SPLIT FOOT PROSTHESIS

BACKGROUND OF THE INVENTION

This invention relates to foot prostheses in general, and specifically to a split prosthetic foot which incorporates a plurality of curvilinear foot portions which cooperate with one another to provide the wearer with performance characteristics not available from prior art prostheses.

A number of prosthetic devices have attempted to provide energy-storing and -releasing functions to simulate ambulation on a natural limb. For example, see my U.S. Pat. No. 4,547,913 for my invention relating to a "Composite Prosthetic Foot and Leg", and U.S. Pat. No. 4,822,363 for my invention relating to a "Modular Composite Prosthetic Foot and Leg". Also, my pending applications Ser. Nos. 07/337,374, 07/585,920 and 07/293,824, now U.S. Pat. No. 5,037,444, disclose prosthetic foot devices with similar preferred materials and methods of manufacture, and with corresponding benefits therefrom.

Each of my aforementioned inventions is characterized by lightweight, elongated structures incorporating polymer impregnation of superimposed reinforcing laminae maintained in the desired configuration. Such configurations and constructions provide the desirable characteristics of strength and flexibility in the prosthetic member, and achieve a simulation of the performance of natural feet which had previously not been attainable. Such prostheses may be provided in modular assemblies, whereby the particular performance characteristics of a given prosthesis may be adapted and readily adjusted to meet the needs and activity level of the individual patient.

Other prosthetic foot devices include U.S. Pat. No. 3,335,428 to Gajdos, which attempts to duplicate the skeletal and skin structure of a natural human foot, U.S. Pat. No. 2,075,583 to Lange, which incorporates a rubber form mounted in operative relationship with a rigid metallic core, and U.S. Pat. No. 4,645,509 to Poggi, which teaches a prosthetic foot incorporating a monolithic keel or beam of relatively massive proportions intended to react to the load of an amputee's body during walking, running, jumping, and the like and to release the resultant stored energy to create foot lift and thrust complementing the amputee's natural stride.

Although several of the aforementioned prostheses have provided flexure in a fore-and-aft direction, such prior art devices are relatively stiff and unresponsive with respect to torsional loading which might result from leaning to one side or from ambulation in a direction other than straight ahead. In fact, such prostheses provide a consistent energy response for loading at any given fore-and-aft location on the prosthesis, regardless of whether the loading occurs at one edge of the prosthesis or at the center thereof.

OBJECTS AND ADVANTAGES OF THE INVENTION

It is, therefore, an object of my invention to provide a prosthetic foot which provides a varying energy-absorbing and energy-storing performance dependent upon the lateral location of the contact between the foot and an underlying supporting surface, as well as the angle of impact therebetween. In particular, the prosthesis of my invention incorporates a plurality of foot portions capable of movement independently from one another.

In a preferred embodiment, as described below, the foot portions are fabricated by providing a slot through virtually the entire prosthesis, effectively dividing it into two independent prostheses. When both of these independent portions are similarly loaded and stressed, such as during straight-ahead walking, the portions cooperate and act in unison to achieve a performance similar to a foot with no division therein. When the prosthesis of my invention undergoes lateral loading, however, the various portions may act independently from one another and thereby provide performance characteristics which may vary substantially from those of a foot with no division therein.

In effect, the prosthesis of my invention simulates the sideways turning of a natural ankle, in that it permits the energy-storing structure of the entire foot to twist slightly from side to side in response to various loading conditions.

Moreover, such independent movement provides additional effective contact area between the bottom of the prosthesis and a confronting supporting surface, under the aforementioned lateral loading conditions. Instead of a single outer edge of the prosthesis contacting the supporting surface, two or more "edges" may achieve such contact, improving the traction or frictional interaction of the prosthesis on the surface.

Another object of my invention is the provision of a prosthetic foot of the aforementioned character which includes connecting or retaining means such as a strap for limiting the movement of the relevant independent foot portions, or selected ones of them, with respect to one another. This insures that the energy-storing capabilities of the entire foot are utilized when the foot is placed under conditions of extreme lateral stresses. In such situations, the connecting means effectively connects selected of the foot portions with a predetermined amount of play therebetween, whereby after one of the connected portions has been displaced that predetermined distance with respect to the other, the strap will require that both connected portions be simultaneously actuated in order for further displacement in that direction to occur.

It is a further object of my invention to provide a prosthetic foot of the aforementioned character which is of modular configuration, resulting in ready assembly and adjustability thereof. The foot of my invention preferably includes forefoot and heel portions that can be readily exchanged with correspondingly-constructed forefoot and heel portions to provide size adjustment or different spring rates to suit the size of foot of the amputee or the stride, height, weight, and activity level of the amputee. Therefore, a range of combinations of spring rate and size can be provided to the amputee, achieving a natural stride and resilience of gait.

Another object of the invention is the provision of a prosthetic foot of the aforementioned character in which the forefoot and heel portions of the prosthesis are fabricated from superimposed laminates maintained in operative relationship by an encapsulating polymer, and further in which said foot is susceptible to bending stress determined by the number of the laminates and polymers in the respective element. Thus, the laminates are encapsulated in a polymer and capable of spring stress response as loads are imposed thereupon during the utilization of said foot.