

Dec. 23, 1969

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3,484,871

ARTIFICIAL FOOT

Filed Dec. 2, 1968

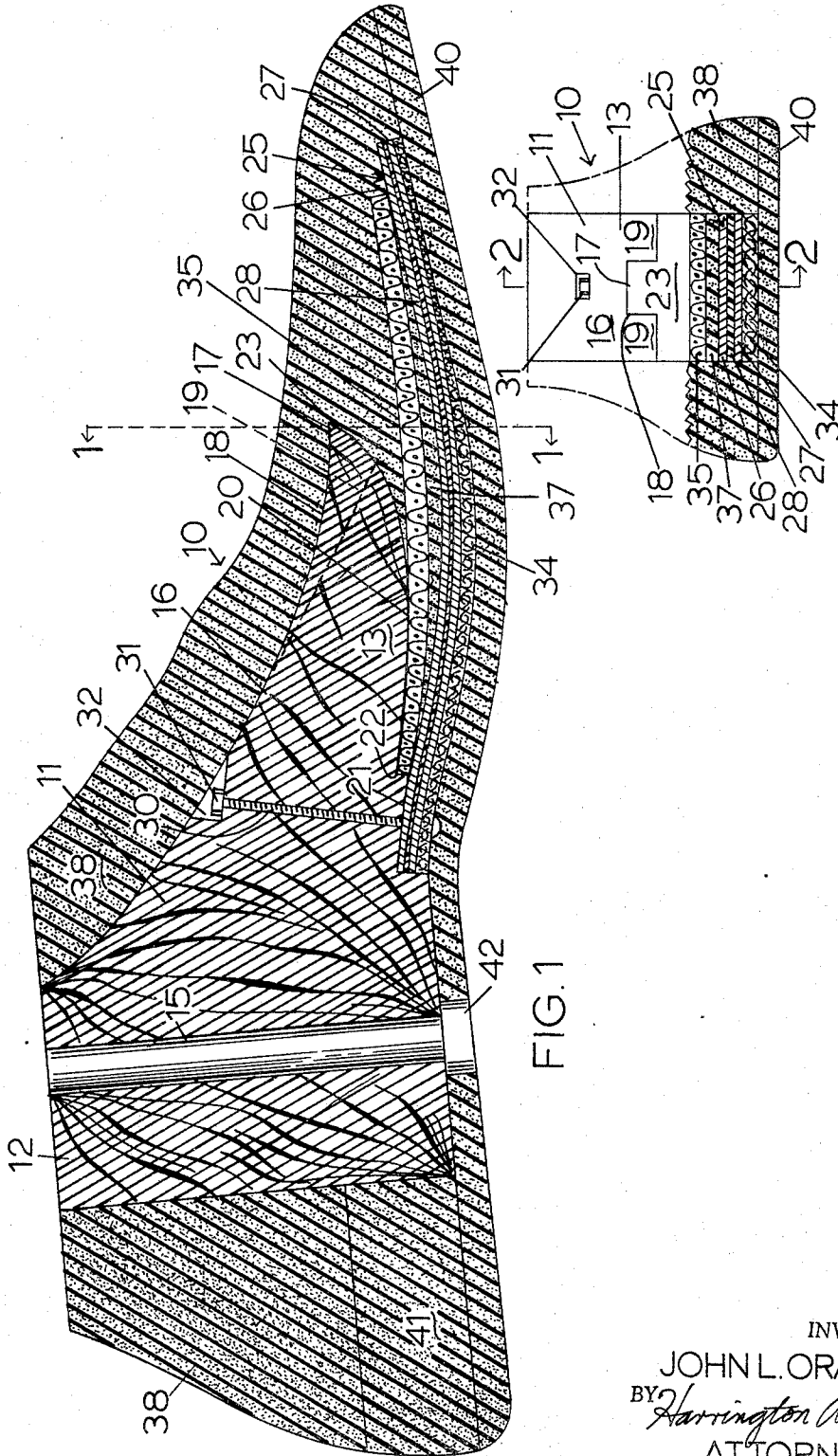


FIG. 1

FIG. 2

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ARTIFICIAL FOOT

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Filed Dec. 2, 1968, Ser. No. 780,344

Int. Cl. A61f 1/08

U.S. Cl. 3-7

1 Claim

ABSTRACT OF THE DISCLOSURE

An artificial foot including an inelastic core occupying substantially the full height of the middle portion of the foot and a flat, elastic leaf spring projecting forward from the core and adapted to flex relative to the core under the weight of the wearer when walking, the core and the spring being completely covered with a resilient material, such as rubber.

BACKGROUND OF THE INVENTION

This invention relates to an artificial foot, and more particularly to an artificial foot adapted to be fixed to a prosthetic ankle element.

Although various types of artificial or prosthetic feet have been used for years, perhaps the most typical artificial foot now in current use is a SACH (Solid-Ankle-Cushion Heel) type foot, such as that described and disclosed in U.S. Patent No. 3,098,239, issued to Nader on July 23, 1963. This foot includes an inelastic keel made of wood, completely covered by a rubber upper portion, a wedge-shaped heel portion beneath the keel, and a sole. Fixed to the wood keel is a flexible belting material which extends forward of the keel within the rubber upper portion.

The SACH type of artificial foot has been found to be too flexible, and without sufficient elasticity. Thus, the wearer of such an artificial foot has experienced in walking an undue collapse of his leg or foot when his weight moves forward over the bottom or landing of his trailing foot and is concentrated upon the front portion of the foot forward of the foot ball.

Not only is the material in the forward portion of a SACH foot too flexible and inelastic, but there is no stop means to limit the upward movement of the front portion of the foot except the inherent elastic qualities of the rubber and the belting.

SUMMARY OF THE INVENTION

It is, therefore, an object of this invention to provide an artificial foot which will overcome the above enumerated disadvantages of the typical SACH artificial foot.

The artificial foot made in accordance with this invention includes an inelastic, preferably wood, core having a main or rear portion adapted to extend substantially the full height of the middle portion of the foot and is adapted to be fixed to a prosthetic ankle segment. The top and bottom surfaces of the front portion of the core converge forward, and the bottom surface curves convexly upward to a front extremity in substantially vertical alignment with the ball of the foot.

This artificial foot also includes an elongated, flat, elastic leaf spring, preferably of metal, of a sufficient gauge and strength that it adequately supports the weight of the wearer when properly assembled with the core in the foot throughout the entire walking cycle of the wearer. The rear end of the leaf spring is fixed flush against the bottom of the core so that the leaf spring projects forward, beneath and beyond the front extremity of the core. The relationship of the spring and the core is such that when the weight of the wearer moves forward across the ball of the foot, the rubber covering portions of the foot as well as the leaf spring, flex around the curved front

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bottom surface of the core, which acts as a limit to the flexing movement of the leaf spring. As the full weight of the wearer is borne by the front portion of the trailing foot, the strength of the spring, and also the strength of the front portion of the wooden core is sufficient to sustain the wearer in his normal walking operation without yielding or collapse. After the trailing foot is lifted, the front and toe portions of the foot are restored to their original inoperative position, by the unflexing of the elastic spring.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an enlarged side sectional elevation taken along the line 2-2 of FIG. 2, of an artificial foot made in accordance with this invention, and its inoperative position; and

FIG. 2 is a reduced section taken along the line 1-1 of FIG. 1, with the upper portions of the upper foot cover broken away, but outlined in phantom.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in more detail, the artificial foot 10 includes a solid, inelastic core 11, preferably made of wood, having a rear or main portion 12 and a front portion 13. The core 11, including the unitary rear portion 12 and the front portion 13, is of substantially uniform width slightly less than the overall width of the foot 10, as shown in FIG. 2.

The main core portion 12 extends substantially the full height of the middle portion of the foot 10 and is provided with a vertical bore 15 therethrough for receiving securing means, such as an elongated bolt, to fixedly secure the core 11 and thereby the foot 10, rigidly to a prosthetic ankle element, now shown.

The front core portion 13 has a top surface 16 which slopes forward and downward to conform to the general contour of the corresponding upper portion of the foot 10. The top surface 16 terminates in a front edge or extremity 17, which is in substantial vertical alignment with the ball of the foot.

The top surface 16, adjacent the front extremity 17, is relieved on both sides to form a middle tongue member 18 and a pair of depressed areas 19 on opposite sides of the tongue member 18.

The bottom surface 20 of the front core portion 13 projects forward and converges into the front extremity 17. The rear portion of the bottom surface 20 comprises an upwardly off-set flat spring seat 21. That is, the seat 21 is off-set upwardly from the bottom surface of the rear or main core portion 12. The main, or middle, portion of the bottom surface 20 may also be off-set upwardly from the seat 21 at 22, for a purpose to be described later. The front portion of the bottom surface 20 curves in a convex arch 23, forward and upward to merge into the front edge or extremity 17.

Fixed at its rear end portion, flush against the spring seat 21, is a flat, elastic, leaf spring 25, including a pair of spring plates 26 and 27 of uniform gauge, width and length, and arranged in a laminar form. If desired, the plates 26 and 27 may have interposed therebetween a flexible liner fabric, such as a "Teflon" liner 28. The spring 25 may be secured to the spring seat 21 by any convenient means, such as an elongated bolt 30, extending upward through a corresponding opening in the core 11. The upper end of the bolt 30 may be threaded to receive in locking engagement a nut 31, seated within a nut recess 32 in the top surface 16.

The seating arrangement of the rear end portion of the spring 25 is such that the spring 25 projects forward substantially along, below and in the same direction as the bottom surface 20 of the front core portion 13. The front

end of the spring 25 terminates in a position short of the toe of the foot 10, but substantially forward and below the front extremity 17 of the core 11. The strength and gauge of the spring plates 26 and 27 are such that when the foot 10 is flexed, such as when the weight of the wearer shifts forward over the ball of the foot in walking, spring 25 will flex about the ball of the foot and will curve toward the core arch 23. The location and configuration of the core arch 23 is such that it will provide a limit to the upward flexing of the spring 25.

The strength and gauge of the spring 25 is also such that it will withstand numerous flexures, and maintain its elastic properties to restore the toe of the foot 10 to its original position, as disclosed in FIG. 1, after each walking step when the weight of the wearer is released from the foot 10. Furthermore, the strength of the spring 25, as well as its cooperation with the core arch 23, is such that the toe portion of the foot 10 will not bend excessively and give way causing the knee of the wearer to "buckle."

If desired, a lower protective webbing member 34, such as nylon webbing, of the same length and width of the lower spring plate 27, may be fitted flush against the lower spring plate 27 to reduce wear between the spring plate 27 and sole 40.

In a similar manner, an upper webbing member 35 of the same width as the upper plate 26 may be placed flush against the top surface of the plate 26 to assist in protecting the surface of the spring plate 26. The webbing members 34 and 35 may also assist in reinforcing the spring plates 26 and 27.

As disclosed in FIG. 1, the upper webbing member 35 is not as long as the upper plate 26, so that its rear end abuts against the rear wall 22 of the recessed portion of the bottom core surface 20. In this manner, the top surface of the upper spring plate 26 may set flush against the spring seat 21 so that there will be a more rigid connection between the rear portion of the spring 25 and the core 11. The sole purpose of the notched portion 22 is to provide a recess for the upper webbing member 35.

It is also an important feature of this invention to locate a soft resilient pad 37, such as a pad of soft rubber, between the spring 25 and the bottom core surface 20, including the arch 23. The pad 37 provides a cushion between the core 11 and the leaf spring 25 to absorb the shock between these two members during the flexure of the foot 10. In the particular disclosure of FIG. 1, the soft rubber pad 37 is located between the upper plate 27 and the upper webbing member 35, not only to hold the rubber pad 37 in place, but also to provide a protective cover for the soft rubber pad 37 against wear against the arch 23.

The remainder of the foot 10 includes a resilient cover portion 38, preferably of hard rubber, which completely surrounds the top, rear and side portions of the core 11, as well as the top, front and side portions of the spring 25 and webbing members 34 and 35. The bottom of the foot 10 is covered by a hard rubber sole 40, which is fitted flush against the bottom surface of the main or rear core portion 12, and against the bottom surface of the lower webbing member 34.

A soft, resilient rubber heel cushion 41, disclosed in FIG. 1, may be located at the lower portion of the heel portion of the foot 10 and abutting the top of the sole 40. Whether the soft heel cushion 41 is used or not, the heel portion must be behind the core 11 and must not extend beneath the core 11. Otherwise, the foot 10 does not have sufficient rigidity. The softness and the location of the heel portion 41 provide sufficient resilience to absorb the shock of walking.

The hard rubber foot cover portion 38, as well as the sole 40, define the exterior shape of the foot, and are more or less conventional in prosthetic footwear. The relieved or depressed areas 19 in the front core portion 11

prevent the cover portion 38 from being too thin as the cover portion 38 arches across the top of the core portion 11.

FIG. 1 discloses the foot 10 in its normal, inoperative, or standing position, where the weight of the wearer extends vertically through his legs, and all of the weight through one leg is substantially supported by the main portion 12 of the core 11. When the foot 10 acts as the trailing foot in the walking cycle, the weight of the wearer is transmitted gradually forward along the front core portion 13, so that the heel portion of the foot 10, including the rear core portion 12, is raised and the core 11 rocks upon the arch 23 bearing down upon the upper web member 35, soft rubber pad 37, spring 25 and the ball portion of sole 40. As the core 11 is raised, the rear portion of the spring 25 is carried with it causing the flat spring 25 to flex in the ball area of the foot. Spring plates 26 and 27 are strong enough and have sufficient elastic properties to prevent excessive bending even under the weight of a heavy wearer, and yet will permit a normal foot action. The spring 25 is also reinforced by the curved arch 23 of the core which also provides a limit to the flexing movement of the front toe portion of the foot 10, so that the foot 10 will not give way and cause the leg of the wearer to "buckle."

As the weight of the walker moves over the ball area of the trailing foot, the trailing knee is substantially in vertical alignment with the ball area, and the heel of the leading foot engages the ground to begin receiving the weight of the walker. The location of the front extremity 17 of the front core portion 13 over or slightly in front of the ball area of the foot therefore becomes important to prevent the knee from "buckling" and to prevent the leaf spring 25 from breaking.

As the trailing foot 10 is lifted, the elastic properties of the spring plate 26 and 27 will thrust or project the trailing foot, and thus the walker, forward, and will also restore the entire foot to its original position disclosed in FIG. 1.

When the foot 10 becomes the leading foot, the shock of the heel in hitting the ground is absorbed by the heel portion 41, but excessive yielding is prevented by the wood core portion 12 occupying substantially the full height of the middle portion of the foot 10.

In a preferred form of the invention, two leaf spring plates 26 and 27, each having a uniform gauge of .035, are preferably employed in the foot 10. The use of two plates instead of a single thicker plate provides more elasticity in the spring member 25.

A model of the foot 10 has actually been used and found to be more comfortable and to give better support, foot action, and walking impetus than artificial feet which merely have strips of webbing or belting fixed to the wood core or keel.

What is claimed is:

1. An artificial foot comprising:

- (a) an inelastic core having a main portion and a front portion,
- (b) said main portion extending substantially the full height of said foot and having a substantially vertical rear face,
- (c) a vertical bore extending through the full height of said main core portion to receive an elongated securing means for securing the foot to a prosthetic ankle segment,
- (d) said front core portion having top and bottom surfaces converging to a front extremity above the ball of the foot,
- (e) the front converging portion of said bottom surface comprising an arch curving convexly upward into said front extremity,
- (f) the rear portion of said bottom surface comprising an elongated flat seat,
- (g) an elongated, flat, metal, leaf spring having a front end and a rear end, and of sufficient strength and

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elasticity to flex a predetermined distance under the weight of the wearer of the foot when walking, and to be restored to its original position when the weight is relieved,

- (h) securing means fixing said rear end flush against said flat seat, so that said leaf spring projects forward below said bottom surface, and said front end of said spring is spaced forward of said front extremity, 5
- (i) a soft, resilient pad mounted on top of said leaf spring, spanning the width of said leaf spring, and extending substantially from said seat forward substantially beyond said front core extremity to a position adjacent said front end of said leaf spring, 10
- (j) a flexible webbing member mounted upon said resilient pad, said webbing member having a rear end fixed to said bottom core surface in front of said seat, and being substantially coextensive in width and length with said pad, 15
- (k) an upper foot portion of resilient material substantially harder than said pad, covering the front, rear and sides of said core, and the front and side portions of said leaf spring, pad and webbing mem- 20

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ber, some of said foot portion lying between said arch and the top of said webbing member, and
(l) a sole member of resilient material of the same hardness as said upper foot portion covering the bottoms of said core and said leaf spring.

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