MULTI-AXIS PROSTHETIC ANKLE JOINT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to prosthetic devices, and more particularly to a multi-axis prosthetic ankle joint.

2. Discussion of the Background

A prosthetic ankle is a component which connects a prosthetic foot with a prosthetic lower leg. For smooth walking, especially, across uneven ground, it is important for the ankle to be designed for a full range of foot motion with respect to the lower leg prosthesis. Most prosthetic ankles currently on the market are modular in design and do not provide optimally controlled multi-axis motion. Often the prosthetic ankle has such a low stiffness that it effectively reduces any functional capabilities of the attached prosthetic foot, resulting in a choppy, unnatural and uncomfortable gait. Some ankles require adjustments to the assembly in order to achieve the desired function.

A full range of motion may be accomplished by the use of multiple axes of rotation in the ankle joint. However, conventional prosthetic ankle joints that provide multi-axis motion tend to require extensive maintenance including the replacement of parts in order to function properly. This is because the conventional ankle joint designs require elastic members to slide in contact with either a rigid surface, which is typically metallic, or another elastic surface. This surface-to-surface sliding motion is the primary cause of material breakdown.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a multi-axis prosthetic ankle joint which does not suffer from the shortcomings of the prior art.

According to a feature of the invention as set forth in the claims, a multi-axis prosthetic ankle comprises a bottom component adapted to be connected to a prosthetic foot, a lower leg connection component adapted to be connected to a prosthetic lower leg, an elastomeric material securely connecting the bottom component with the lower leg connection component, and a mechanical device suspended in the elastomeric material. The mechanical device comprises a first rigid element connected to the bottom component but not to the lower leg connection component, and a second rigid element connected to the lower leg connection component but not to the bottom component. The first and second elements interlockingly float in the elastomeric material, and are not in direct contact with one another, so as to permit relative movement of the bottom component and the lower leg connection component by deformation of the elastomeric material.

By "interlockingly float" it is meant that the first and second elements are suspended in the elastomeric material in close relation to one another, but do not contact one another except through the intermediary of the elastomeric material. Since the deformation of the elastic material permits multi-axis relative movement of the bottom component and the lower leg connection component, including translational movement, the ankle joint of the invention can simulate natural ankle motion by providing plantar flexion, dorsi flexion, inversion, eversion, translation and internal/external rotational movement. Such motion is optimally controlled by the multi-axis deformation of the elastic material, without sacrificing the energy return of the prosthetic foot. Further, since the components of the mechanical device are bonded to, and encased by, the elastomeric material, the ankle has the ability to absorb and damp both rotational and linear impacts.

Since there is no surface-to-surface sliding motion within the ankle, the material breakdown which might otherwise occur due to surface-to-surface sliding motion is reduced or eliminated.

As force is applied to the ankle, the ankle moves in rotation and translation with a fluid motion by deforming the rubber medium. According to a further feature of the invention, at least one mechanical stop is positioned to prevent the relative angular movement of the ankle from deforming the elastic material beyond the elastic limit thereof. Since the deformation of the elastomeric material is thus always kept within the elastic limit, any tendency of breakdown in the elastomeric material is further reduced.

According to a further feature of the invention, the mechanical device comprises a generally U-shaped first part connected to the bottom component so as to define a first aperture, and a generally U-shaped second part connected to the lower leg connection component so as to define a second aperture. The first part floatingly extends through the second aperture, and the second part floatingly extends through the first aperture.

According to yet a further feature of the invention, a multi-axis prosthetic ankle comprises a bottom component adapted to be connected to a prosthetic foot, a lower leg connection component adapted to be connected to a prosthetic lower leg, an elastomeric material securely connecting the bottom component with the lower leg connection component, and mechanical means for limiting a deformation of the elastic material.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a top plan view of an embodiment of a multi-axis prosthetic ankle according to the invention, showing the encasing elastomeric material in phantom lines;

FIG. **2** is a front elevation view of the multi-axis prosthetic ankle of FIG. **1**;

FIG. **3** is a side elevation view of the multi-axis prosthetic ankle of FIG. **1**;

FIG. **4** is a top plan view of the lower leg connection component of the embodiment of FIG. **1**;

FIG. **5** is a front elevation view of the lower leg connection component of FIG. **4**;

FIG. **6** is a front elevation view of the bracket mounted to the lower leg connection component in FIG. **1**;

FIG. **7** is a top plan view of the bottom component of the embodiment of FIG. **1**;

FIG. **8** is a sectional view taken along lines VIII—VIII of FIG. **7**; and

FIG. **9** is a sectional view of taken along lines IX—IX of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the attached figures which illustrate a non-limiting embodiment of a multi-axis prosthetic ankle