the highest spring rate possible and which will still enable the insert to be fully compressed at the commencement of the muscle contraction or positive movement portion of the jumping maneuver. Too stiff of an insert will not enable the insert to be fully compressed during the muscle contraction or negative movement portion of the jump. If the spring is not fully compressed at the commencement of the muscle contraction, jumping performance can actually be hindered as a result of the inserts limiting the force which can be exerted during a portion of the muscle contraction. Too soft

of an insert will not store the maximum amount of energy, therefore limiting the beneficial effect of the insert and possibly resulting in excess of deformation during normal walking. While ideally the insert spring rate would be specifically selected for each wearer considering the wearer's weight and athletic ability, commercial shoes having permanently installed inserts can be made with regular or stiff inserts. Spring rate of the inserts would also vary as a function of shoe size.

For jumping sports it is believed that ball and heel elastic elements should have a substantially equal geometry and spring rate. It should be recognized that the heel and ball spring rates can be varied as desired depending upon the expected use of the shoe. It should also be appreciated that only a single insert may be used in certain circumstances. For example, a long-distance running shoe may utilize a heel insert only while the sprinter's shoe may utilize a ball insert only.

A second embodiment 60 of the elastic insert is shown in Figures 6-8. The insert is formed of a rectangular sheet 62 having a cutout 64 formed therein which should define a continuous outer ring 66 and a plurality of leaves 68,68',68'',68''' projecting inwardly from the outer ring 66. The insert is preferably made up of upper and lower elements 70,72 as shown in Figure 7. The outer ring 66 of each element is generally planar and parallel to the shoe sole. The element is elastically deflectable along an axis generally perpendicular to the shoe sole. The leaves of each element project out of the plane of the ring in the free state as shown in Figure 7 and cooperate with the corresponding leaf in the other element. The ends of the leaves are locally parallel to the opposing leaf, as shown.

Preferably, as in the first embodiment, the leaves of the upper and lower element are fastened together using a suitable fastener such as a rivet or the like. Also similar to the first embodiment, the elastic element has a fully compressed height equal to two times the sheet thickness T, and the leaves are generally tapered having a width greatest adjacent the outer ring.

A third embodiment of the elastic insert 76 is shown in Figure 9. The difference between insert 76 and insert 60 is web 78 which extends across the insert connecting on opposite of the element outer ring. It should be appreciated that a wide variety of leaf configurations can be constructed by cutting one or more cutouts of various shapes to suit the desired application.

A fourth embodiment of the elastic insert 80 is shown Figure 10 and 11. Preferably, insert 80 is made up of upper and lower elements in a similar fashion as the earlier embodiments described. Insert 80 is similar in appearance to insert 20 shown in Figures 1 and 2. A first and a second cutout

region 82 and 84 is formed in the elastic insert to define a generally spiral shaped leaf 86 affixed at both ends to continuous outer ring 88. The leaf has a central boss 90 and a hole 92 provided therein for attachment of a rivet or the like. The leaf is widest at the outer ring 88, and becomes narrowest at the attachment to the boss 90.

The elastic insert 80 exhibits significantly different load versus deflection characteristics than previously described elastic inserts utilizing leaves of cantilever design. Leaves of a cantilever design have a fairly linear load versus deflection curve as shown on line 94 in Figure 12. In order to increase the energy storage capacity of the elastic insert given maximum load, a non-linear load versus deflection curve is preferred and which has an initially steep slope and a very low slope high deflection. The elastic insert 80 combines the load versus deflection characteristics of the cantilevered spring shown in curve 94 with that of a dome spring or belleville washer represented by curve 96 to achieve the load versus deflection curve represented by line 98.

Figure 13 shows a schematic representation of a cantilevered beam affixed at one end and load at the other. Beam 100 has a length l. When force F is exerted on the free end of the beam, the free end deflects a distance d. Deflection in the classical cantilevered beam shown in Figure 13, is expressed by the following equation:

$$d = Fl^3/3EI$$

Where E is equal to the modulus elasticity and I is the beam moment of inertia. Force F is exerted on the end of the beam causes an equal and opposite reaction force F_R at the wall attachment. Force F also causes a bending moment M_0 to be exerted at the wall attachment, where M_0 equals Fl . While the sheer load on the beam is uniform throughout its length, the moment varies directly proportional to the length. At the wall, bending moment is maximum, at the free end of the bending moment is zero with a linear progression therebetween. The bending load exerted on the beam will therefore be greatest adjacent the affixed attachment, and the minimum at the free end.

In order to prevent stress concentration, and to minimize the weight of the insert, in the various preferred embodiments, the leaves are generally tapered, being widest adjacent the outer ring, and narrowest adjacent the loading point. This tapered leaf design results in a substantially uniform stress distribution. Beam 68 in insert 60 shown in Figure 6 acts like a classical cantilever beam as shown in Figure 13, with the exception that its width and moment of inertia varies as a function of length. The beam is loaded in both the bending and sheer

modes. The spiral leaf design incorporated in insert 26 is also loaded in torsion. The relative magnitude of the bending in the torsional load varies throughout the beam length as a function of geometry. In the embodiment of the insert shown in Figure 1, over two-thirds of the energy is stored in the spring as a result of torsional deformation. In insert 80, in addition to shear bending and torsion, the beam is also loaded in axial compression.

As a result of forming the insert from a sheet of material having a uniform thickness, the leaf will have a generally rectangular cross-sectional area having a width substantially greater than its thickness. The rectangle shape enables the polar moment inertia of the leaf cross-section to be maximized to better resist torsion in the spiral insert designs shown in Figures 1 and 10.

The elastic inserts in the preferred embodiment can be fabricated of high quality spring steel, such as SAE 9254, SAE 1074 or equivalent, but it should be appreciated that other materials could be used. Common spring materials and their properties are listed in Mark's Standard Handbook for Mechanical Engineering, 8th Edition, pages 8-78, which is incorporated by reference herein. Other material, such as titanium sheet or molded fiber reinforced composites, could also be used in applications where weight is critical.

In order to manufacture an elastic insert, flat plate stock, such as spring steel stock having the appropriate thickness is selected. While the steel is in the annealed state, it is cut to the desired plan view using a milling or stamping operation. Preferably, the insert is de-burred to remove sharp corners. The leaf is then plastically deformed out of the plane of the outer ring to achieve the desired free height. The elastic insert element is then heat treated using a conventional quenching techniques to harden the spring. In the preferred embodiment where the elastic insert is made up of a pair of elements, the two elements are axially aligned with their leaves engaging one another and fastened together using a rivet or the like.

It is also understood, of course, that while the form of the invention herein shown and described constitutes a preferred embodiment of the invention, it is not intended to illustrate all possible forms thereof. It will also be understood that the words used are words of description rather than limitation, and that various changes may be made without departing from the scope of the invention disclosed.

Claims

1. A shoe to be worn on the foot of a person, comprising a generally planar sole member (40) having an exterior and interior surface (46,

resp. 48), an original height (h) and a peripheral edge; an upper member (42) affixed to the sole periphery to generally surround the foot of the wearer; an insole (44) conforming with the sole interior surface (48) for cooperation with the foot; and an elastic insert (20) oriented between the sole interior surface and the insole and arranged to elastically deform along an axis generally perpendicular to the sole member, characterised in that said insert (20) is provided with a continuous generally planar outer ring (30) having a cut-out region (32) formed therein defining a leaf (34) projecting in a free state out of the plane of the ring, said leaf elastically deflecting toward said ring plane and the sole member (40) being compressed upon the exertion of a load along said insert axis and the leaf returning when the sole member expands to its original height (h).

2. The shoe of Claim 1 wherein said elastic insert further comprises an upper (24) and lower (26) element oriented in stacked alignment along said axis, each element provided with said continuous generally planar outer ring (30) having a cut-out region formed therein defining said leaf (34) projecting out of the plane of the respective ring in the free state, said leaves projecting toward and cooperating with one another.
3. The shoe of Claim 2 wherein the insert further comprises fastener means (38) for attaching the leaves of the upper and lower elements together.
4. The shoe of Claim 2 or Claim 3 wherein said outer ring is substantially circular.
5. The shoe of any of Claims 1-4 wherein said insert leaf is substantially spiral in shape.
6. The shoe of any preceding claim, comprising two elastic inserts, namely a ball insert to generally underly the ball of the foot of the wearer, and a heel insert to generally underly the heel of the foot of the wearer.
7. A shoe as claimed in Claim 1 or Claim 2 wherein the said insert comprises a continuous outer ring (66) and a plurality of leaves (68,68') projecting inwardly of said ring and each leaf, counting along one dimension of the insert, extends in the opposite direction transversely of that dimension to the adjacent leaf or leaves.

8. A shoe as claimed in any of Claims 1 - 6 wherein the or each insert element comprises a continuous outer ring (88) and a pair of cut-out regions (82, 84) to define a spiral leaf.

Patentansprüche

1. Ein am Fuß einer Person zu tragender Schuh, enthaltend ein im wesentlichen ebenes Sohlenteil (40) mit einer äußeren und einer inneren Oberfläche (46 bzw. 48), einer ursprünglichen Höhe (h) und einer Umfangskante; einen oberen Abschnitt (24), der am Sohlenumfang befestigt ist und im wesentlichen den Fuß des Trägers umgibt; eine Innensohle (44), die mit der inneren Oberfläche (48) der Sohle zum Zusammenwirken mit dem Fuß zusammenpaßt; und einem elastischen Einsatz (20), der zwischen der inneren Oberfläche der Sohle und der Innensohle ausgerichtet und so angeordnet ist, daß er sich längs einer im wesentlichen rechtwinklig zum Sohlenteil verlaufenden Achse elastisch verformt, dadurch gekennzeichnet, daß der Einsatz (20) mit einem durchgehenden, im wesentlichen ebenen äußeren Ring (30) versehen ist, in dem ein ausgeschnittener Bereich (32) ausgebildet ist, der die Form eines Blattes (34) bestimmt, das frei aus der Ebene des Rings herausragt, wobei sich das Blatt unter der Einwirkung einer Last elastisch zur Ringebene hin verbiegt und das Sohlenteil (40) längs der Einsatzachse komprimiert wird, und wobei das Blatt sich wieder zurückbiegt, wenn das Sohlenteil seine ursprüngliche Höhe (h) wieder erreicht.
2. Schuh nach Anspruch 1, wobei der elastische Einsatz weiterhin ein oberes (24) und ein unteres (26) Element enthält, die in Achsrichtung übereinander ausgerichtet sind, wobei jedes Element mit dem durchgehenden, im wesentlichen ebenen äußeren Ring (30) versehen ist, in dem der ausgeschnittene Bereich ausgebildet ist, der die Form des Blattes (34) bestimmt, das aus der Ebene des betreffenden Rings frei herausragt, wobei die Blätter in Richtung aufeinander hervorstehen und miteinander zusammenwirken.
3. Schuh nach Anspruch 2, wobei der Einsatz weiterhin eine Befestigungseinrichtung (38) zur Befestigung der Blätter des oberen und des unteren Elements aneinander enthält.
4. Schuh nach Anspruch 2 oder 3, wobei der äußere Ring im wesentlichen kreisförmig ist.

5. Schuh nach einem der Ansprüche 1 bis 4, wobei das Einsatzblatt im wesentlichen spiralförmig ist.
- 5 6. Schuh nach einem der vorangegangenen Ansprüche, enthaltend zwei elastische Einsätze, insbesondere einen Balleneinsatz, der im wesentlichen unter dem Fußballen des Schuhträgers liegt, und einen Ferseneinsatz, der im wesentlichen unter der Ferse des Schuhträgers liegt.
- 10 7. Schuh nach Anspruch 1 oder 2, wobei der Einsatz einen durchlaufenden Ring (66) und eine Mehrzahl von Blättern (68, 68') enthält, die innerhalb des Rings vorstehen, und wobei sich jedes Blatt, gerechnet längs einer Dimension des Einsatzes, in der entgegengesetzten Richtung quer zu dieser Dimension zum angrenzenden Blatt bzw. den angrenzenden Blättern erstreckt.
- 15 8. Schuh nach einem der Ansprüche 1 bis 6, wobei das eine bzw. jedes vorhandene Einsatzelement einen durchlaufenden äußeren Ring (88) und ein Paar von ausgeschnittenen Bereichen (82, 84) enthält, die die Form des Spiralblatts bestimmen.
- 20 25 30

Revendications

1. Chaussure destinée à être portée au pied d'une personne, comprenant un élément de semelle généralement plan (40) qui comporte une surface intérieure et une surface extérieure (46, 48 resp.), une hauteur d'origine (h) et un bord périphérique ; un élément supérieur (42) fixé à la périphérie de la semelle pour entourer de façon générale le pied du porteur de la chaussure ; une semelle intérieure (44) épousant la surface intérieure (48) de la semelle pour coopérer avec le pied ; et une insertion élastique (20) orientée entre la surface intérieure de la semelle et la semelle intérieure et conçue pour se déformer élastiquement le long d'un axe généralement perpendiculaire à l'élément de semelle, caractérisée en ce que la dite insertion (20) est pourvue d'un anneau extérieur (30) continu et de forme générale plane dans lequel est formée une région découpée (32) qui définit une lame (34) faisant saillie, dans son état libre, hors du plan de l'anneau, la dite lame fléchissant élastiquement vers le dit plan de l'anneau et l'élément de semelle (40) étant comprimé lorsqu'une force s'exerce dans la direction du dit axe de l'insertion, et la lame retournant à son état initial quand l'élément de semelle reprend sa hauteur

d'origine (h).

2. Chaussure selon la revendication 1, dans laquelle la dite insertion élastique comprend de plus un élément supérieur (24) et un élément inférieur (26) orientés selon un alignement d'empilage dans la direction du dit axe, chaque élément étant pourvu du dit anneau extérieur continu (30) de forme générale plane et présentant une région découpée qui définit la dite lame (34) faisant saillie hors du plan de l'anneau respectif dans son état libre, les dites lames faisant saillie l'une vers l'autre et coopérant ensemble.

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3. Chaussure selon la revendication 2, dans laquelle l'insertion comprend de plus des moyens de fixation (38) pour solidariser ensemble les lames des éléments supérieur et inférieur.

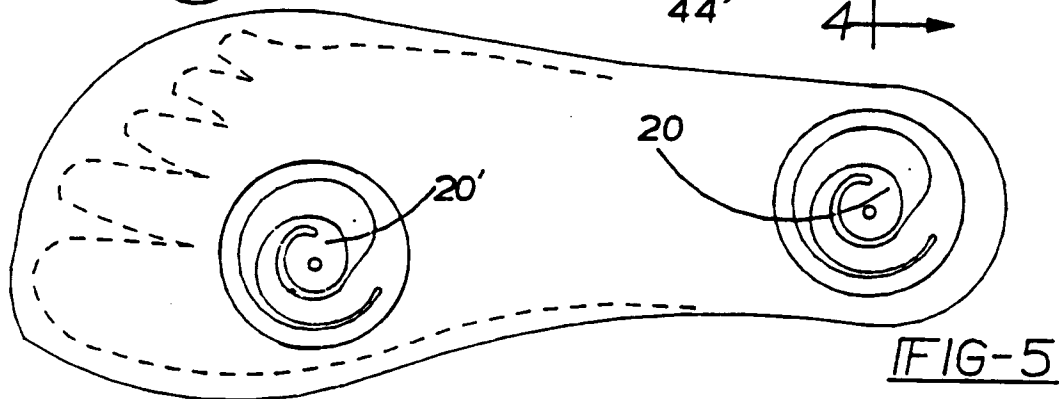
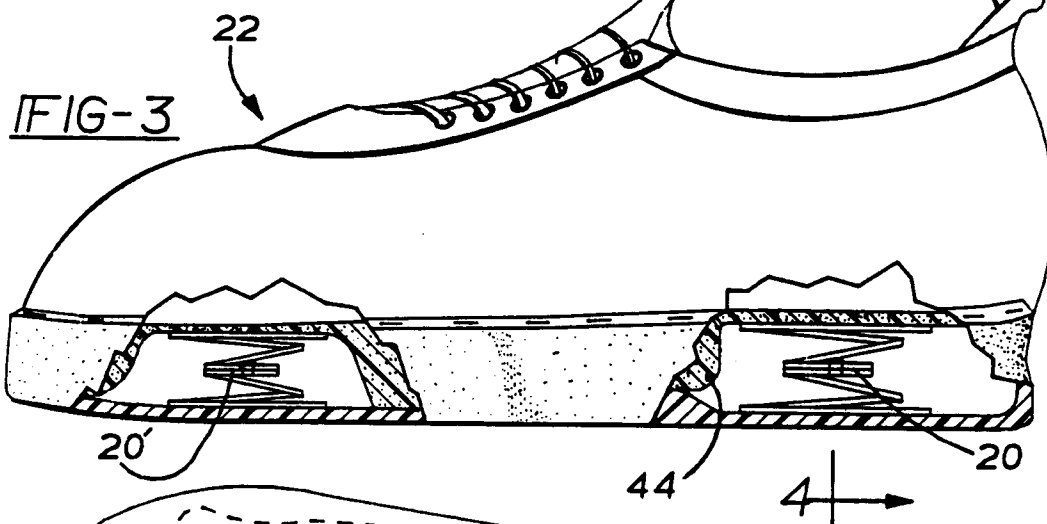
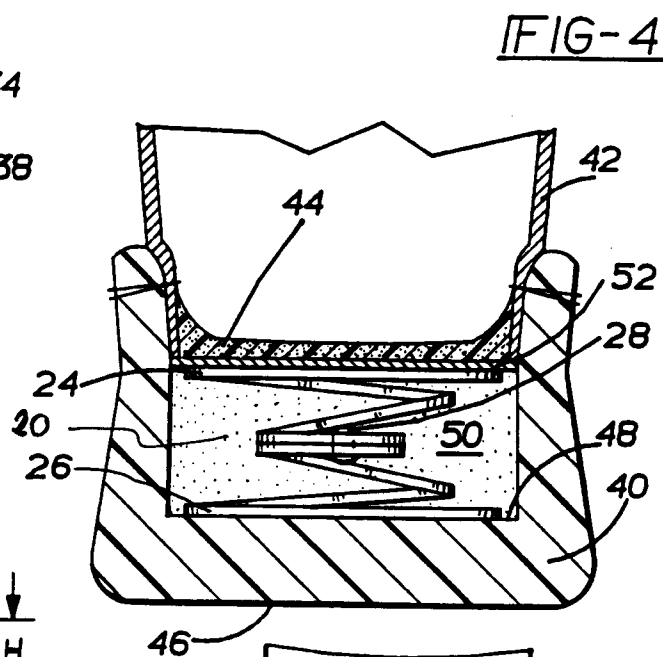
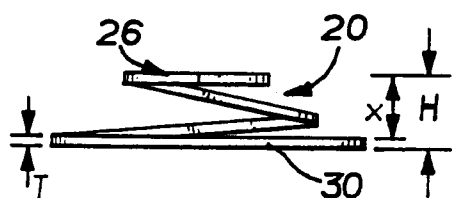
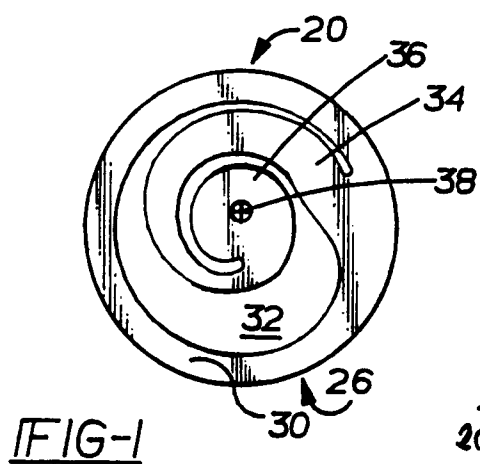
20
4. Chaussure selon la revendication 2 ou 3, dans laquelle le dit anneau extérieur est pratiquement circulaire.

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5. Chaussure selon l'une quelconque des revendications 1-4, dans laquelle la dite lame formant insertion a pratiquement une forme en spirale.
6. Chaussure selon l'une quelconque des revendications précédentes, comprenant deux insertions élastiques, c'est-à-dire une insertion de demi-pointe pour venir de façon générale sous l'éminence métatarsienne du porteur de la chaussure et une insertion de talon qui est placée de façon générale sous le talon du pied du porteur.

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7. Chaussure selon la revendication 1 ou la revendication 2, dans laquelle la dite insertion comprend un anneau extérieur continu (66) et plusieurs lames (68,68') qui font saillie vers l'intérieur du dit anneau et chaque lame, en comptant le long d'une dimension de l'insertion, s'étend dans la direction opposée transversalement à cette dimension, vers la ou les lames adjacentes.

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8. Chaussure selon l'une quelconque des revendications 1-6, dans laquelle l'élément d'insertion, ou chaque élément d'insertion, comprend un anneau extérieur continu (88) et deux régions découpées (82,84) pour définir une lame en spirale.

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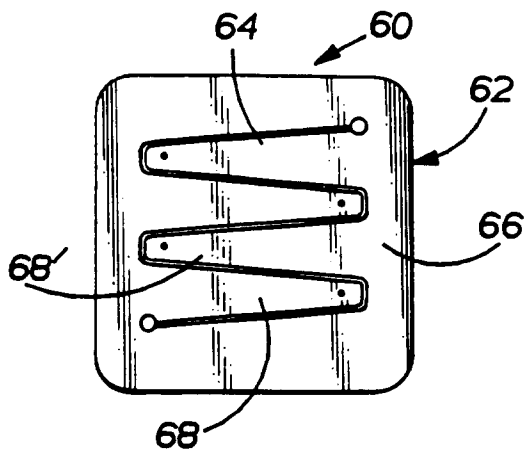


FIG-6

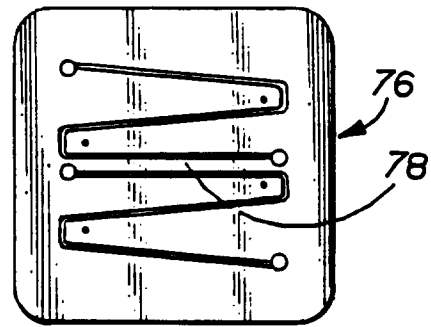


FIG-9

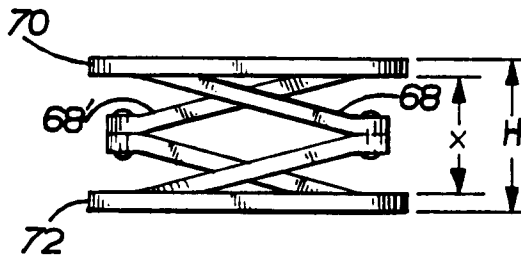


FIG-7



FIG-8

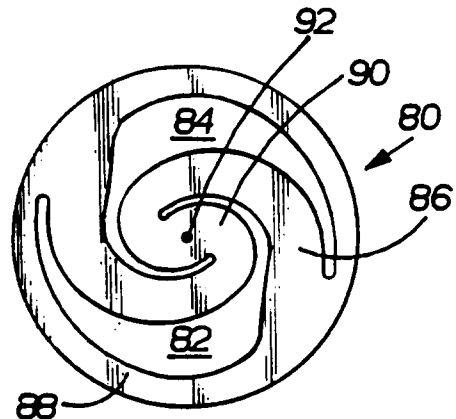


FIG-10

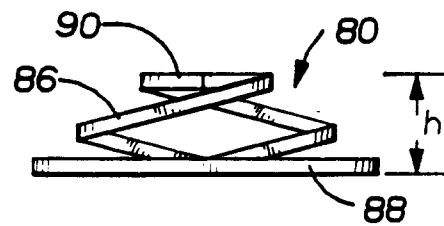


FIG-11

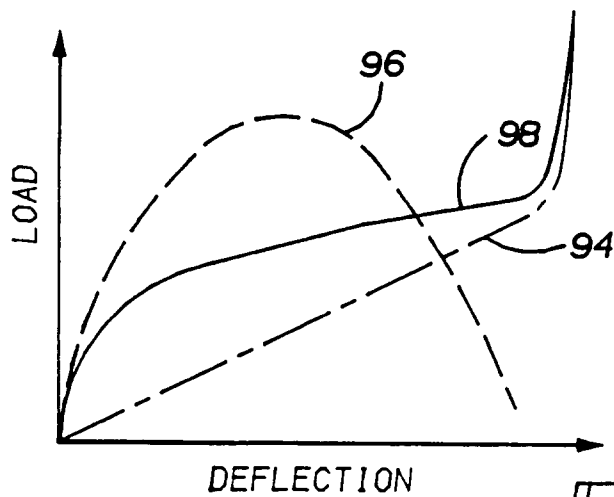


FIG-12

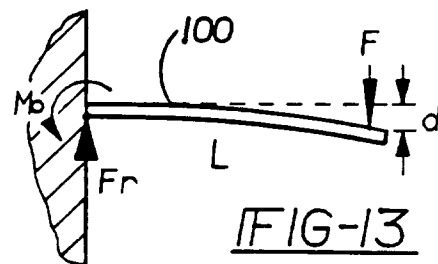


FIG-13