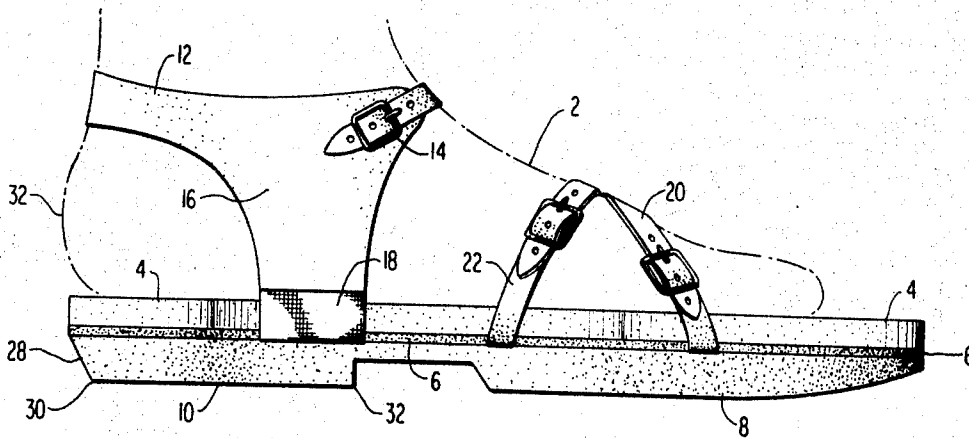


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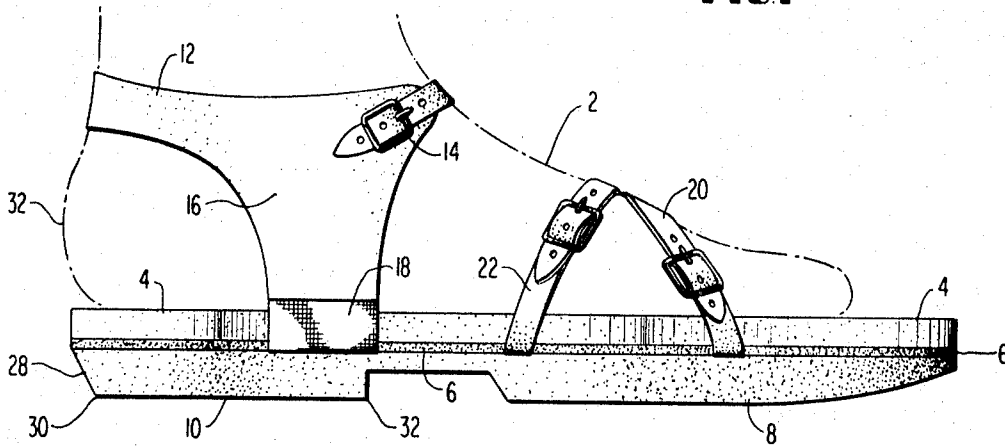
FIG. 1

FIG. 2

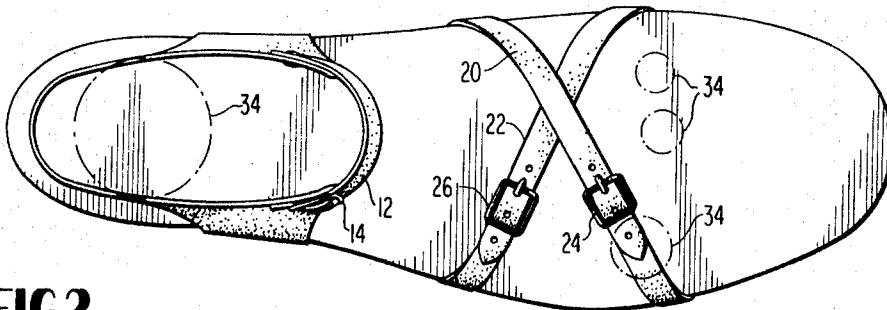


FIG. 3

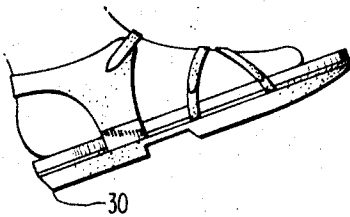


FIG.4

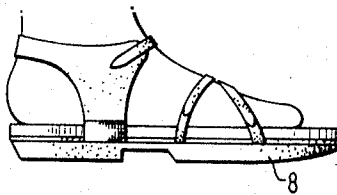
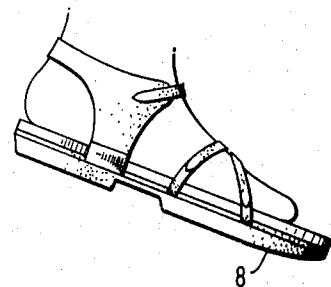


FIG.5



FOOTWEAR ARTICLE AND METHOD FOR FACILITATING WALKING

This invention is related to the structure and use of an article of footwear primarily intended for rheumatoid arthritic patients and others who have extreme difficulty in walking as a result of deformities or sensitivity which renders the foot incapable of functioning in a normal manner.

Normal walking involves a gait having two principal phases, a swing phase when the foot is moving forwardly and is not supported by the ground surface, and a stance phase during which the foot is supported by the ground surface. The stance phase may be further subdivided into the heel strike portion when the heel of the foot or shoe initially contacts the ground surface, a foot flat portion during which the weight is shared by the heel and the forefoot and the push-off or toe-off portion during which the weight and pressure are borne by the forefoot and the foot pushes rearwardly to provide the forward thrust of the body. Throughout the stance phase, the foot is constantly undergoing a change in orientation, with a general rocking motion producing the transition from the heel strike portion to the foot flat portion, and then from the foot flat portion to the push-off portion.

For various reasons, many medical patients are unable to walk in a normal fashion, due to deformities of the foot, paralysis or extreme sensitivity of the forces created during a normal gait. Patients having rheumatoid arthritis, leprosy and severe diabetes are illustrative. For example, arthritic patients have painful prominent callosities on the sole of the foot, deformities which create a functionally short foot and sensitivities which prevent the normal exertion of pressure by the toes. This requires such patients to perform the push-off portion of gait with the ball of the foot. This invention is intended to permit such persons to walk and/or to reduce the degree of pain required to walk. A number of features of the present invention contribute to its performance.

According to one feature of the invention, a rigid and unbendable platform for the foot is provided on its upper surface with a padding material which minimizes concentrations of pressure and deforms under the pressure of the foot to provide a foot-surrounding ridge to prevent shifting of the foot during walking.

The invention is also intended to promote proper functioning of the forefoot mechanics of some patients, by avoiding any lateral constriction of the midtarsal area and permitting the heel to lift off the platform padding during the transition from foot flat to push-off portion of gait. This latter feature permits many patients to use the proper metatarsal motion since the heel must rise to cause the heads of the metatarsals to come in proper sequence and shift the pressure profile from lateral to medial. Means are also provided for biasing the heel portion of the wearer's foot against the padding on the platform, which is particularly important with patients who are unable to exert downward pressure with their toes to restore the heel into contact with the padding.

Another feature involves a novel combination of known sole and heel structures. The sole tread surface is inclined forwardly and upwardly to permit a patient to roll toward the push-off, thereby reducing the extent of shearing forces between the foot and the article of

footwear. The rearwardmost portion of the heel is forwardly displaced from its usual position in order to reduce impact loading of the forefoot during the transition from the heel strike to the foot flat portion gait.

According to the disclosed embodiment of the invention, the patient is also permitted to stand still with ease since the tread surface is constructed to assume a stable non-rocking orientation at the foot flat portion of gait, unlike some prior devices which have had arcuate surfaces extending continuously throughout the length of the heel and sole area.

The preferred embodiment of the invention also minimizes discomfort on the upper surface of the foot during the swing phase of gait when the article of footwear is supported by the foot. This advantage is realized by placing the forefoot-retaining strap immediately behind the extremely pressure-sensitive points at the base of the great toe and the base of the fifth toe. This feature is particularly important in footwear designed for patients whose feet are extremely sensitive to pain.

For a more complete understanding of the invention, a preferred embodiment is shown in the accompanying drawings wherein

FIG. 1 is a side elevation thereof, showing the position of a foot supported on the device;

FIG. 2 is a plan view of the device which also illustrates the principal areas of pressure of a typical arthritic patient; and,

FIGS. 3-5 illustrate the device of this invention at the three principal portions of the stance phase of gait.

Referring to FIG. 1, it will be seen that the foot of a patient is at the location shown in broken lines at 2 where it rests on a layer of padding material 4 located on the upper surface of a rigid platform core 6. The areas of maximum pressure of one arthritic patient's foot are designated by the broken lines 34. On the undersurface of the platform core 6 is the bottom of the sandal which is preferably made of cushion crepe and provides a tread surface having a sole portion 8 and a heel portion 10. Various materials may be used in the manufacture of the components of the device, but it is important that its overall structure be substantially unbendable.

The wearer's heel is retained on the device by means of a loop 12 which has a buckle 14. The loop 12 encircles the foot above the instep, in the vicinity of the ankle. A strap 16 having an elastic or gore portion 18 connects the loop 12 with the platform so that the elastic 18 biases the wearer's heel against the padding material 4 of the platform. The biasing force is insufficient to hold the heel in contact with the padding material 4 during the latter portions of the stance phase of gait. The heel is permitted to lift off the padding material by at least about one-half inch as the elastic 18 extends, thereby permitting normal functioning of the forefoot mechanics in the midtarsal and metatarsal regions. An optimum distance of lift-off is about three-quarters of an inch. The amount of force exerted by the elastic may be adjusted to some degree by changing the size of the loop 12, thereby changing its elevation and the amount of tension in the elastic 18.

The forefoot is held against the padding 4 of the platform by means such as the straps 20 and 22 which have buckles 24 and 26. With some patients who have unusually sensitive feet, it is important that the straps 20 and 22 be located rearwardly of the extremely pressure-sensitive portions of the forefoot, specifically the

base of the great toe and the base of the fifth toe. Furthermore, it is important that the straps 20 and 22 are spaced transversely of the foot so they do not laterally constrict the foot to interfere with the normal distribution of weight and pressure in the midtarsal region.

The particular materials used for making products according to the invention are not critical. The padding 4 may be conventional foam rubber, a thermolabile polyethylene foam material used in orthopedics and sold under the trademark Plastazote or generic polyethylene foam preferably providing a durometer reading of about 57-61 Shore. This latter material is particularly desirable since, after a few weeks, it will bottom-out to conform to the foot of the wearer so that the foot will be surrounded by a ridge of padding which will prevent shifting of the foot on the upper surface of the sandal. In this condition, the padding does not act as a resilient cushion, but serves to avoid pressure concentrations by conforming to the sole of the foot.

As will be seen in FIG. 1, the heel has a downwardly and forwardly inclined rear surface 28 which serves, in a previously-known matter, to locate the entirety of the sandal heel and its rearwardmost ground-contacting edge 30 of the heel at least one-eighth to one-quarter inch forward of the anatomical rear edge 32 of the wearer's foot. This serves to shorten the steps of the patient, locate the impact-receiving point of the heel closer to the center of the pressure-sustaining area of the wearer's heel and to shorten the heel lever to reduce the force of impact created when the sole portion 8 strikes the ground surface at the foot flat portion of gait. This latter operation may also be achieved by providing a slight upward and rearward inclination of the tread surface of the heel portion 10 so that the heel will rock from its forward edge 32 into the foot flat portion of gait.

The sole portion 8 is inclined upwardly and forwardly, preferably in an arcuate fashion known in the prior art, so that the transition from the foot flat to the push-off portion of gait may occur gradually without the necessity for excessive shearing forces between the foot and the padding material 4 at the point of push-off. The sole 8 has its rearward portion located approximately in the plane of the undersurface of the heel portion 10 so that a wearer may stand still with the longitudinally spaced points on the sole and heel simultaneously contacting the ground surface. The weight is then distributed on the sole and heel portions of the device. Accordingly, the wearer is not required to balance himself on an arcuate tread surface which would produce an unstable, uncomfortable rocking of the sandal and foot.

The normal use of the invention is shown in FIGS. 3, 4 and 5, with FIG. 3 illustrating the heel strike portion of gait where the rearwardmost ground-contacting edge 30 of the tread surface strikes the ground to create upward pressures on the foot in the heel area surrounded by the broken lines 34 in FIG. 2.

Continuation of the normal gait causes the tread portion to pivot downwardly on the rear edge 30 until the foot flat portion of gait is reached as shown in FIG. 4. This is also the position assumed by the foot and sandal when the patient is standing still. At this point, the weight is supported by the forefoot and heel.

Next, the foot rocks forwardly on the arcuate undersurface of the sole portion 8. During this rocking movement, the forefoot mechanics are at work with the

usual midtarsal and metatarsal movement occurring for many patients. At this point, the lifting of the wearer's heel extends the elastic 18 so that the foot will lift off the padding material 4 to permit the proper functioning of the forefoot mechanics. The ability of the sole portion to rock forwardly reduces the amount of shearing force required at the push-off portion of gait and thereby further avoids or minimizes the amount of discomfort to which the patient is subjected.

The disclosed sandal has been found to perform a cadence-monitoring function which reduces the amount of pain experienced by the patient. The steps are shorter and less frequent, so there is a reduction in velocity which also minimizes the forces of impact and shear produced during the stance phase of gait.

Those skilled in the art will realize that a wide variety of materials may be used in practicing the invention and that it is desirable to design the sandal or other article of footwear according to measurements and analysis of the anatomical and functional characteristics of the individual patient's feet. In some instances, only selected features described above will be required for the patient. Therefore, it is emphasized that the invention is not limited to the sole embodiment disclosed which incorporates all important features of the invention, but the invention is to be construed in the light of the claims which follow.

I claim:

1. An article of footwear for patients who have functionally foreshortened feet, comprising,
a ground-contacting base including a tread surface which has a sole portion and a heel portion which are relatively immovable with respect to each other, said sole portion being inclined forwardly upward to reduce the shear forces on a patient's foot during push off,
said heel portion having its rearwardmost ground-contacting portion located forwardly of the anatomical rear portion of the patient's foot to reduce impact loading of the forefoot at the foot flat portion of gait,

a foot-supporting means above the base for conforming to the shape of the patient's foot, and,
a forefoot retaining means constructed to allow maximum midtarsal motion,

heel retaining means for laterally positioning the patient's heel on the foot-supporting means while permitting at least a one-half inch displacement of the patient's heel from the foot supporting means during the push-off portion of the patient's gait.

2. An article of footwear according to claim 1 wherein the heel retaining means includes a generally horizontal loop for encircling the patient's foot above the instep and means for connecting said loop to said base.

3. An article of footwear according to claim 2 wherein the means for connecting said loop to said base is elastic.

4. An article of footwear according to claim 1 wherein the foot supporting means is a permanently deformable pad means which extends laterally beyond a patient's foot to provide a ridge which surrounds the foot and prevents lateral shifting thereof.

5. An article of footwear according to claim 4 wherein the deformable pad means is of foam material.

6. An article of footwear according to claim 1 wherein the tread surface has portions which are longi-

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tudinally spaced apart and are positioned to simultaneously contact a flat ground surface, thereby assuming a stable non-rocking position when a patient is standing still.

7. An article of footwear according to claim 1 wherein the forefoot retaining means includes strap means located to overlie a patient's foot exclusively rearwardly of the toes to avoid discomfort to the foot during that portion of the gait when the foot is raised and the article of footwear is supported by the foot.

8. An article of footwear according to claim 7 wherein the opposite ends of the strap are spaced transversely from the patient's foot to avoid lateral constriction of the foot and to maximize the distribution of pressure on the underside of the foot during the push-off portion of stance phase of gait.

9. A method of facilitating walking by patients with highly sensitive or functionally foreshortened feet, said method being performed by attaching to the foot an article of footwear which has a substantially unbendable platform provided on its upper surface with a layer of padding material and provided on its lower surface with a tread surface which has a sole portion and a heel portion, said tread surface assuming a stable non-rocking condition when at rest on a flat ground surface, said sole portion being inclined forwardly and upwardly to reduce the shear forces on a patient's foot during the toe-off portion of gait, said heel portion having the entirety of its ground-contacting surface located forwardly

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wardly of the anatomical rear portion of the patient's foot to reduce impact loading of the forefoot at the foot flat portion of gait.

10. The method of claim 9 wherein the article of footwear is attached to the forepart of the foot by passing a strap over the forepart of the foot rearwardly of the toes without laterally constricting the foot, thereby providing for maximum midtarsal motion during the toe-off portion of gait.

11. The method of claim 1 wherein the foot is laterally confined by that portion of the padding material which is uncompressed and lies laterally of the foot.

12. The method of claim 1 wherein the article of footwear is attached to the foot by forming a loop around the foot in the vicinity of the ankle, and resiliently biasing the loop toward the platform with a force having a magnitude such that the heel will lift off the upper surface of the platform only during the toe-off portion of gait.

13. The method of claim 12 wherein the article of footwear is attached to the forepart of the foot by passing a strap over the forepart of the foot rearwardly of the toes without laterally constricting the foot, thereby providing for maximum midtarsal motion during the toe-off portion of gait.

14. The method of claim 13 wherein the foot is laterally confined by that portion of the padding material which is uncompressed and lies laterally of the foot.

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