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(56) Documents Cited
EP 0016268 A1 **WO 95/30391 A1** **US 4685926 A**

(58) Field of Search
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INT CL^6 **A61F 2/60 2/64 2/68**

(54) Abstract Title
Knee Prosthesis with Locking Components

(57) An artificial knee comprises first and second pivotally interconnected knee components (L and U), and first and second interengaging lock components (38 and 28) associated therewith for locking the knee components together when in a predetermined pivotal configuration. The first lock component (38) is slidably mounted with respect to the first knee component (L), and has a locking member (38a) engageable within a locking detent (28g) associated with the second knee component (U), the detent constituting the second lock component. A spring (41) biases the first lock component (38) towards a locking position in which the locking member (38a) is engageable within the locking detent (28g). An operating member (40) associated with the first knee component (L) is engageable with the first lock component (38). The operating member (40) is movable between positions in which the locking member (38a) is respectively restrained from, and free for, movement towards the locking position.

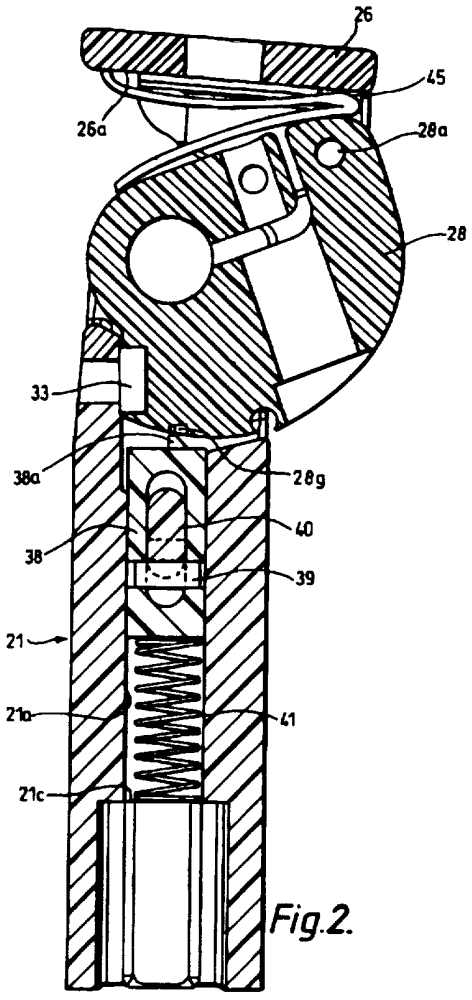

Fig.2.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

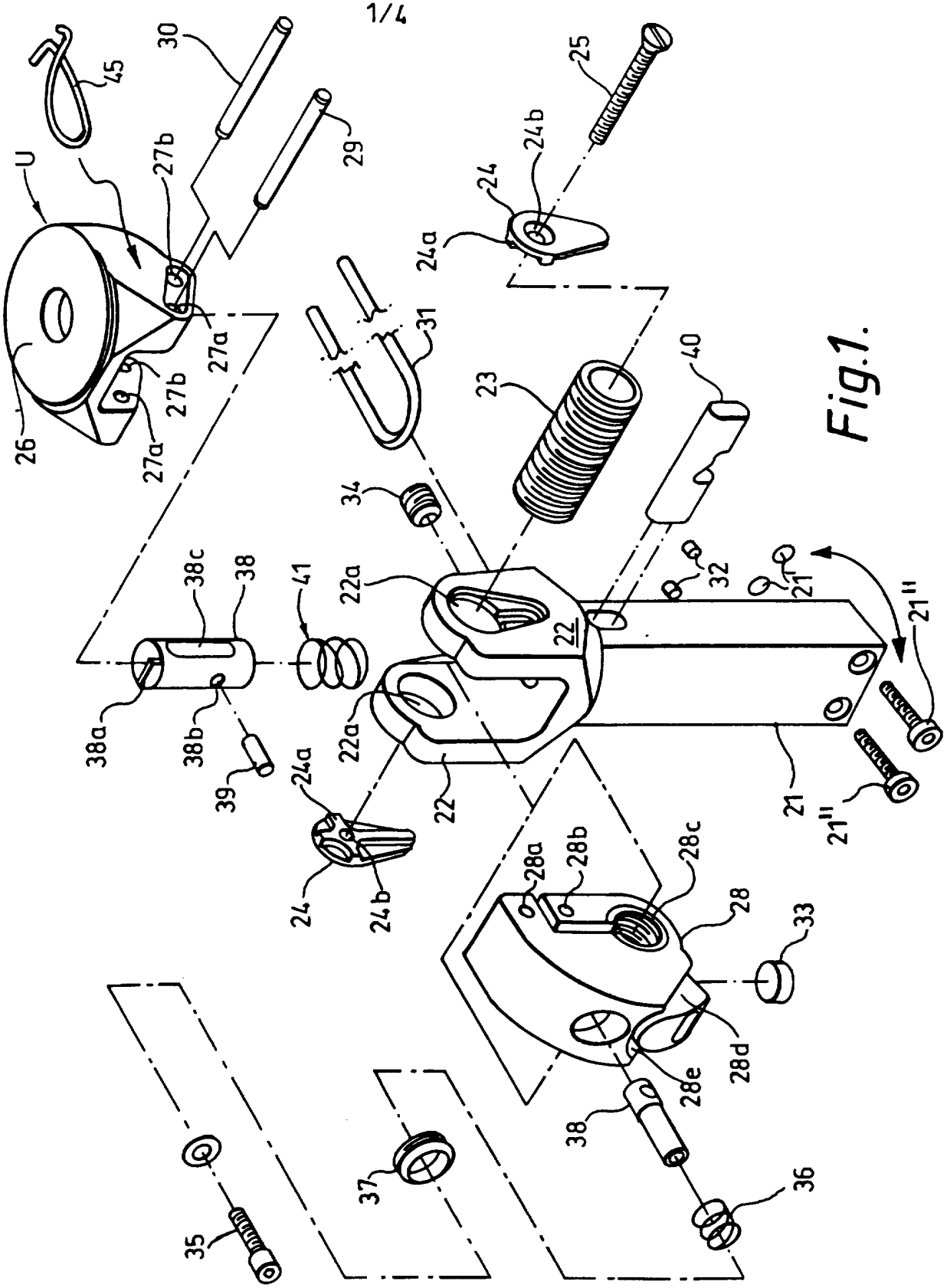
U
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Fig.1.

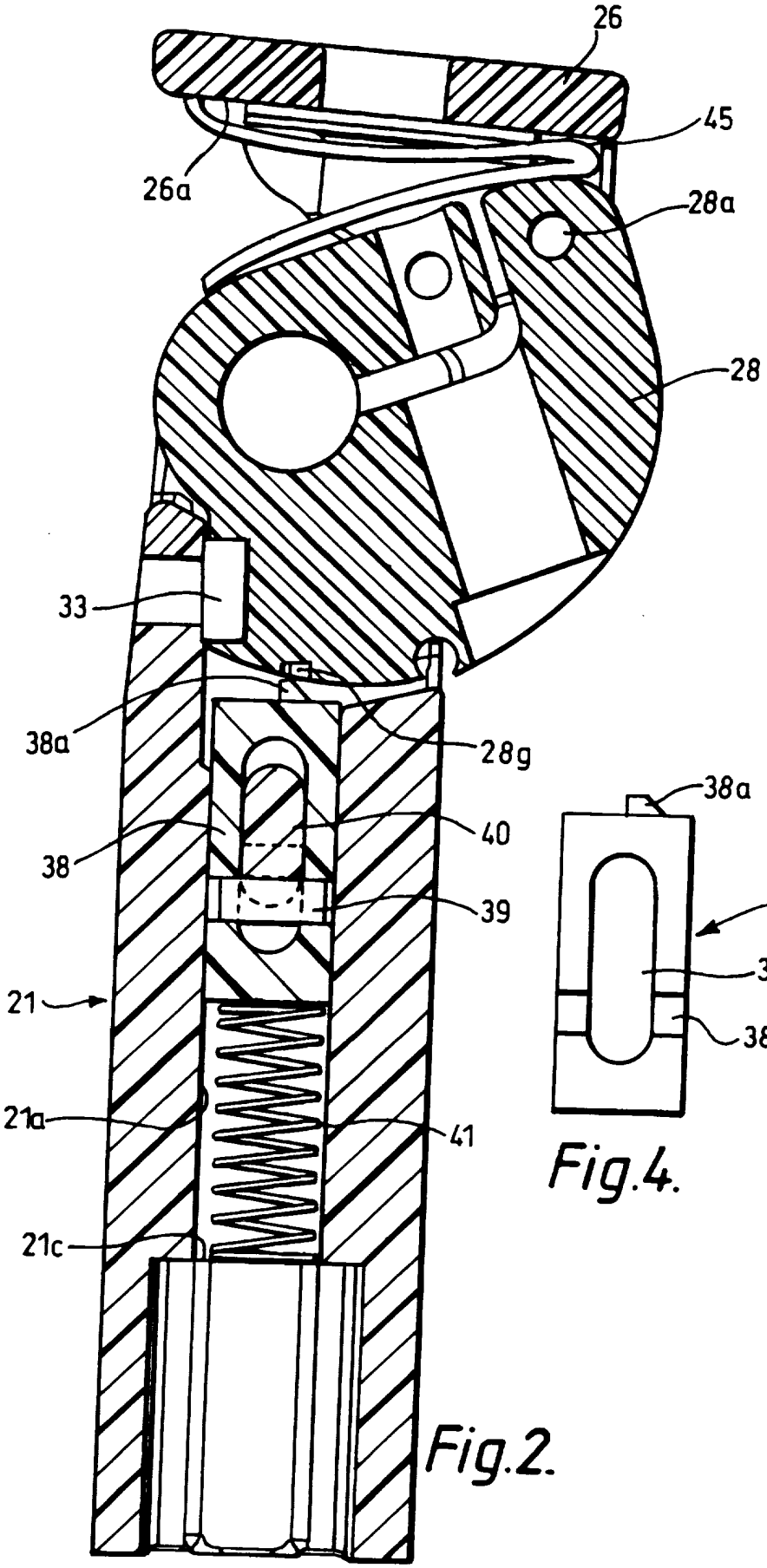

Fig.2.

Fig.4.

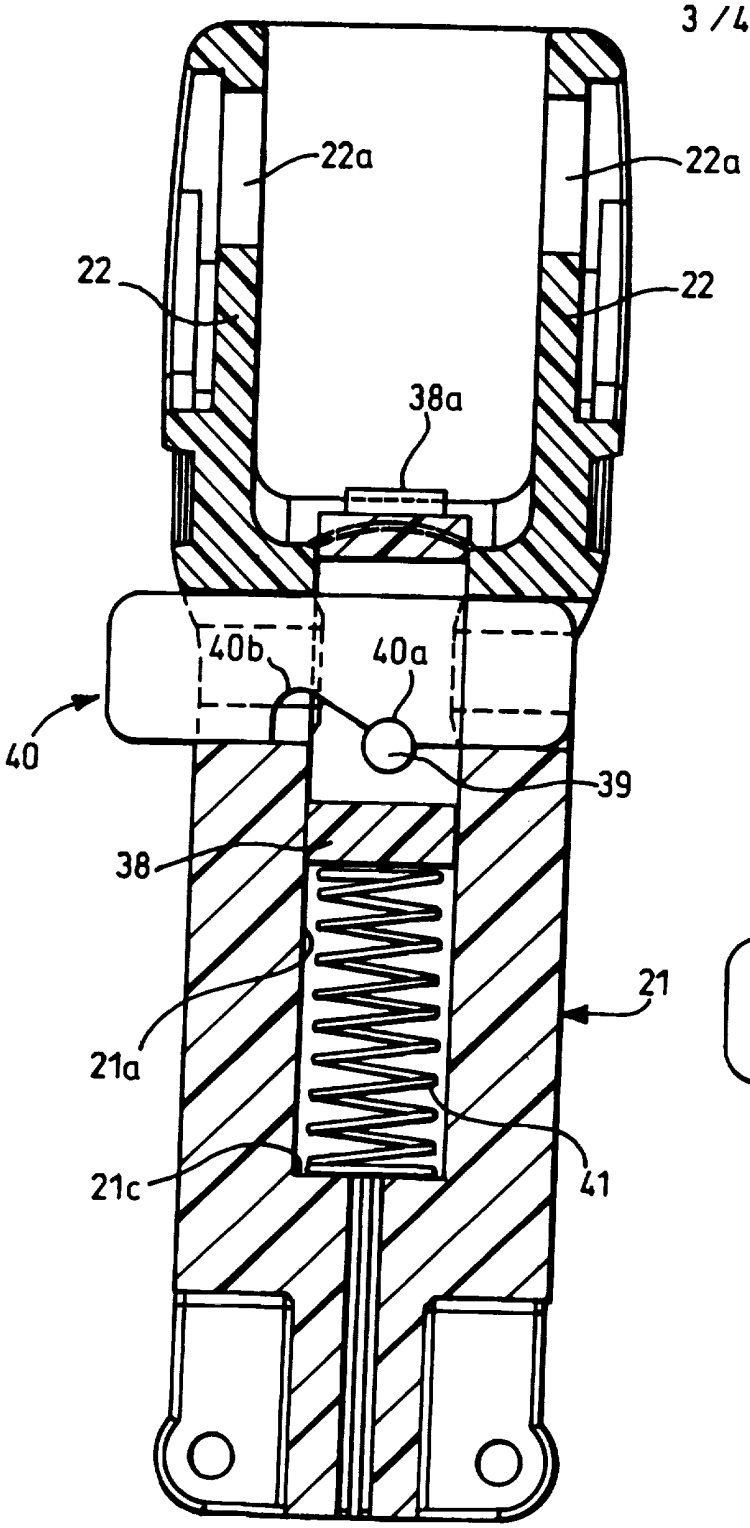

Fig.3.

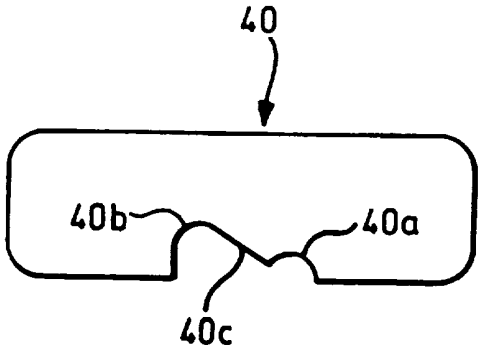

Fig.5.

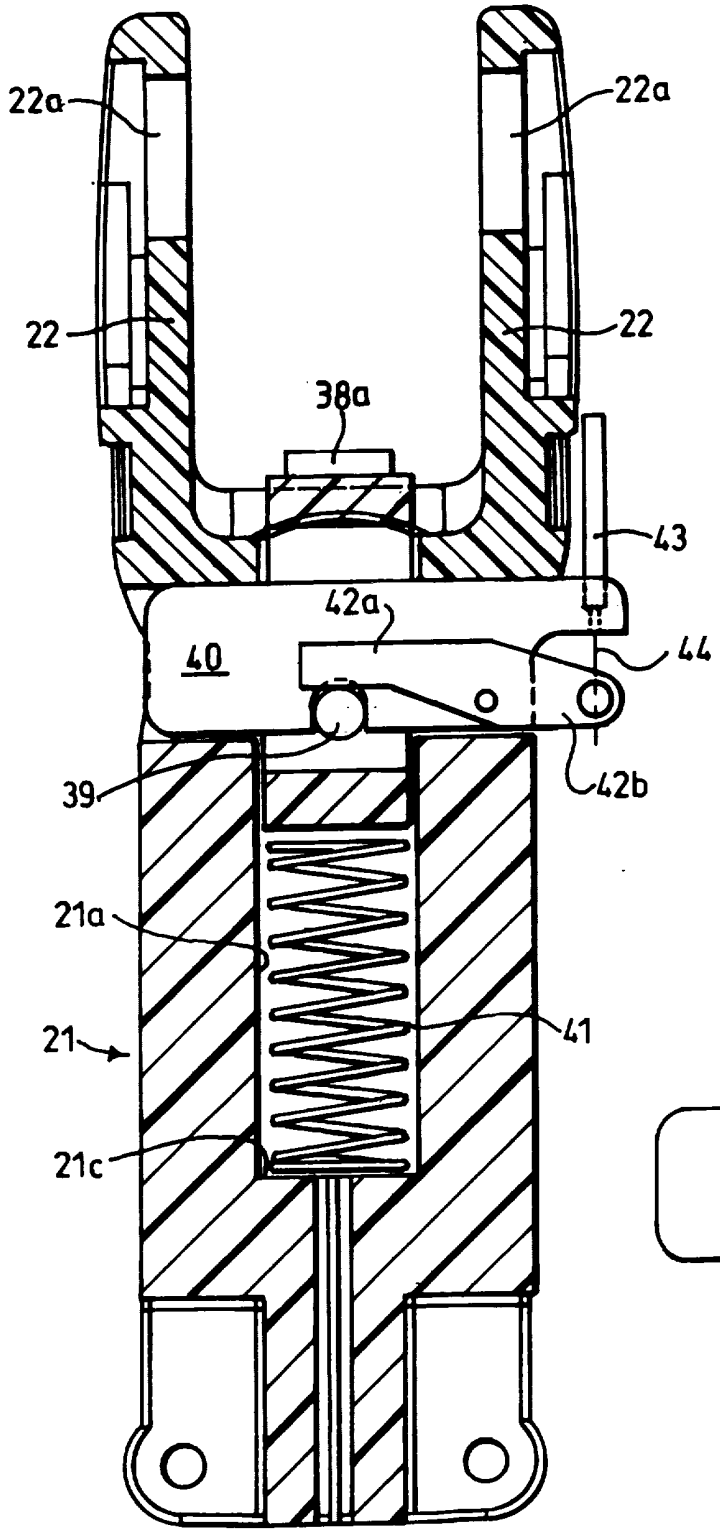

Fig.6.

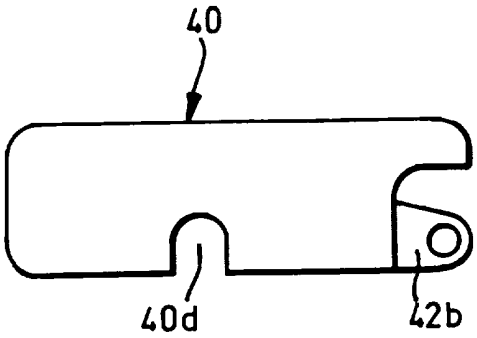

Fig.7.

KNEE PROSTHESIS

This invention relates to a knee prosthesis.

It is usual for a leg amputee to wear a prosthesis in order to provide the wearer with improved mobility. Such a prosthesis should be comfortable to wear, and should simulate the natural movement of the replaced limb.

A known knee prosthesis includes a pair of split collars pivotally attached, in use, to a thigh member and a shin member respectively. One of the collars carries a brake drum, around which a brake band passes. In use, as the knee is loaded, an actuating lever engages the brake band to tighten it against the brake drum, thereby locking the knee in any desired position. The disadvantage of this known artificial knee is that it requires the use of machined elements, and so is relatively expensive. It is also difficult to provide such a prosthesis with means for locking the knee in an extended position.

The aim of the invention is to provide an improved form of artificial knee.

The present invention provides an artificial knee comprising first and second pivotally interconnected knee components, first and second interengaging lock components associated respectively with the first and second knee components for locking the knee components together when in a predetermined pivotal configuration, the first lock component being slidably mounted with respect to the first knee component, and being provided with a locking member which is engageable within a locking detent associated with the second knee component, the locking detent constituting the second lock component, spring means for biassing the first lock component towards a locking position in which the locking member is engageable within the locking detent, and an operating member associated with the first knee component and engageable with the first lock component, the operating member being movable between first and second operating positions, in which the locking member is respectively restrained from, and free for, movement towards the locking position.

In a preferred embodiment, the artificial knee further comprises first and second interengaging brake components for locking the knee components together, the first and second brake components being associated respectively with the first and second knee components, one of the brake components being made of a resiliently deformable material,

and the arrangement being such that, when the artificial knee is subjected to a first load condition, the brake components are substantially free to slide against one another, and, when the artificial knee is under a second, higher load condition, said one brake component is resiliently deformed against the other brake component to lock the two brake components together, thereby locking the two knee components together.

Advantageously, the first and second brake components are provided with interengaging surfaces which are inclined to the axis about which the two knee components are pivoted, and the first and second brake components constitute the pivotal interconnection between the two knee components. Preferably, the first and second brake components are inner and outer brake members, the outer brake member being rotatable about the inner brake member about the axis of rotation of the knee, and the locking detent is formed in the outer periphery of the outer brake member.

Conveniently, the first brake component is an externally-screw threaded member, the flanks of the threads being inclined to the pivot axis. Preferably, the first brake component is provided with an acme screw thread. The first brake component may be made of a generally rigid material such as stainless steel.

Preferably, the second brake component has a base portion and a pair of arms, the internal surface of the base portion being rounded and being provided with an internal screw thread which complements the external screw thread of the first brake component. Advantageously, the second brake component is said one brake component and said resiliently deformable material is a plastics material, and the locking detent is formed in the base portion of the second brake component,

In a preferred embodiment, the operating member passes through an elongate aperture provided within the first lock component, and is formed with cam means for engagement with the first lock component. Conveniently, the cam means is constituted by a pair of notches and an intermediate cam surface, the first and second notches being engageable with the first lock component when the operating member is respectively in its first and second operating positions. Preferably, the artificial knee further comprises a pin associated with the first lock component, the pin being mounted at right-angles to the operating member and co-operating, in use, with the first and second notches when the operating member is in its first and second operating positions.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which:-

Figure 1 is an exploded perspective view of a first form of prosthetic knee constructed in accordance with the invention;

Figure 2 is a longitudinal cross-section of part of the first form of prosthetic knee, and shows the knee in an "unlocked" position;

Figure 3 is a longitudinal cross-section, taken at right-angles to that of Figure 2, and also shows the knee in an "unlocked" position;

Figure 4 is a side elevation of a locking member of the first form of knee;

Figure 5 is a side elevation of a lock actuating member of the first form of knee;

Figure 6 is a longitudinal cross-section similar to that of Figure 3, of a second form of prosthetic knee constructed in accordance with the invention, and shows the knee in a "locked" position; and

Figure 7 is a side elevation of a lock actuating member of the second form of knee.

Referring to the drawings, Figures 1 to 5 show a first form of prosthetic knee having upper and lower members, indicated generally by the references U and L, pivotally interconnected in the manner described below. In use, the upper member U is fixed to an above-knee socket (not shown), and the lower member L is fixed to an artificial shin (not shown).

The lower member L is constituted by a generally rectangular base 21, and a pair of integrally-formed, upwardly-extending lugs 22. The base 21 can be fastened to an artificial shin (not shown) by means of nuts 21a and bolts 21b. The lower member L is made of glass-fibre-filled-nylon 6,6. The lugs 22 are formed with aligned apertures 22a. An acme screw 23, having a thread of trapezoidal cross-section is supported within the apertures 22a in the lugs 22. The acme screw 23 is made of stainless steel, and is prevented from rotating relative to the lugs 22 means of a pair of torque arms 24 mounted in correspondingly-shaped apertures 22b formed in the lugs. The torque arms 24 are each formed with a cross-shaped projection 24a, these projections mating with slots (not shown) formed in the opposite end faces of the screw 23. The torque arms 24 are fixed to the lugs 22 by a threaded pin 25 which passes through aligned apertures 24b in the torque arms, through the centres of the apertures 22a, and centrally through the screw 23. The

screw 23 is formed with an external acme screw thread 23a having five turns per inch (0.2 inch pitch).

The upper member U is a one-piece moulded member made of glass-fibre-filled nylon 6,6. The member U includes an upper base plate 26, and an lower, partially cut-away tubular section 27. The section 27 is pivotally connected to the lower member L in a manner described below. The base plate 26 is fixed to the above-knee socket by means of an alignment mechanism (not shown).

A generally D-shaped brake member 28 is mounted in the tubular section 27 of the upper member U by means of a pair of pins 29 and 30. The pin 29 passes through aligned circular apertures 27a in the tubular section 27, and through a circular aperture 28a in one arm of the brake member 28. The pin 30 passes through aligned elongate apertures 27b in the section 27, and through a circular aperture 28b in the other arm of the brake member 28. The brake member 28 is made of unfilled nylon 6,6, and is formed with an internal trapezoidal cross-section (acme) screw thread 28c which complements the external screw thread 23a of the screw 23. The brake members 23 and 28 constitute load-bearing means for pivotally connecting the upper and lower members U and L.

The brake member 28 is formed with a nose 28d. A bungee cord 31 made of fabric-sheathed rubber passes round the nose 28d and seats in a groove 28e formed between the nose and the main portion of the brake member 28. The free ends of the cord 31 pass down inside the base 21 of the lower member L, and are fixed thereto by threaded members 32. The bungee cord 31 provides extension assist to the knee when unlocked, that is to say it assists the knee to swing forward to straighten the associated leg during walking or running. Thus, as the knee is unlocked, and the leg starts to swing forward, the energy stored in the bungee cord 31 (by the action of bending the knee during the immediately preceding loading process) is released to act on the nose 28d and assist with the knee extension action.

In use, the internal thread 28c of the brake member 28 is a sliding fit on the thread 23a of the acme screw 23 when the prosthetic knee is not under load, and there is a clearance between the free end of the thread 23a and the base of the internal thread 28c. When the brake member 28 is loaded, the threads 28c and 23a tend to move in directions jamming their flanks together, thereby locking the brake member to the screw 23.

Although nylon 6,6 running in polished stainless steel produces very low static and dynamic friction, the angle of the interengaging flanks of the threads 23a and 28c produces a total reaction force which is much greater than the radial load on the screw 23, thereby achieving good resistance to torque (and hence good braking) with relatively low applied loads. This braking action is described in greater detail in WO97/10781.

This prosthetic knee includes a hyper-extension stop 33 seated in a counter-bore 28f in the brake member 28. The stop 33 co-operates with an adjustable stop member 34 constituted by a screw mounted in a threaded bore formed in the lower member L.

The braking arrangement of Figures 1 to 5 is operated by rotating the two pins 29 and 30 about each other, these pins being roughly in line with the centreline of the axis of rotation of the knee members L and U, that is say with the axis of the acme screw 23. The rotation of the pins 29 and 30 about each other in the anti-clockwise direction (as seen in Figure 2) thus imparts a powerful mechanical "squeezing" of the screw 23, providing braking action.

In order to provide the necessary adjustability for the brake mechanism, the brake member 28 is held in a disengaged state when the knee mechanism is not weight bearing by means of a threaded pin 35 and a spring 36. A hollow adjusting screw 37 serves to pre-load the spring 36 appropriately for each user of the knee. This is especially important to ensure that the knee both brakes under weight bearing in every stride, and releases as weight is removed to allow free swing of the shin. The threaded pin 35 is attached to the pin 30 by means of a clevis 38 and bears on the adjusting screw 37 effectively preventing relative counter-clockwise rotation of the pins 29 and 30. Tightening of the threaded pin 35 then removes excessive clearance between the brake member 28 and the acme screw 23, and adds friction for swing control. The pin 35 thus prevents the brake member 28 from separating as hyper-extension loads rotate the pins 29 and 30 in the "loosen" (clockwise) direction (as seen in Figure 2).

The prosthetic knee described above is similar to that of the embodiment of Figures 10 to 12 of W097/10781. This prosthetic knee does, however, include a releasable locking mechanism which gives the knee advantages over that of WO97/10781. A first form of locking mechanism, constructed in accordance with the invention, is shown in Figures 2 to 5. This mechanism includes a latch 38 which is made of aluminium, and is

slidably mounted within a channel 21a formed in the base 21 of the lower member L. The upper end of the latch 38 is formed with a projection 38a which, in use, is engageable with a notch 28g formed in the brake member 28. The latch 38 supports a pin 39 which is made of stainless steel, and is positioned within a circular diametrical aperture 38b. An actuating lever 40 which is made of aluminium, is slidably mounted within an aperture 21b formed at right-angles to the axis of the base 21, the actuating member also passing through an elongate aperture 38c formed within the latch 38 at right-angles to the circular aperture 38b. As shown in Figures 3 and 5, the actuating member 40 is formed with a pair of notches 40a and 40b in its lower surface, the two notches being connected by an inclined cam surface 40c. A compression spring 41 acts between the lower surface of the latch 38 and an abutment surface 21c provided at the lower end of the channel 21a. The spring 41 does, therefore, bias the latch 38 upwards, tending to move the projection 38a towards the brake member 28.

As can be seen from Figure 3, the pin 39 is engageable in either of the notches 40a and 40b. When the actuating member 40 is in the position shown in Figure 3, the pin 39 engages within the notch 40a, thereby holding the latch 38, against the force of the spring 41, in a position in which the projection 38a is held down away from the brake member 28. Thus, even if the notch 28g is in alignment with the projection 38a, the brake member 28 is free to rotate, and is in the unlocked position. If, however, the actuating member 40 is moved to the right of the position shown in Figure 3, so that the pin 39 slides along the cam surface 40c and into the notch 40b, the spring 41 is effective the move the latch 38 upwards so that, provided they are in alignment, the projection 38a can move upwards into the notch 28g to lock the brake member 28 against rotation with the knee in the fully extended position.

The locking mechanism described above enables an amputee to lock the knee in the fully extended position, and to release the knee from this position, by a simple sliding movement of the actuating member 40. This permits the knee to be locked in full extension, which is particularly useful for an amputee in many situations, for example on uneven ground, when going downhill or down steps, nd when moving through a resistant medium such as long grass or water. The locking of the knee in this manner prevents unexpected knee flexions in situations where there is resistance to forward movement of

the foot. Locking of the knee in full extension is also useful when an amputee takes a shower, as locking the knee in the extended position enables the amputee to wear the prosthetic device whilst showering, thereby enabling an amputee to maintain a stable stance. In this connection, it should be noted that prosthetic knees which do not have locking mechanisms are usually removed by an amputee, when showering, to prevent unexpected knee flexions.

Figures 6 and 7 show a modified form of locking mechanism. Only the modified parts of this mechanism will be described in detail, and like reference numerals will be used for like parts. The main modification is that the actuating member 40 has a single notch 40d an actuating lever 42 being pivotedly mounted on the actuating member 40. The actuating lever 42 has a first arm 42a which is engageable with the pin 39, and a second arm 42b which extends away from the pivot in the opposite direction to the arm 42a. The free end of the arm 42b is connected to a release lever 43 by means of a cable 44. The release lever 43 can be operated to pivot the actuating lever 42 from the locked position shown in Figure 6, in which the free end of the arm 42a is raised and the free end of the arm 42b is depressed, into the unlocked position, in which the free end of the arm 42b is raised and the free end of the am 42a is depressed, thereby forcing the pin 39, and hence the latch 38, downwards against the force of the spring 41. Thus, with the actuating lever 42 in the locked position, the projection 38a is in engagement with the notch 28g, and the brake member 28 is locked. In order to release the locking mechanism, it is merely necessary to pull on the operating lever 43, thereby pivoting the actuating lever 42 and depressing the pin 39 and the latch 38.

Although the prosthetic knees described above are largely made of what is generally considered to be low strength materials (such as nylon 6,6 or partially-filled nylon 6,6), the particular locking arrangements described provide effective locking without risk of damaging the knee components. This is because the locking member (the notch 28g) provided on the brake member 28 is positioned as far away as possible from the axis of rotation of the knee, that is to say on the periphery of the brake member. This ensures a maximum moment arm for the force applied to the brake member 28 by the latch 38, and so ensures a minimum locking force applied to the brake member.

The prosthetic knee described above may be modified by providing a spring 45 (see Figures 1 and 2) between the underneath surface 26a of the upper base plate 26 and the adjacent surface of the brake member 28. This spring may be a generally U-shaped leaf spring whose opposite arms bear respectively on the surface 26a and the brake member 28. This spring may be made of plated, galvanised music wire, and acts to enhance brake release by rotating the pins 29 and 30 about each other in the clockwise direction (as seen in Figure 2), thereby releasing the mechanical "squeezing" of the screw 23.

CLAIMS

1. An artificial knee comprising first and second pivotally interconnected knee components, first and second interengaging lock components associated respectively with the first and second knee components for locking the knee components together when in a predetermined pivotal configuration, the first lock component being slidably mounted with respect to the first knee component, and being provided with a locking member which is engageable within a locking detent associated with the second knee component, the locking detent constituting the second lock component, spring means for biassing the first lock component towards a locking position in which the locking member is engageable within the locking detent, and an operating member associated with the first knee component and engageable with the first lock component, the operating member being movable between first and second operating positions, in which the locking member is respectively restrained from, and free for, movement towards the locking position.

2. An artificial knee as claimed in claim 1, further comprising first and second interengaging brake components for locking the knee components together, the first and second brake components being associated respectively with the first and second knee components, one of the brake components being made of a resiliently deformable material, and the arrangement being such that, when the artificial knee is subjected to a first load condition, the brake components are substantially free to slide against one another, and, when the artificial knee is under a second, higher load condition, said one brake component is resiliently deformed against the other brake component to lock the two brake components together, thereby locking the two knee components together.

3. An artificial knee as claimed in claim 2, wherein the first and second brake components are provided with interengaging surfaces which are inclined to the axis about which the two knee components are pivoted, and the first and second brake components constitute the pivotal interconnection between the two knee components.

4. An artificial knee as claimed in claim 2 or claim 3, wherein the first and second brake components are inner and outer brake members, the outer brake member being rotatable about the inner brake member about the axis of rotation of the knee.

5. An artificial knee as claimed in claim 4, wherein the locking detent is formed in the outer periphery of the outer brake member.

6. An artificial knee as claimed in any one of claims 1 to 5, wherein the first brake component is an externally-screw threaded member, the flanks of the threads being inclined to the pivot axis.

7. An artificial knee as claimed in claim 6, wherein the first brake component is provided with an acme screw thread.

8. An artificial knee as claimed in claim 6 or claim 7, wherein the first brake component is made of a generally rigid material such as stainless steel.

9. An artificial knee as claimed in any one of claims 6 to 8, wherein the second brake component has a base portion and a pair of arms, the internal surface of the base portion being rounded and being provided with an internal screw thread which complements the external screw thread of the first brake component.

10. An artificial knee as claimed in claim 9 when appendant to claim 8, wherein the second brake component is said one brake component and said resiliently deformable material is a plastics material.

11. An artificial knee as claimed in claim 9 or claim 10, wherein the locking detent is formed in the base portion of the second brake component.

12. An artificial knee as claimed in any one of claims 1 to 11, wherein the operating member passes through an elongate aperture provided within the first lock component, and is formed with cam means for engagement with the first lock component.

13. An artificial knee as claimed in claim 12, wherein the cam means is constituted by a pair of notches and an intermediate cam surface, the first and second notches being engageable with the first lock component when the operating member is respectively in its first and second operating positions..

14. An artificial knee as claimed in claim 12 or claim 13, further comprising a pin associated with the first lock component, the pin being mounted at right-angles to the operating member and co-operating, in use, with the first and second notches when the operating member is in its first and second operating positions.

15. An artificial knee substantially as hereinbefore described with reference to, and as illustrated by, Figures 1 to 5 or Figures 6 and 7 of the drawings.

The Patent Office

12

Application No: GB 9724679.7
Claims searched: 1-15

Examiner: Anwar Gilani
Date of search: 13 March 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): A5R (RFA)

Int Cl (Ed.6): A61F 2/60, 2/64, 2/68

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP0016268 A1	(ROBERT KELLIE & SON) p.7 l.30-p.8 l.11, claim 1	1
A	WO95/30391 A1	(AMBROISE HOLLAND B.V.) p.10 l.28-33	1
A	US4685926	(HAUPT) column 4, l.34-39, figs. 1 and 2	1

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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