ARTIFICIAL FOOT AND ANKLE

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. §119(e) of U.S. Provisional Application No. 60/126,348, filed Mar. 26, 1999, the disclosure of which is incorporated by reference herein.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

The development of this invention was supported by Grant 5R44 AR43290-03 from the National Institutes of Health/National Institute of Arthritis and Musculoskeletal Diseases.

BACKGROUND OF THE INVENTION

Many biomechanical systems or prostheses are known that assist an amputee in walking, running, and performing other types of locomotion. One known type of artificial foot and ankle is disclosed in U.S. Pat. No. 5,376,139, the disclosure of which is incorporated by reference herein. This prosthetic device provides contacting cam rolling surfaces and elastic connections that more closely imitate the forces on the foot during locomotion.

SUMMARY OF THE INVENTION

The present invention relates to an artificial foot and ankle based on the principles of operation of the artificial foot and ankle in the above noted U.S. Pat. No. 5,376,139. The artificial foot and ankle includes a keel component, an ankle component, and a central bumper component interposed between the keel component and the ankle component. The ankle component has a lower surface with a radius of curvature greater than the radius of curvature of an upper surface of the keel component in both a sagittal plane and a frontal plane. The curvature of the central bumper component corresponds to the curvature of the keel component. In this way, the ankle component is capable of a rolling motion over the central bumper component and the keel component.

A holding assembly holds the keel component, the ankle component, and the central bumper component together. The holding assembly comprises a generally U-shaped member disposed along medial and lateral sides and a bottom surface of the keel component and along medial and lateral sides of the central bumper component. A pin extends between upper ends of the U-shaped member and is disposed through an opening in the ankle component, whereby the ankle component is capable of rotation about the pin. The pin may be adjustable on the U-shaped member to provide a desired amount of motion of the foot and ankle.

A dorsiflexion stop assembly may also be provided to control the amount of dorsiflexion. The dorsiflexion stop assembly comprises a strap member extending through corresponding openings in the keel component and the central bumper component and attached to a dorsiflexion rod adjustably mounted at the anterior of the ankle component to provide a tension adjustment of the strap member. A compressible strap bumper may be disposed within a loop of the strap member to provide a gradual dorsiflexion stop.

DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** is a side view of the artificial foot and ankle of the present invention;

FIG. **2** is an exploded view of the artificial foot and ankle of FIG. **1**;

FIG. **3** is an exploded view of an ankle component;

FIG. **4** is an isometric view of a keel component;

FIG. **5** is an isometric view of a central bumper;

FIG. **6** is an exploded view of the central bumper of FIG. **6**;

FIG. **7** is an isometric view of a holding assembly;

FIG. **8** is an exploded view of the holding assembly of FIG. **7**;

FIG. **9** is an isometric view of a dorsiflexion stop;

FIG. **10** is an exploded view of the dorsiflexion stop of FIG. **9**;

FIG. **11** is a side view of a further embodiment of the present invention; and

FIG. **12** is a side view of a still further embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. **1** and **2**, an artificial foot and ankle assembly **10** of the present invention comprises an ankle component **12**, a keel component **14**, a central bumper component **16**, and a dorsiflexion stop assembly **18**. The components are held together by a holding assembly **20**.

The ankle component **12**, shown more fully in FIG. **3**, includes a main ankle member **22**, a dome **24**, and an inverted pyramid **26** molded in for attachment to other components. The ankle component is preferably made from a glass and/or carbon reinforced vinyl ester material. The lay-up of the material provides the required strength.

Referring to FIG. **4**, the keel component **14** is also made from a glass and/or carbon reinforced vinyl ester material. The toe portion **30** of the keel component **14** constitutes a leaf spring design having any suitable number of graduated layers or plates **32***a*, **32***b*, **32***c* (three are shown) to allow for a more responsive forefoot. The particular configuration of the toe portion is determined by the user's parameters and preferences. The keel component also has an arch **34** along its bottom surface to provide the keel component with a fairly uniform thickness and a reduced weight.

The radius of curvature on the bottom surface **36** of the ankle component **12** faces downwardly, and the radius of curvature on the top surface **38** of the keel component **14** faces upwardly, as can be seen in FIG. **2**. The magnitude of the radius of the ankle component is greater than the magnitude of the radius of the keel component in both the sagittal and frontal planes.

Referring to FIGS. **5** and **6**, the central bumper component **16** is provided between the ankle and keel components **12**, **14**. The central bumper component is preferably formed from an elastic, polyurethane material, which provides shock absorption and serves to restore the foot to its neutral position after a plantarflexion, dorsiflexion, inversion, or eversion load is applied. The central bumper component preferably has a hardness value between **50**A and **90**A. The actual hardness is determined by the user's parameters and preferences.

The radius of curvature of the central bumper component is equal to the radius of curvature of the keel component on both the bottom and top surfaces **40**, **42** of the bumper. This allows for the ankle component to roll along the top surface