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Friberg

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[54] **ARTIFICIAL LEG**

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[52] **U.S. Cl.** **3/21,** 3/1.2, 3/23, 3/27

[51] **Int. Cl.** **A61f 1/08**

[58] **Field of Search** 3/22–29, 1.2, 3/21

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Assistant Examiner—Ronald L. Frinks
Attorney, Agent, or Firm—Harness, Dickey & Pierce

[57] **ABSTRACT**

An artificial leg — of modular structure — for above-knee amputees comprising a thigh section, a shank section, and a knee joint connecting the thigh and shank sections. The shank section is formed with an ankle to which is journalled a foot section. A mechanism is provided to bring about controls over the shank section motions, said mechanism being housed in a shell-shaped calf section constituting the upper part of the shank. The ankle has a cylindrical top portion received in a sleeve in the lower portion of the calf section for securing and adjusting said ankle relatively the calf section. At the lower end of the calf section is also arranged a base designed and serving to receive and secure a fork-like attachment means in which the lower end of said mechanism is journalled.

3 Claims, 7 Drawing Figures

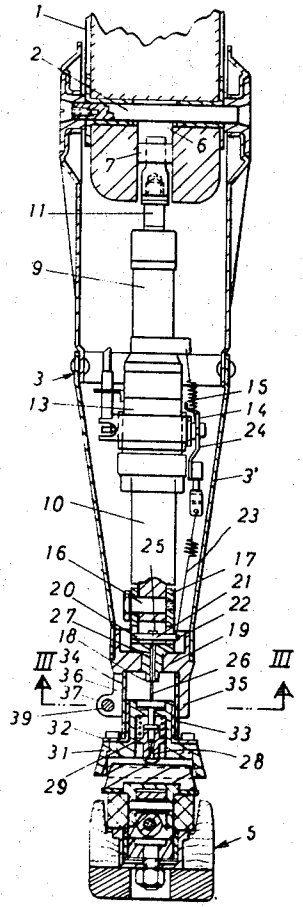

Fig. 1

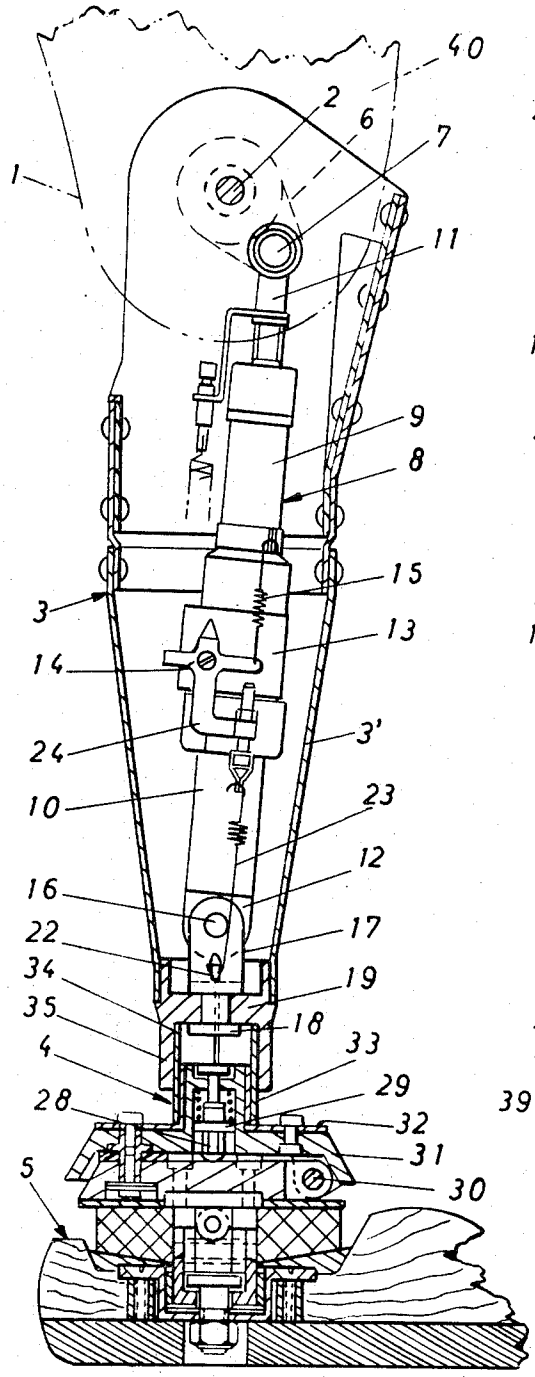
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Fig. 2

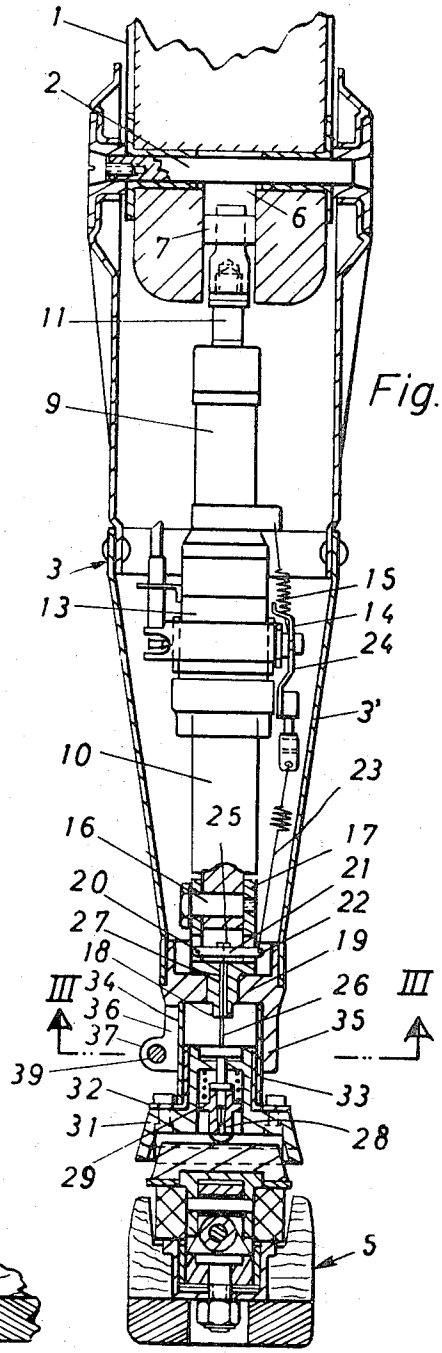
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Fig. 4

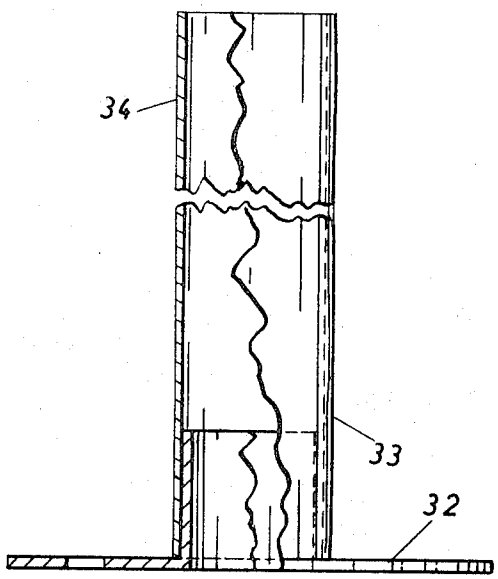


Fig. 6

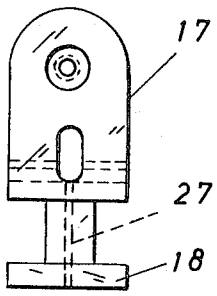


Fig. 7

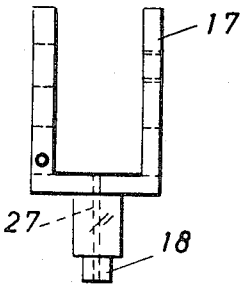


Fig. 5

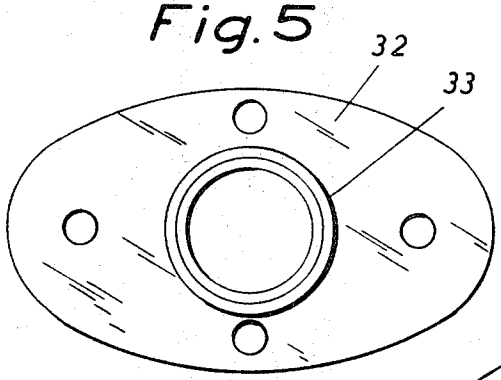
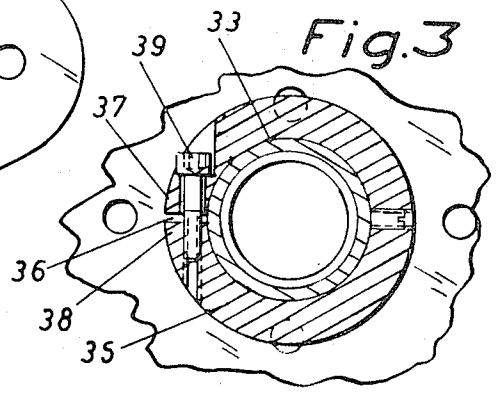


Fig. 3



ARTIFICIAL LEG

BACKGROUND OF THE INVENTION

The present invention relates to artificial legs and particularly to above-knee prostheses comprising an upper leg component or thigh section which by means of a knee joint shaft is pivotally connected to a lower leg component or shank section having an ankle portion to which an artificial foot is preferably pivotally connected, and also comprising a mechanism or unit controlling the shank section motions, i.e., knee flexion or knee extension, during the swing phase and/or stance phase. The shank section comprises a calf-section shaped as a shell and in the interior of which said mechanism or unit controlling the knee joint functions as defined above is enclosed.

In establishing which qualities and functions are to be imparted to an artificial leg it is of utmost importance to doctors and prosthetists that they are able to observe the ability of the amputee to take advantage of these qualities and functions. The majority of the observations must be carried out in connection with studies during the walk training exercises or other kinesiotherapy exercises of the amputee. This is true both in the case of patients who have previously been amputated and who want to replace an out-of-date prosthesis by a more modern and multifunctional one as in the case of recent amputees.

It is highly desirable that the kinesiotherapy starts as soon as possible after the amputation as an early start has a decisive influence on the obtainment of optimum recovery of the convalescent as well as of optimum conditioning of his leg stump. In order to be able to start the therapy early it is necessary that a temporary prosthesis is immediately available. This temporary prosthesis must be multifunctional, i.e., it must be capable of performing all the functions required to enable the patient at the earliest possible stage of his walking training to achieve good posture and the best possible gait and ambulatory capability.

A leg prosthesis which does not meet these requirements constitutes and impediment to the patient and in the long run may even be harmful to him. At the same time such a faulty prosthesis deprives the rehabilitation team (including doctors and prosthetists) of the advantages of acquiring an extensive basis for their evaluation and prescription of the permanent prosthesis. The prescription of a leg prosthesis is difficult enough even without such lack of an adequate evaluation basis.

Hitherto commercially available and partly mounted fittings of wood — so called set-ups — are not suitable for use as temporary prostheses. The reason therefor is that they are heavy and that they are not suited for or do not lend themselves to be simply and quickly mounted. Even less do they permit selection among a plurality of available mechanisms for controlling for instance the knee joint functions of one particular mechanism which may be especially well suited in the individual case. Consequently, it becomes impossible to reproduce many of the various functions which must be studied and considered before the design of the final and permanent prosthesis most adequate for the patient can be decided upon.

In this connection it should be remembered that in recent years the possibilities of rehabilitating amputees have improved considerably in as much as a new technique is now being used. This new technique accentuates the need of immediate access to a temporary prosthesis and emphasizes the need for a system of prefabricated and precision-made prosthetic components which allow themselves to be quickly and simply assembled into a multifunctional, temporary prosthesis which may be completed or converted to form a permanent (final) prosthesis providing all the functions which in the individual case are desirable in order to meet high demands on comfort, cosmesis and ambulatory capability. To use provisional components and maybe components chosen at random for the temporary prosthesis is undesirable as such components will impede rather than further a correct composition of the prosthesis and make it impossible to achieve an acceptable biomechanical function. The use of such makeshift prosthetic parts has hitherto been allowed too extensively to attain the per se desirable rapid start of the kinesiotherapy for recent amputees. Almost without exceptions the consequence has been an artificial gait which far from resembles the best possible gait that the patient may achieve. In addition to mounted set-ups of wood intended for so called conventional prostheses and which are not suited for making up a temporary prosthesis, a multitude of types and brands of components are available on the market which are constructed for — and in shape and design limited to — one particular device or mechanism for controlling the knee joint during the swing or stance phases. These components are completely adjusted to the functions of the mechanism in question. The mechanism is often bulky and as a result the minimum dimensions of the finished prosthesis do not permit the configuration and shape of the prosthesis to simulate those of the natural leg. For this reason it becomes impossible to fully meet the demands on function and cosmesis, i.e., on good design and adequate performance. Further disadvantages are the heavy weight and the length of time necessary to assemble the prosthesis. The above-mentioned drawbacks apply to recent amputees as well as to prior amputees.

These last-mentioned constructions thus are definitely unsuitable as temporary prostheses. As they are limited by the functions of a particular mechanism they do not offer a broad and adequate basis for the evaluation by the rehabilitation team. Their inadequacy as temporary prostheses also makes them less fit for use as permanent or final prostheses. The reason herefor is that the patient would be forced to readjust the motion pattern adopted during the training with the aid of the temporary prosthesis, the latter serving the double purpose — in the case of recent amputees — of providing an adequate conditioning of the stump and — in the case of both recent amputees and prior amputees — of providing for optimum ambulatory capability and walking technique. A permanent prosthesis which does not perform the functions which during the kinesiotherapy have been found suitable and fitting for a particular amputee patient naturally cannot be prescribed or accepted by the modern rehabilitation technique.

Also other types have been used as temporary artificial legs. Most of them do, however, suffer from several defects largely reducing their suitability as prostheses for temporary or permanent use.

It is thus important that the temporary prosthesis lends itself to reproducing a plurality of various functions concerning knee joint control, ankle function, co-

ordination between knee and feet motions, and so on. Obvious reasons speak for constructing the temporary prosthesis in a way enabling it to be easily and advantageously completed and converted into a multifunctional and permanent prosthesis. The types of prostheses now available do not fulfil these fundamental demands. They suffer from one or several of the following drawbacks:

1. They reduce the prosthetic team's observations on the amputee into one type only of a friction during the swing phase — most often the mechanical friction which is far from acceptable from a biomechanical point of view;

2. they are reduced to use in connection with one single mechanism for controlling the knee joint functions;

3. they presuppose the use of maybe one single type of artificial foot, it being then indirectly — but inacceptably so — assumed that this foot and its particular alignment is a good choice for all amputees;

4. they do not enable obtainment of acceptable cosmesis, nor do they offer adequate protection of the mounted mechanism for swing and/or stance control (this is true of the few types constructed for such mounting), and

5. without exceptions they suffer from the severe limitation of not providing means or devices to coordinate the knee joint function with that of the ankle and foot. Such coordination is an absolute requirement if one is to simulate with any degree of success the function of the natural leg in this respect, which simulation at least one mechanism for swing and stance control available today is capable of performing.

SUMMARY OF THE INVENTION

The present invention eliminates the above-mentioned drawbacks and makes it possible to convert in a simple way a temporary prosthesis into a permanent one. The invention is characterised in that the ankle at least at its upper end is in the shape of a cylindrical tube and that the lower end of the shell-shaped calf section is provided with a clamping means adapted to enable vertical adjustment of the ankle relatively to the shell-shaped calf section and to secure said ankle to said calf section, and in that the lower end of the shell-shaped calf section is provided with a base portion serving to secure an attachment means to which the lower end of the knee function controlling mechanism is preferably hingedly connected.

Among the advantages obtained by means of the invention may be mentioned the following:

The length of the prosthesis may be altered in a simple an quick way, which is important for children and teen-agers during their growth period;

Simplified storage of prosthesis components with the surgical prosthetist or in clinics, as the shank, the knee joint mechanism, the ankle and the artificial foot may be standardized and only the ankle needs be cut into the correct length before mounting,

knee joint mechanisms of various types for swing and for stance control may be mounted in the shank section, and

by means of cosmetic covers of foam plastic the leg may be given a shape corresponding to the shape of the sound leg.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described more in detail in the following with reference to the accompanying drawings wherein

FIG. 1 is a vertical longitudinal section through an artificial leg in accordance with the invention,

FIG. 2 is a similar longitudinal section as seen when the leg is turned over 90° relatively FIG. 1,

FIG. 3 illustrates on an enlarged scale a horizontal longitudinal section along linge III—III in FIG. 2,

FIG. 4 is a side view showing partly in longitudinal section an upright incorporated in the ankle part,

FIG. 5 is a plan view of the upright in FIG. 4,

FIG. 6 is a side view of a fork member incorporated in the shank section, and

FIG. 7 is an end view of the fork member of FIG. 6.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The upper leg or thigh socket **1** is as shown in FIG. **1** connected to the lower leg component or shank section **3** by means of a shaft **2** forming the articulated knee joint. The shank section **3** comprises a shell-shaped calf section **3'** at the lower portion of which an ankle **4** is attached so as to be articulated to an artificial foot **5.** From the thigh socket **1** projects forwardly an arm **6** which by means of a pivot **7** is connected to the upper end of an hydraulic mechanism **8** providing swing and stance phase control and permitting rotational movement of the shank section **3** relatively the thigh socket **1** within an angle of about 130°. In accordance with the embodiment illustrated, the hydraulic mechanism **8** comprises two cylinders **9, 10** which contain liquid and are positioned co-axially in the longitudinal direction relatively each other and have one displaceable piston (not shown) each. These pistons are rigidly attached on a common piston rod **11.** Reference number **12** designates the attachment loop of the lower cylinder **10.** The piston rod **11** extends through a bushing in a valve housing **13** positioned between the cylinders **9, 10.** In the valve housing is inserted a valve (not shown) provided with a valve arm **14** by means of which a channel communicating the interiors of the two cylinders **9, 10** may be closed off to block the knee joint in a particular position. The valve is turned to closing position by means of a traction spring **15.**

The mechanism **8** controlling the knee joint functions, i.e., the swing and stance phases, is hingedly connected at its lower end by means of a bolt **16** to a fork-like member **17** which by means of a bayonet catch **18** is detachably secured in a base portion **19** at the lower end of the calf section **3'**. The base portion **19** preferably may be made integral with the rest of the calf section **3'**. In the fork member **17** is journalled by means of a pin **20** (or bolt) one end of a lever **21,** the opposite end **22** of which is connected by means of a thread-like link **23** to the lower portion **24** of the valve arm **14.** A coupling wire **26** is attached at its upper end **25** to the lever **21,** said coupling wire passing freely through a vertical channel **27** formed in the fork member **17.** The lower end of the coupling wire **26** is by means of a chuck **28** attached to a regulating member **29** which is operated by the vertical movements of the artificial foot and is vertically displaceable in the ankle portion **4.**

The ankle portion 4 comprises an ankle plate 31 which by means of a horizontal shaft 30 is articulated to the artificial foot 5, a tube-like upright 33 having a flange 32 thereon being attached to said plate 31. The upper end 34 of the upright 33 is insertable in a clamping sleeve 35, said sleeve extending downwardly from the base portion 19. The clamping sleeve 35 is provided with a vertically extending slit 36 and clamping sleeve portions 37 and 38 on either side of said slit 36 may be tightened about ankle means 89 the upper end 34 of the upright by means of a clamping screw 39.

Obviously, the calf section 3' together with its associated control mechanism 8 and the parts pertaining thereto may be stored in for instance a clinic in a mounted condition ready for application in the socket 1 fitting the femoral stump 40 of an amputee. The same calf section 3' may be used for practically all above-knee amputees. Also the artificial foot 5 in a few various sizes thereof may be stored in a mounted condition, ready for use, the ankle portion 4 including the ankle plate 31 being, if desired, also mounted on the artificial foot. After measuring the length of the sound leg of the amputee the length of the artificial leg is established and the upright 33 on the ankle 4 is shortened to the correct length. The coupling wire 26 is attached by means of its lower end to the chuck 28 and the upper upright end 34 is by means of the clamping screw 39 secured after setting of the correct foot angle by turning the upright 33 in the clamping sleeve 35. The artificial leg is thereafter ready for application, followed by adjustment, if needed, and is then fit for use.

The artificial leg may easily be surrounded by sections made of plastics or enclosed in plastics to impart to the prosthesis a configuration which as closely as possible simulates the configuration of the sound leg.

The embodiment as illustrated and described is to be regarded as an example only and the various parts of the prosthesis may be constructively altered in various ways within the scope of the appended claims. Instead of the hydraulic mechanism 8 a purely mechanical device may be used. It is evident that the shank section 3 may house any suitable mechanism of this kind and the invention is not limited to the embodiment disclosed. The invention is not either limited to the construction of the artificial foot 5 illustrated in the drawings. The fork member 17 may be attached to the base portion 19 in some other way than by means of a bayonet catch, for instance by means of a threaded pin.

What I claim is:

1. In an improved artifical leg, particularly intended for above-knee amputees, comprising a thigh section, a shank section, a knee joint shaft articulating said thigh section to said shank section, an ankle section on said shank section, said ankle section comprising an upper ankle plate forming the upper portion of said ankle section, a horizontal shaft, a lower foot plate articulated at the forward end of said ankle plate by means of said horizontal shaft, and a spring being mounted between said foot plate and said ankle plate behind said horizontal shaft for forcing them apart, an artifical foot, means pivotally connecting said artificial foot to said foot plate, a mechanism for controlling the knee joint functions, said shank section comprising a calf section enclosing said knee joint function controlling mechanism, a cylindrical tube portion affixed to and extending upwardly from said upper ankle plate within the lower end of said calf section, clamping means at the lower end of said calf section for enabling adjustment of said cylindrical tube portion and said ankle section relative to said calf section and for securing said ankle section to said calf section, a base portion at the lower end of said calf section above said cylindrical tube portion, an opening formed in said base portion, said horizontal shaft being located ahead of the prosthesis weight supporting line passing through said thigh section, said knee joint shaft and said ankle section, a vertical bore in said upper ankle plate, a clamping element displaceable in said bore, an elongate member clamped by said element, extending in part through said base portion opening and being provided to actuate said knee-joint function controlling mechanism as a result of the vertical displacement of the clamping element in said bore, and a shoulder at the upper end of said bore for holding said spring in a compressed state between said shoulder and said clamping element.

2. An improved artificial leg as set forth in claim 1 wherein the clamping means comprises a clamping sleeve integral with the calf section, said ankle section being rotatably mounted in said clamping sleeve for setting the desired foot angle.

3. An improved artificial leg as set forth in claim 1 wherein the elongate member comprises a flexible transmitter.

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