Title: ARTIFICIAL JOINT WITH LOCKING MECHANISM

Abstract: An artificial joint including a main body and a lower portion adapted to pivotally engage the main body about a control axis while having a locking means that is integral with the lower portion. An upper portion adapted to pivotally engage the main body about a flexing axis and has an engagement means adapted to engage and disengage the locking means upon the pivoting rotation of the upper portion relative the main body. A biasing means is adapted to engage both the main body and the lower portion thereby biasing the locking means to engage the engagement means, and at least one stopping surface adapted to limit motion between the main body and the lower portion. The locking means is activated when a load is imposed on the artificial joint and passes through a line posterior to the control axis, and is deactivated when the load passes through a line anterior to the control axis.
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Artificial Joint with Locking Mechanism

Field of the Invention

This invention relates in general to artificial joints and more particularly to an artificial knee joint for use in prosthetic or orthotic applications having a locking means that provides support, stability and unrestricted motion.

Background of the Invention

Artificial joints generally utilize a variety of mechanisms to control their movement and to provide support and stability. Specifically an artificial knee joint needs to bend or articulate during sitting, kneeling or ambulating. By providing improved control of the leg during the swing-phase of the gait when the person is walking or running, one also improves the look of the gait and makes the gait look more natural.

Improved support and stability when one is standing or putting weight on the leg is critical during the support-phase or stance-phase of the gait cycle otherwise the artificial joint may bend uncontrollably causing the amputee to fall. Amputees have some control during stance by the way they load the leg and how they use their remaining muscles at the hip. Alternatively, a prosthetist can align a prosthesis to be more or less stable by placing the knee joint axis behind the load bearing plane or load line. However, this tends not to produce ideal gait characteristics.

Many different designs for artificial knee joints have been proposed to address the issue of support/stance-phase control, including a built-in "locking" mechanism for this purpose. Typically, these designs are joints which lock manually during ambulation so that the person has a choice of walking with his leg locked in extension or in a free swing. If the locked position is chosen, the person is forced to walk stiff legged. However, as noted above flexing at the knee during walking may result in uncontrollable movement and a buckling of the person’s leg.
Artificial joints with automatically engaging locking mechanisms also have some major disadvantages. One disadvantage in current automatic locking mechanisms is that the automatic locking can occur only when the user has achieved full extension of the knee. The timing of the locking can cause an accident for the person as they may not be able to fully extend the knee before loading or placing weight on the leg. This would result in the knee to fold uncontrollably and allow the person to fall as noted above. Another disadvantage relates to the fact that although the locking mechanism automatically locks, these joints require manual operation to disengage or unlock the joint. This in turn requires that the user must have a free hand to activate the disengagement mechanism and could discourage the user from the therapeutic bending of the knee.

Prior art artificial joints have been devised to address some of the noted problems. For example, US Patent Application 2002/0183673 A1 by Naft discloses an electromechanical orthotic knee joint. It uses sensors that electronically provide signals to actuate a magnetic coil that brings together a set of serrated disks, thus preventing flexion. US Patent 5,267,950 issued to Weddendorf on December 7 1993 discloses an orthotic knee joint mechanism that under loading presses a set of bevelled serrated members into a bevelled surface, thus locking the knee. When unloaded the surfaces are not engaged and flexion/extension at the knee joint is possible.

Thus an artificial joint with a locking mechanism which provides improved stabilization and support while at the same time providing unrestricted motion is desirable.

Summary of the Invention

An object of one aspect of the present invention is to provide an improved artificial joint having an automatic locking means.

In accordance with one aspect of the present invention there is provided an artificial joint including a main body and a lower portion adapted to pivotally engage the main body about a control axis while having a locking means that is integral with
the lower portion. The artificial joint further includes an upper portion adapted to
pivotally engage the main body about a flexing axis and has an engagement means
adapted to engage and disengage the locking means upon the pivoting rotation of the
upper portion relative the main body.

The artificial joint further includes a biasing means adapted to engage both the
main body and the lower portion thereby biasing the locking means to engage the
engagement means, and at least one stopping surface adapted to limit motion between
the main body and the lower portion. An additional stopping surface is included to
limit the motion of the upper portion. The locking means is engaged when a load is
imposed on the artificial joint and passes through a line posterior to the control axis,
and is disengaged when the load passes through a line anterior to the control axis.

Preferably, the locking means is a latch member integral with the lower
portion. Conveniently when the artificial joint is a knee joint for example, the latch
member may be position in the front of the artificial joint or in the rear of the artificial
joint. Furthermore the artificial joint may also include a swing-phase control means.

Preferably the biasing means is a spring to bias the latch member in the
engaged position. The stopping surfaces may include resilient material to help
dampen impact during various movements of the artificial joints.

Advantages of the present invention are automatic engagement and
disengagement of the locking means, improved stabilization and support when weight
is placed on the joint while providing unrestricted motion, the locking means may be
placed in the front or rear of the artificial joint depending on its intended use,
simplified design, more compact design relative to traditional artificial joints, reduced
manufacturing costs, for use as an orthotic, prosthetic or robotic joint and may be used
as a knee joint or elbow joint.

**Brief Description of the Drawings**

A detailed description of the preferred embodiments is provided herein below
by way of example only and with reference to the following drawings, in which:
Figure 1a in a side view, illustrates an artificial joint having the locking means in the back of the joint in accordance with a preferred embodiment of the present invention;

Figure 1b in a side front view, illustrates an artificial joint having the locking means in the front of the joint in accordance with a preferred embodiment of the present invention;

Figure 2a in a side view, illustrates the artificial joint of Figure 1 in a disengaged position.

Figure 2b in a side view, illustrates the artificial joint of Figure 2 in a disengaged position.

Figure 3a in a side view, illustrates the artificial joint of Figure 1 in an engaged position.

Figure 3b in a side view, illustrates the artificial joint of Figure 2 in an engaged position.

Figure 4a in a side view, illustrates the artificial joint of Figure 1 during gait.

Figure 4b in a side view, illustrates the artificial joint of Figure 2 during gait.

Figure 5a in a side view, illustrates the artificial joint of Figure 1 during gait.

Figure 5b in a side view, illustrates the artificial joint of Figure 2 during gait.

Figure 6a in a side view, illustrates the artificial joint of Figure 1 during gait.

Figure 6b in a side view, illustrates the artificial joint of Figure 2 during gait.

Figure 7a in a side view, illustrates the artificial joint of Figure 1 during gait.

Figure 7b in a side view, illustrates the artificial joint of Figure 2 during gait.

Figure 8 in a side view, illustrates the artificial joint of Figure 1 in a prosthetic knee joint.
Figure 9 in a side view illustrates the artificial joint of Figure 8 during flexing of the joint.

Figure 10 in a side view illustrates the artificial joint of Figure 8 during flexing of the joint.

Figure 11 in a side view illustrates the artificial joint of Figure 8 during flexing of the joint.

Figure 12 in a side view illustrates the artificial joint of Figure 8 including a swing-phase control means.

Figure 13 in a side view illustrates the artificial joint of Figure 12 including a swing-phase control means.

Figure 14 in a side view illustrates the artificial joint of Figure 12 including a swing-phase control means.

Figure 15 in a side view illustrates the artificial joint of Figure 2 in a prosthetic knee joint.

Figure 16a in a side view illustrates the artificial joint of Figure 15 including a swing-phase control means.

Figure 16b in a side view illustrates the artificial joint of Figure 15 including a swing-phase control means.

Figure 16c in a side view illustrates the artificial joint of Figure 15 including a swing-phase control means.

Figure 17 in a side view illustrates the artificial joint of Figure 1 in an orthotic knee joint.

Figure 18 in a side view illustrates the artificial joint of Figure 17.
In the drawings, preferred embodiments of the invention are illustrated by way of example. It is to be expressly understood that the description and drawings are only for the purpose of illustration and as an aid to understanding, and are not intended as a definition of the limits of the invention.

5 **Detailed Description of the Preferred Embodiment**

Referring to Figure 1, there is illustrated in a side view, an artificial joint 10 in accordance with a preferred embodiment of the present invention. The artificial joint 10 includes a main body 12 and a lower portion 14 adapted to pivotally engage the main body 12 about a control axis 15 while having a locking means 16 that is integral with the lower portion 14. The artificial joint 10 further includes an upper portion 18 adapted to pivotally engage the main body 12 about a flexing axis 20 and has an engagement means 22 adapted to engage and disengage the locking means 16 upon the pivoting rotation of the upper portion 18 relative the main body 12. The pivotal rotation of the upper portion 18 relative to the main body 12 also allows for the articulation or flexion and extension of the joint when the locking means 16 is disengaged from the engagement means 22.

The artificial joint 10 further includes a biasing means 22 adapted to engage both the main body 12 and the lower portion 14 thereby biasing the locking means 16 in an engaged position. At least one stopping surface 24 is adapted to limit motion between the main body 12 and the lower portion 14. An additional stopping surface 26 is included to limit the motion of the upper portion 18. The locking means 16 is engaged when a load is imposed on the artificial joint 10 and passes through a line posterior to the control axis 15, and is disengaged when the load passes through a line anterior to the control axis 15.

The locking means 16 may be further defined as a latch member 28 or similar latching mechanism that is integral with the lower portion 14. By having the latch member 28 integral with the lower portion 14, the design of the artificial joint 10 can be compact and simplified. The engagement means 22 may be further defined as a step 30 that is adapted to engage the latch member 28. The step 30 is integral with the upper portion 18 thereby contributing to the compactness and simplification of the
design of the artificial joint 10. The biasing means 22 may be defined as a spring 24 such as an extension spring.

The stopping surfaces 24 and 26 may include a resilient material to dampen impact during their engagement. The stopping surfaces may also be adjustable. The stopping surfaces 24 may be further defined as a first stopping surface 32 that limits the motion of the lower portion 14 by its engagement with the main body 12 when the artificial joint 10 is in a disengaged position, and a second stopping surface 34 that limits the motion of the lower portion 14 be its engagement with the main body 12 when the artificial joint is in an engaged position. The stopping surface 26 may be further defined as a stopping surface 36 that limits the movement of the upper portion 18 relative the main body 12 when the artificial joint 10 is in a fully extended position.

The artificial joint 10 may have a number of applications such as a prosthetic, orthotic or robotic joint, and may be used for a knee or elbow by way of example only. More specifically the use of the artificial joint 10 as a knee joint allows for different positioning of the locking means 16 or latch member 28 in the artificial joint 10. For example the locking means 16 may be positioned at the rear of the knee joint or at the front of the knee joint. The preferred positioning of the locking means 16 will depend on the how the artificial joint 10 is being used. When the artificial joint 10 is applied to a prosthetic, the locking means 16 may be positioned in the front so as to have improved flexion of the artificial joint 10. When the artificial joint 10 is applied to an orthotic, the locking means 16 may be positioned in the back.

When the artificial joint 10 is utilized as a knee joint with the locking means 16 positioned in either the front or the back of the artificial joint 10, the lower portion 14 may be further defined as a shank portion 38 and the upper portion 18 may be defined as a thigh portion 40. Typically the thigh portion 40 will attach to the thigh part of the prosthesis or orthosis and the shank portion 38 will attach to the shank part of prosthesis or orthosis. The flexing axis 20 may be further defined as a knee axis 21 that allows for the knee joint to articulate as an anatomical knee might, the thigh
portion 40 relative to the shank portion 38. The knee axis 21 is located above the control axis 15.

The artificial joint 10 may also include a swing phase-control means 42. The swing phase-control means 42 includes a piston and cylinder assembly 44 that has a first end 46 adapted to engage the upper portion 18 or thigh portion 40, and a second end 48 adapted to engage the lower portion 14 or the shank portion 38. The piston and cylinder assembly 44 may be hydraulic, spring-assisted or pneumatic.

Referring to Figures 2a to 7b, during typical gait motion the artificial joint 10 in a knee having both the latch member in the front and the back, functions in the following way. The knee joint extends at the end of the swing-phase and the thigh portion 40 engages stopping surface 26. At this point the locking means 16 and the engagement means 22 become aligned and the shank portion 38 pivots relative to the main body 12 with the assistance of the biasing means 22 so that locking means 16 engages the engagement means 22.

The stance phase commences when the person places weight on the leg and therefore has foot contact. Typically initial contact with the ground surface will generally be made at the rear of the foot. In an artificial joint 10 that does not have a lock, the force of loading will generally result in a knee flexion moment that will cause knee flexion and hence knee instability. With artificial joint 10, such flexion is prevented by the engagement of the locking means 16. Specifically the flexion moment about the control axis 15, acts to push the locking means 16 securely against the second stopping surface 34 therefore further securing the engagement of the locking means 16. Toward the end of the stance-phase, the loading transfers to the forefoot. This extension moment about control axis 15 causes the shank portion 38 to pivot to disengage the locking means 16. The knee joint can now be voluntarily flexed by applying a hip flexion moment thereby beginning of the swing-phase.

Referring to Figures 8 to 11 when the artificial joint 10 is applied to a prosthetic knee with the locking means 16 in the rear of the artificial joint 10, some modifications may be required. Specifically the thigh portion 40 further includes a
first coupling means for connecting the thigh portion 40 of the prosthesis and a second coupling means for connecting the shank portion 38 of the prosthesis. As noted above the stopping surfaces 36 and 34 may include resilient material to dampen the impact during knee extension and impact of the locking means 16. Stopping surface 32 may be further defined as the head of a screw that threads into the shank portion at the front of the knee joint. With this arrangement the distance of stopping surface 32 can be adjusted to minimize the gap between locking means 16 and thigh portion 40 as the knee joint is being flexed.

The biasing means 22 may be an extension spring used to pull the shank portion 38 into the lock-engaged position. In this embodiment the distance between knee axis 21 and control axis 15 is maximized to limit the amount of pivoting and therefore motion by the shank portion 38 needed to engage and disengage the locking means 16, thereby reducing the feeling of instability in the artificial joint 10. Excessive motion may also be eliminated by the proper adjustment of stopping surface 32. Figures 10 and 11 represent various degrees of knee flexion with and without the additional flexion at the control axis 15 of the shank portion 38 during kneeling. Stopping surface 37 defines the final resting position of the shank portion 38. The swing phase-control means 42 referred to in Figures 12 to 14 may be easily included into the artificial joint 10. The piston and cylinder assembly 44 impacts the artificial joint 10 as it partially resists the motion of the thigh portion 40 relative to the main body 12 and/or shank portion 38.

Figure 15 illustrates the artificial joint 10 as a prosthetic knee joint with the locking means 16 in the front of the knee joint. This embodiment may have the similar modifications as when the locking means 16 is positioned in the rear of the artificial joint 10. Specifically the first stopping surface 32 may actually be integral with the main body 12. Furthermore this embodiment may include the swing phase-control means 42 as depicted in Figures 16a to 16c.

Referring to Figures 17 and 18 the artificial joint 10 may be applied to an orthotic knee joint having the locking means 16 in the rear of the knee joint. This embodiment may require modifications namely a reduced length of the overall
artificial joint 10 achieved by proximally relocating the shank portion 38 using a shank portion connection 50 and providing a clearance 52 for the thigh portion 40 so that knee flexion is still possible. A manual locking mechanism 54 for over-riding the automatic engagement and disengagement of the locking means 16 may also be included to provide extra stability by being able to lock the artificial joint 10 and walking stiff-legged.

Other variations and modifications of the invention are possible. All such modifications or variations are believed to be within the sphere and scope of the invention as defined by the claims appended hereto.
I CLAIM:

1. An artificial joint comprising:
   (a) a main body;
   (b) a lower portion adapted to pivotally engage the main body about a control axis and having a locking means integral with the lower portion;
   (c) an upper portion adapted to pivotally engage the main body about a flexing axis and having a engagement means adapted to engage and disengage the locking means upon the pivoting rotation of the upper portion relative the main body;
   (d) a biasing means adapted to engage both the main body and the lower portion thereby biasing the locking means to engage the engagement means;
   (e) at least one stopping surface adapted to limit motion between the main body and the lower portion; and
   (f) at least one stopping surface adapted to limit motion of the upper portion;

   wherein the locking means is engaged when a load is imposed on the artificial joint passes through a line posterior to the control axis, and is de-engaged when the load passes through a line anterior to the control axis.

2. An artificial joint as claimed in claim 1 wherein the locking means is a latch member.

3. An artificial joint as claimed in claim 2 wherein the engagement means is a step adapted to engage the latch member.
4. An artificial joint as claimed in claim 1 wherein the biasing means is a spring.

5. An artificial joint as claimed in claim 1 wherein the stopping surfaces include a resilient material.

6. An artificial joint as claimed in claim 5 wherein the stopping surfaces are adjustable.

7. An artificial joint as claimed in claim 5 wherein the stopping surfaces are a first stopping surface limiting the motion of the lower portion by its engagement with the main body in a disengaged position and a second stopping surface limiting the motion of the lower portion by its engagement with the main body in an engaged position.

8. An artificial joint as claimed in claim 5 wherein the stopping surface is a stopping surface limits the upper portion when the artificial joint is in a fully extended position.

9. An artificial joint as claimed in claim 1 wherein the artificial joint is used as a prosthetic, orthotic or robotic joint.

10. An artificial joint as claimed in claim 9 wherein the artificial joint is a knee joint.

11. An artificial joint as claimed in claim 10 wherein the lower portion is a shank portion and the upper portion is a thigh portion.

12. An artificial joint as claimed in claim 11 wherein the latch member is positioned at the front of the knee joint.

13. An artificial joint as claimed in claim 11 wherein the latch member is positioned at the rear of the knee joint.
14. An artificial joint as claimed in claim 12 further comprising a swing phase-control means including a piston and cylinder assembly having a first end adapted to engage the upper portion and a second end adapted to engage the lower portion.

15. An artificial joint as claimed in claim 13 further comprising a swing phase-control means including a piston and cylinder assembly having a first end adapted to engage the upper portion and a second end adapted to engage the lower portion.

16. An artificial joint as claimed in claim 14 wherein the piston and cylinder assembly is hydraulic or pneumatic.

17. An artificial joint as claimed in claim 15 wherein the piston and cylinder assembly is hydraulic or pneumatic.

18. An artificial joint as claimed in claim 12 further comprising a manual locking mechanism for over-riding the automatic engagement and disengagement of the locking means.

19. An artificial joint as claimed in claim 13 further comprising a manual locking mechanism for over-riding the automatic engagement and disengagement of the locking means.

20. An artificial joint as claimed in claim 9 wherein the artificial joint is an elbow joint.
A. CLASSIFICATION OF SUBJECT MATTER

IPC: A61F2/50 (2006.01) , A61F 2/58 (2006.01) , A61F 2/64 (2006.01) , A61F 5/01 (2006.01) , E05B 65/00 (2006.01) , B25J 17/00 (2006.01)

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: A61F* (2006.01), E05B 65/00 (2006.01), B25J 17/00 (2006.01)
USPC: 623*
ECLA: A61F002/64 P2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Qpat (FAMPAT)
keywords: prosthesis, knee, ortho*, joint, axis, lock, bias, spring

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents
*A* document defining the general state of the art which is not considered to be of particular relevance
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