# MULTI-AXIS PROSTHETIC ANKLE JOINT

## FIELD OF THE INVENTION

This invention relates generally to prosthetic devices, and more particularly, to a universal multi-axis ankle joint comprising front and back polyurethane bumpers of different densities positioned within a metal housing for connection between a lower leg component and a foot component which provides multiple axes of rotation for the ankle.

## BACKGROUND OF THE INVENTION

For smooth walking across uneven ground, it is important for an amputee to have a prosthesis capable of providing a full range of motion for the foot component with respect to the lower leg component. A full range of motion is accomplished by the use of a multiple axes of rotation ankle joint. Prior prosthetic devices provided a lower leg component having an integral foot component without provision for an ankle joint. This type of prosthesis made it difficult for the amputee to maneuver on relatively even ground, much less on uneven ground. Recognizing this problem, prosthetic foot components were developed which provided a single axis of rotation. These prosthetic feet typically included adjustable anterior and posterior deflection bumpers for transition from plantar flexion to dorsiflexion. The single axis of rotation ankle joint is integral with the foot component. The disadvantages of this design is that, although being an improvement over designs with no axis of rotation, it does not provide stability on uneven ground.

Recognizing the need for a multiple axes of rotation ankle joint, a prosthetic foot and ankle combination manufactured by Blatchford Endolite under the tradename "Multiflex" was developed to provide a full range of natural action. This design includes a ball and socket ankle joint integrally connected to the foot component through a serrated connection. A disadvantage with this type of design is that it is not universally adaptable for use between any manufacturer's lower leg and foot component. Other disadvantages of this design is that the ankle component is quite large, requires a special serrated adapter for attachment to the foot, and is expensive to manufacture.

Consequently, a need exists for an improved multiple axes prosthetic ankle component which is universally adaptable between any manufacturer's lower leg and foot components, and is compact, lightweight, and inexpensive to manufacture.

## SUMMARY OF THE INVENTION

The present invention provides a multiple axes prosthetic ankle joint for lower limb prosthetic application which reduces the problems of prior existing multiple axes ankle components and is lightweight, universally adaptable for most lower leg components, and is easy and inexpensive to manufacture.

In a preferred embodiment, the multiple axes ankle joint comprises a metal housing including a bottom portion which can be positioned on or within a foot component and a top portion having a prosthetic link for connection to a lower leg component. Two polyurethane dampeners are positioned within the housing between the upper and lower portions and comprise a front bumper and a rear bumper. The front bumper has a higher durometer hardness than the rear bumper to act as a stop in the mid-stance position. The exact durometer hardness for both the front and rear bumpers can be varied depending upon the weight and activity level of the amputee.



The upper and lower portion of the housing, and the front and rear dampeners all include overlapping flanges having a hole passing therethrough. When the ankle joint is assembled, the holes are aligned for the passage of a pin for firmly connecting the ankle components together. The holes passing through the flanges on the upper housing member are elongated to also accommodate inversion and eversion motion as well as compression of the ankle. The lower portion of the housing also includes a hole through the bottom surface so the ankle joint can be bolted to the foot component. The front and rear bumpers also include a vertical hole for insertion of a plastic cylindrical limiter of varying lengths to further limit motion and to "tune" the amount of potential motion for the ankle joint.

These and other aspects of the invention will be more fully described in the following detailed description and the accompanying drawings.

Brief Description of the Drawings FIGS. **1** is a perspective view of the multiple axis ankle joint of the present invention;

FIGS. **2** is an exploded side elevational view of the ankle joint of FIG. **1**;

FIGS. **2***a* is a top view of the front damper of the ankle joint of FIG. **1**;

FIGS. **2***b* is a top view of the rear damper of the ankle joint of FIG. **1**; and

FIGS. **3** is an exploded side elevational view, showing the ankle joint of FIG. **1** incorporated into a below-knee prosthesis.

## DETAILED DESCRIPTION

FIGS. **1** and **2** illustrate the multi-axis prosthetic ankle joint **10** of the present invention. The ankle joint comprises a metal housing including a bottom portion **12** and a top portion **14**. The bottom portion of the housing has a cup-shaped base **16** having a hole **18** positioned in its bottom surface for connecting the ankle joint to a foot component. The bottom portion further includes vertical flanges **20**, one extending upwardly on either side of the bottom portion (only one is shown in the drawing). Flanges **20** have a hole **22** for passage of a pin **24** which rigidly secures all of the components of the ankle joint together as discussed more fully herein.

Top housing portion **14** includes a prosthetic link which includes a male connector **26** having a spherically convex base **28** rigid with a generally flat plate **30**. The male connector includes a central boss **32** of frustopyramidal configuration which projects upwardly away from the spherically convex base. The frustopyramid formed by the main portion of the boss is of square crosssection and has four uniform sides facing angularly upwardly and outwardly in four directions spaced apart by 90°. Positioned on the lower surface of the base **30** are two downwardly extending flanges **32** (only one shown) having an oval-shaped hole **34** for passage of pin **24**. Holes **34** are elongated to accommodate plantar and dorsiflexion, inversion and eversion motion as well as compression of the ankle to be discussed more fully herein.

Two polyurethane dampeners are positioned within the housing between the bottom portion **12** and the top portion **14** and comprise a front bumper **36** and a rear bumper **38**. As also shown in FIGS. **2***a*, front bumper **36** is T-shaped having a rounded front portion **38** and a perpendicularly extending rear portion **40**. Rear portion **40** includes a horizontally