Sept. 6, 1949. U. K. HENSCHKE ET AL 2,480,856

LEG PROSTHESES

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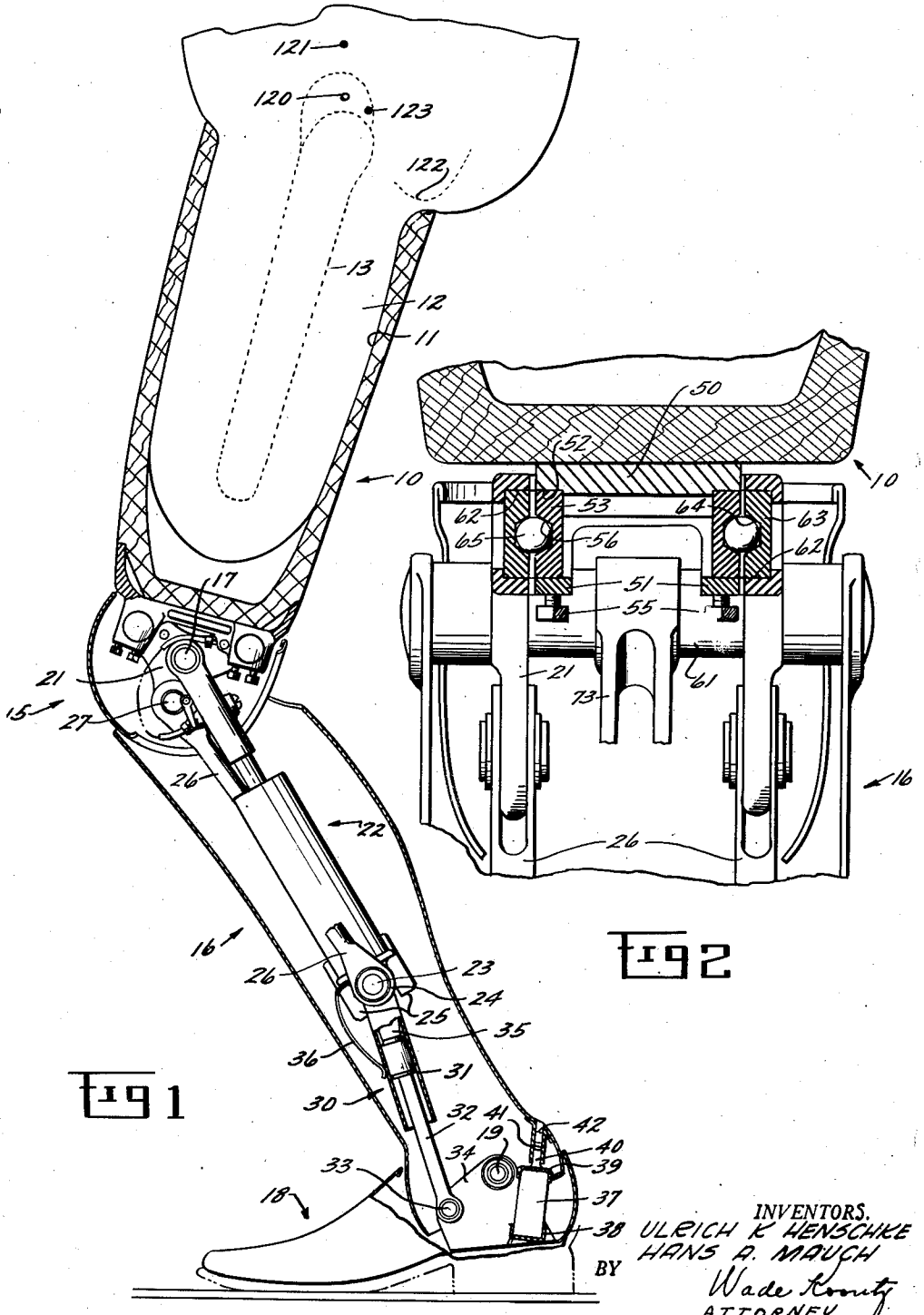


Fig 1

Fig 2

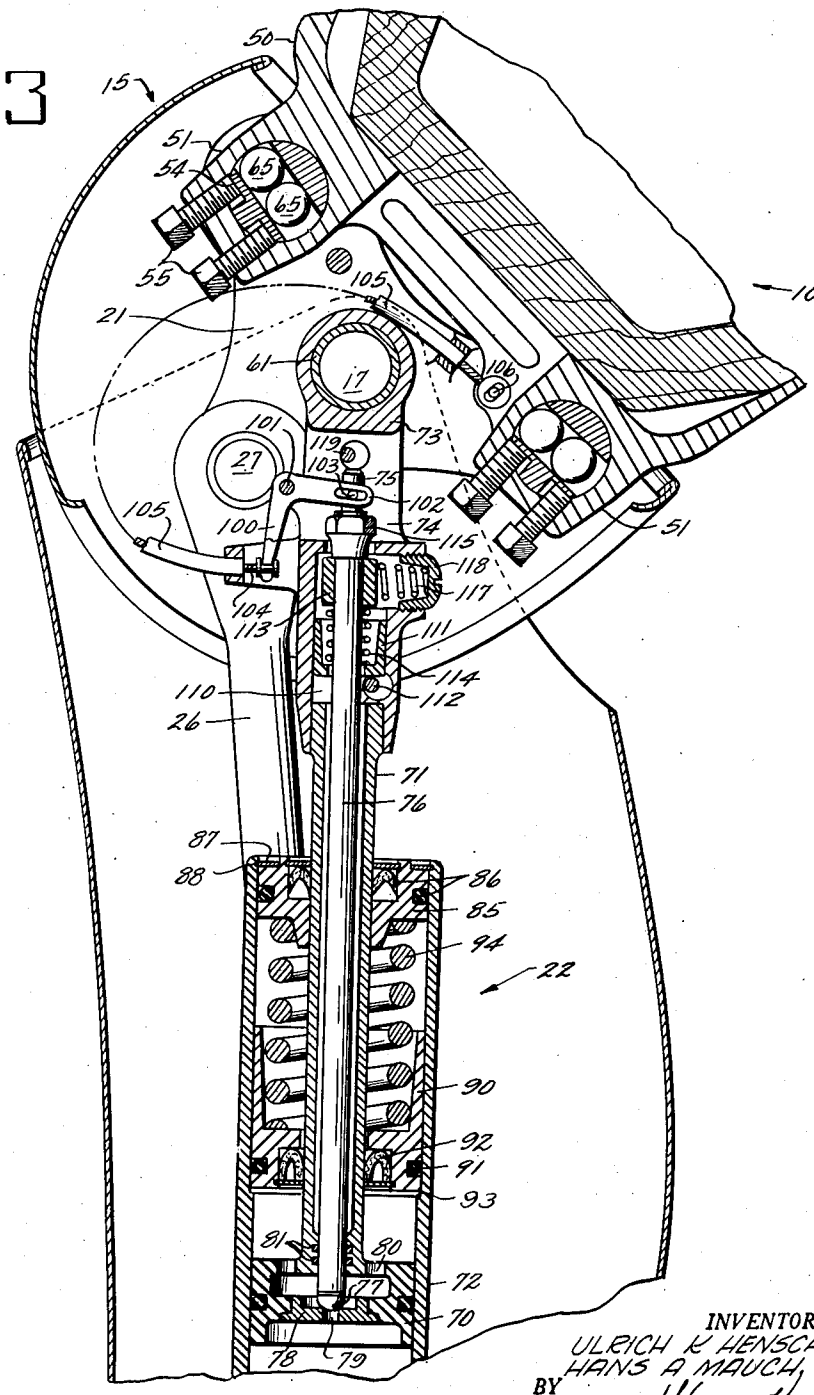
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LEG PROSTHESES

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Fig 3



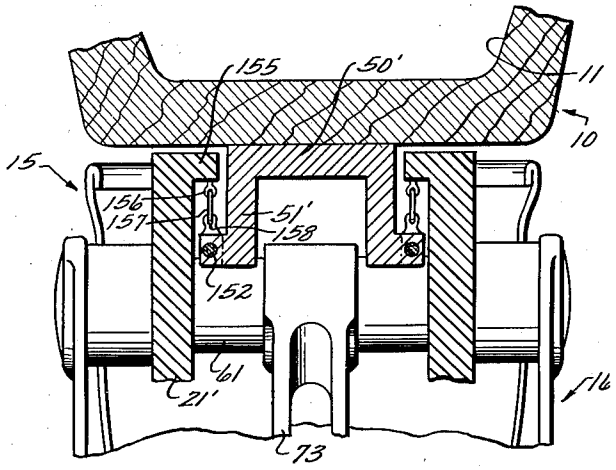
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Sept. 6, 1949. U. K. HENSCHKE ET AL 2,480,856

LEG PROSTHESES

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Fig 4



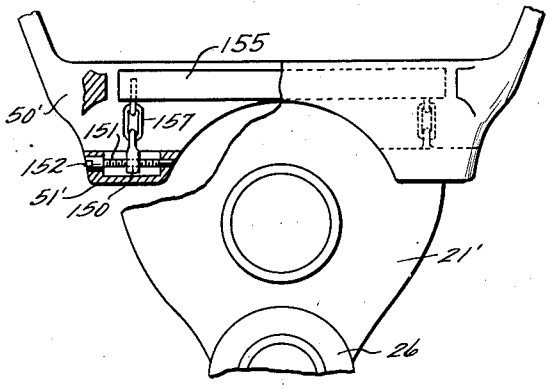


Fig 5

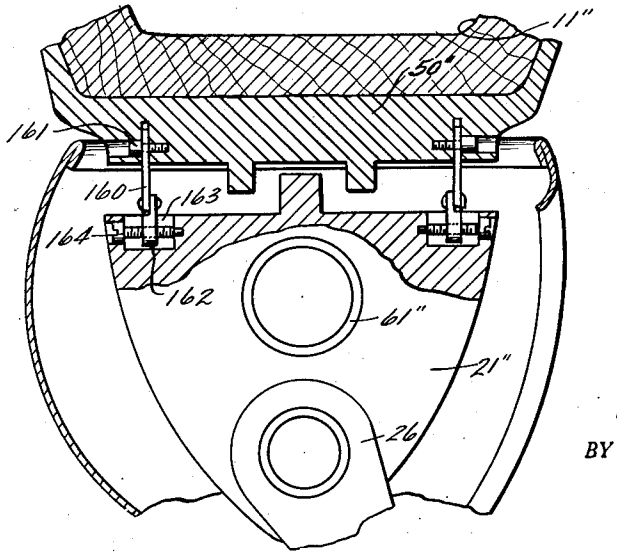


Fig 6

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UNITED STATES PATENT OFFICE

2,480,856

LEG PROSTHESIS

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Application July 9, 1948, Serial No. 37,745

21 Claims. (Cl. 3—2)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without payment to us of any royalty thereon.

This invention relates to artificial legs and more particularly to artificial legs attachable to thigh stumps of amputees wherein the amputee can control the function of the leg by shifting the center of gravity of his body and/or by slight muscular efforts of the stump.

One of the most obvious disadvantages of known artificial legs compared with the natural leg is the impossibility to stand on the artificial leg with bended knee and to make slow knee bends. An amputee, therefore has no security against jackknifing and he can not naturally ascend or descend stairs, or walk on inclines. Numerous mechanical as well as hydraulic or pneumatic types of knee brakes have been suggested to fulfill the functions of muscular action in order to provide above the knee amputees with a better prosthesis but their review reveals that the essential difficulty does not lie in the particular construction of the brake but in finding a control for the brake that will work correctly for all phases of walking, stepping up and down, etc. Automatic control by stepping on the heel or on the toe, or both together, or by the body's weight have often been tried but none of these automatic systems can be used for all types of walking without a switch installation for some types of walking, for instance, descending stairs. Such unnatural installations soon become an annoyance for the amputee. More successfully proved is the use of the so-called voluntary controls by special muscles. One possibility is the control by means of one hand which can be graded very accurately and learned most speedily but, since the amputee must rely on the free use of his hands more than an average person, this type of control can not be recommended for practical use. Another possibility is the use of the abdominal muscles for control which has been quite successful although the necessity of an abdominal belt may be objectionable for a number of amputees.

The present invention provides a control which achieves about the same functional results as the hand or the abdominal control without requiring any special attachment outside the prosthesis. In carrying out this invention, the changing position of the center of gravity of the amputee's body relative to a transverse axis located near the hip joint and more particularly in the area between the natural hip joint and the tuber of the ischium bone of the pelvic girdle and/or the

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exertion of little muscular efforts in the stump, are utilized to control the knee lock. If the center of gravity of the body is anterior to this axis and/or the stump is pressed backward, the bending of the knee is braked or locked, but, if the center of gravity is posterior to this axis and/or the stump is pressed forward, the knee brake or lock is unlocked. The location of that transverse axis near the hip joint has the effect that the shifting of the center of gravity of the amputee's body not only works as a controlling means when the amputee is standing on the straightened prosthesis but also when he puts his weight on the bended artificial leg because that bending does not affect the location of the axis relative to the center of gravity. Thus the location of the axis according to the invention enables the amputee to control the leg in the same unmodified manner through all walking types including walking upstairs, downstairs, uphill, downhill and sitting down. The amputee, furthermore, can operate the control even when the prosthesis does not touch the floor if, as this invention provides for, the shifting of the controlling means occurs with a small amount of friction by which a certain control position will be maintained unless a minimum force is exerted in order to change it. This force can be exerted by the amputee by a jerk of his stump forward or backward.

To make it easier for the amputee to distinguish between the braking and the fully locking position of the controlling means the invention further provides for an elastically overridable stop in the course of the control movement. The position of this stop is adjustable and is set so that the knee brake, when the control just touches the stop, yields under the weight of the amputee with a rate convenient to him in walking downstairs and downhill. By overriding this stop the amputee can lock the brake fully which is useful, for instance, in walking upstairs.

In order to eliminate the disadvantage of walking shocks of the conventional artificial leg, a suitable elastic element in connection with the knee lock is used according to this invention to make the lock resilient. Different designs are possible for the practical realization of a control described in the above paragraphs but are common in accordance with this invention in that the socket which encloses the stump is not rigidly connected with the upper part of the knee joint but is made turnable relative to that part about a transverse axis which lies near the hip joint and more particularly in the area between the

natural hip joint and the tuber of the ischium bone. Since such an axis can not be provided technically in a normal way, because it would for the most part be situated inside the amputee's body, the movement of the socket about the axis is achieved according to the present invention by guiding two or more points of the lower part of the socket, along orbits, the center of which lies in that axis, or along tangents of such orbits, or along curves which run approximately on those tangents or approximately on the orbits themselves. The guiding can be done according to this invention either by rollers and tracks, or by ball bearing sections, or by swinging levers, or by elastic steel bands, all this to diminish friction. By making the position of the guiding parts adjustable, it is possible to choose the spacial location of the transverse axis mentioned above at the convenience of the amputee.

A leg made in accordance with this invention provides excellent simulation of the natural sequence of leg movements. When the heel of the artificial leg is set on the floor during the walking cycle, the knee will be locked by the operation of the knee brake through the knee control. A tendency of the knee to buckle in this phase is produced by the relatively stiff heel bumper and the slightly cushioned knee bending is permittted by reason of the elastic elements connecting the knee lock to absorb stepping shocks. A complete jackknifing is prevented by the knee lock such that the knee bends only as far as it is made possible by the elastic elements. By the help of the energy stored in the elastic elements, the leg straightens out as the amputee rolls over the ball of the foot. All of these motions are coordinated in such a manner that the center of gravity remains as nearly level as possible and is so much the same as in the natural leg action that its artificial nature is barely recognizable, if at all. In walking downstairs or downhill or for sitting down, the amputee shifts his center of gravity forward and/or presses his stump backward until the controlling means touch the above mentioned elastically overridable stop. The leg then yields under the weight of the body at a rate adjusted at the convenience of the amputee.

In walking upstairs or uphill, the amputee puts the prosthesis forward and upward in a conveniently bended position then operates the control with a force strong enough to override the stop, thus fully locking the prosthesis and passes over the stiff bended artificial leg. By the small amount of friction provided within the controlling means, the leg maintains its braking and bending position long enough to put it on the next step of the stairs with sufficient clearance. At the top of the stairs the amputee disengages the brake and straightens the leg by forward movement and a short backward jerk of the stump.

In all these walking types, up and downstairs and up and downhill the elastic element, which makes the knee lock resilient, serves as a shock absorbing means.

It is a primary object of this invention to provide an artificial leg for above the knee amputees that is capable of simulating natural leg motion in use without the necessity of outside controls.

It is another object of this invention to provide a thigh prosthesis in which the motion of the center of gravity of the wearer with respect to a transverse axis located near the hip joint and more particularly in the area between the natural hip joint and the tuber of the ischium bone

and/or little muscular efforts of the stump are utilized to control the knee brake.

It is still another object of this invention to provide an artificial leg for above the knee amputees in which this motion of the center of gravity of the wearer and/or little muscular efforts of his stump are utilized to rotate the socketed thigh part of the leg with respect to a transverse axis located near the hip joint and more particularly in the area between the natural hip joint and the tuber of the ischium bone to control the knee brake by guiding two or more points on the lower part of the socketed thigh part along orbits, the center of which lies in that transverse axis or along tangents of such orbits, or along curves which run approximately on those tangents, or approximately on the orbits themselves.

It is a further object of this invention to provide a thigh prosthesis in which the thigh part of the leg is attached to the knee by slightly shiftable elements, this shifting motion being transmitted by related elements to a knee brake controlling means and wherein the course of these transmission elements a small amount of friction is provided by which a certain position of the controlling means is maintained unless a minimum force is exerted by the wearer in order to change it.

It is still another object of this invention to provide a thigh prosthesis containing a knee brake and a voluntarily actuated controlling means for the knee brake wherein the controlling movement causing engagement of the brake is limited by an adjustable elastically overridable stop which is set so that the knee brake, if the control just touches the stop, yields under the weight of the amputee at a rate convenient to him in walking downstairs and downhill and wherein by overriding the stop the amputee can lock the brake fully.

It is a further object of this invention to provide a thigh prosthesis having a knee joint in which the prosthesis includes a knee lock containing elastic means that resiliently permits slight knee bending during the first phase of the step while the knee is locked to maintain the center of gravity of the wearer substantially on the same level throughout the step and wherein the relatively stiff heel bumper is provided, which may be disengageable, the stiffness of the heel bumper serving to produce a bending moment in the knee joint after heel contact.

It is still a further object of this invention to provide a thigh prosthesis in which a pantograph or an equivalent kinetic arrangement producing relative knee and foot movement includes a knee lock connected in the pantograph by elastic means wherein the elastic means resiliently permits slight bending during the first phase of the step while the knee is locked to maintain the center of gravity of the wearer substantially on the same level throughout the step.

It is still another object of this invention to provide a thigh prosthesis having a knee brake controlling means to brake, lock and release the knee brake in accordance with the shift of the wearer's body and/or little muscular efforts in his stump transmitted through the thigh part of the prosthesis, one element of this locking arrangement being elastic to permit slight knee bends during the stepping phase of the wearer and to absorb the shocks transmitted through the leg during the walking cycle.

It is still a further object of this invention to provide a thigh prosthesis in which the thigh part of the leg is attached to the knee by shiftable ele-

ments, the relative motion between the knee and the thigh about a transverse axis located near the hip joint and more particularly in the area between the natural hip joint and the tuber of the ischium bone being transmitted by related elements to a knee brake controlling means, the knee brake constituting a part of a pantograph interconnecting the thigh part with the foot part effecting relative knee and ankle movement and the controlling means being effective to lock and release the knee brake in accordance with the shift of the amputee's body and/or little muscular efforts in the stump transmitted through the thigh part, one element of the pantograph connecting the knee brake being elastic to permit slight knee bends during the stepping phase of the amputee and to absorb the shocks transmitted through the leg during the walking cycle.

These and other objects and advantages may become more apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a view partly sectional and partly elevational of an artificial leg as attached to an amputee;

Fig. 2 is a fragmentary cross sectional view of the knee element with some parts shown in elevation;

Fig. 3 is an enlarged fragmentary view of the artificial leg showing a number of the elements in detail;

Fig. 4 is a sectional view of a modified knee element guiding means;

Fig. 5 is another view of the modification of Fig. 4 with parts broken away to show details of construction; and

Fig. 6 is a fragmentary sectional view of another modification of the knee element guiding means.

Referring more particularly to Fig. 1, there is shown a thigh part 10 of an artificial leg having a socket 11 receiving the thigh stump 12 of an amputee with the thigh bone 13 shown in broken lines. The thigh part 10 is connected to a knee element 15 in a manner later to be described and a shank 16 is pivotally connected to the knee element at 17 forming the knee joint. At the lower end of the shank 16 is a foot 18 pivotally connected to the shank to form the ankle joint 19.

The knee joint 17 and the knee element 15 is fixed by rigid members 21 (of which only the far one is shown in Fig. 1) supporting the pin forming the knee joint. Also pivoted on this knee joint 17 is a fluid cylinder, generally referred to by the reference character 22, that has a cross pin 23 on its lower end with bearing members 24 on the outer ends thereof operable in tracks 25 positioned longitudinally of the shank and on the inner wall surface thereof. Pivotally mounted on this cross pin 23 on opposite sides of the fluid cylinder are two elastic members 26, preferably metal, which at their outer ends are pivotally supported on the rigid members 21 of the knee element at points 27 situated near or on a line through the knee joint and the longitudinal axis of the thigh part. Also pivotally connected to the cross pin 23 is a telescoping element 30 comprising an upper cylindrical component 31 and a lower piston and rod component 32 much the same as the pantograph telescoping element disclosed in our copending application Serial No. 37,744, filed July 9, 1948. The lower end of the piston and rod component 32 is pivotally connected to the foot part 18 at 33 through the agency of a pair of upstanding plate members 34 integral with the foot and providing one component of the ankle joint. The piston of the rod component 32 in its inward and normal position in the cylindrical component 31 rests against a resilient member 35 which absorbs shocks imposed on the ball of the foot in a manner more fully described in the above named copending application. The leaf spring 36 is fixed with respect to the lower end of the fluid cylinder 22 in any well known manner with its free end producing a laterally biasing moment counterclockwise on the cylindrical component 31 to produce a pinching effect and friction between the two components of the telescoping elements 30 for the same reasons set out in our aforementioned copending application.

A relatively stiff heel bumper 37 has one end seated in a cup 38 fixed to the foot part 18 and the other end seated in a cup member 39 that has a cylindrical extension 40 slidable in a tubular extension 41 integral with the shank 16. The upper ends of the tubular extension 41 is threaded in which a screw 42 is adjustable to regulate the compressive forces on the bumper and consequently limit the plantar flexion of the foot. The advantages of the bumper 37 will become clearer as the description proceeds.

Referring more particularly to Figs. 2 and 3 with occasional reference to Fig. 1, there is shown fragmentary views with the parts in section of the connecting structure between the thigh part 10 and the knee element 15, and the structure of the fluid cylinder element 22 with the related knee control. The lower end of the thigh part 10 has a saddle member 50 with four downwardly extending portions 51 each of which has a bore 52 therein to form aligned pairs in the forward and rearward part of the knee element parallel to the axis of the knee joint 17. Set within each bore 52 is a guiding element 53 which has two notches 54 cut in the circumference thereof to receive the ends of set screws 55 which are threadedly supported in the downwardly extending portions 51. By manipulation of the set screws 55, each of the guiding elements 53 can be rotated to change the angle of an outwardly facing ball track 56 therein.

The knee element 15 includes, as heretofore mentioned, a pair of rigid members 21 through which a pin 61 extends forming the knee joint 17. The shank 16 is pivotally attached to the outer extremities of the pin 61 and so formed to be rotatable through approximately 100 degrees with respect to the thigh part 10. The upper ends of the rigid members 21 have bores 62 therein in pairs having centers equal in distance to the centers between the pairs of bores 52 in the member 50 of the thigh part. Within each of these bores 62 is a guiding element 63 having an inwardly facing ball track 64 therein. Two balls 65, preferably steel, are placed in the ball tracks 56, 64 of each of the companion guiding elements 53, 63, the two balls 65 being short of filling the lengths of the ball track to permit a small amount of relative movement between the thigh part 10 and knee element 15 in a direction of the tracks 56, 64. The balls 65, are, of course, retained in their tracks 56, 64 by the surface of the bores 52 and 62 of the members 50 and 21, respectively.

The fluid cylinder mechanism 22 is, as heretofore described, pivotally connected to the knee joint 17. This connection is established by a piston member 70 of the fluid cylinder mechanism having a tubular stem extension 71 extending outside the cylinder 72 with a portion 73 journaled on the pin 61. The portion 73 of the stem 71 is

divided at 74 for a short distance to accommodate the actuator end portion 75 of a valve stem 76 having a head portion 77 cooperatively related with a valve seat 78 within the piston 70 to control the flow of fluid, as oil, through the piston via passages 79 and 80. The valve stem 76 passes through the tubular stem portion 71 of the piston and is sealed against fluid leakage between these two stem portions by sealing rings 81.

The fluid cylinder 72 is closed at its bottom end. The top end is closed by a ring 85 through which the tubular stem 71 is slidable with these slidable surfaces sealed against fluid leakage by sealing rings 86, as is well recognized in the art. The ring 85 is retained in the end of the fluid cylinder by a snap ring 87 held in a groove 88 in the upper cylinder wall, or by other suitable well known means. A piston 90 is slidable in the upper portion of the hydraulic cylinder between the ring 85 and the piston 70 with an opening concentrically thereof to slidably accommodate the tubular stem 71. The piston 90 has sealing rings 91 and 92 to eliminate fluid leakage between the piston 90, cylinder wall and tubular stem 71, respectively. The piston 90 is limited in its downward movement by a shoulder 93 on the inner surface of the fluid cylinder. A spring 94 is interposed under compresion between the ring 85 and the piston 90 such that fluid, as oil, may be introduced in the part of fluid cylinder formed by the piston 90 and the lower end of the cylinder and shall be retained under pressure to the amount exerted by the force of the spring 94. In this manner, the piston 70 works in a fluid under pressure and there is little chance of air pockets fouling the operation thereof. Furthermore, the spring and piston compensate for the stem 71 volume and temperature expansion of the hydraulic fluid as well as produce a slight leg extension bias by reason of the spring 94 tending to extend the hydraulic element.

Within the divided portion 74 of the tubular stem 71 is a bent lever 100 pivoted at 101 such that one arm is contiguous to the actuating end of the valve stem 76. This arm has an elongated slot 102 therein that receives a pin 103 carried by the actuating end of the valve stem 76. The other end of the bent lever has attached thereto a Bowden wire 104 that passes through a flexible casing 105 to connect in an eyelet 106 situated in the saddle member 59. One end of the flexible casing 105 is physically attached to the tubular stem 71 and the other end is attached to the members 21 in any well known manner. Any relative movement between the thigh part 10 and the knee element 15 through the ball and track connection will operate to move the Bowden wire 104 within the casing 105 to rotate the bent lever 100 about its pivot 101 to actuate the valve 77 whereby the piston 70 may be fluidly locked or unlocked in the fluid cylinder.

The upper end of the tubular stem 71 just below the divided portion 74 is cylindrically enlarged at 110 to receive a cup-shaped piston 111 slidable in the cylindrical portion 110. The piston 111 is adjustable to height by an adjustable eccentric pin 112. Above the piston 111 is a sleeve 113 slidable on the valve stem 76 and biased upwardly from the piston 111 by a spring 114 against a nut 115 adjustable on the stem 76. The lower end of the nut 115 is capable of passing through an opening in the top of the cylindrically enlarged portion 110 but the sleeve 113 is large enough to engage the casing surrounding this opening. A spring 117 adjustably biased by a cap screw 118 presses laterally against the sleeve 113 producing a certain amount of friction between the sleeve and the surface of the valve stem 76. The upward movement of this valve stem is limited by an eccentric 119. If pull is exerted on the Bowden wire 104, the lever 100 pushes the valve stem 76 downward. The first part of this movement occurs against the friction of the sleeve 113 until nut 115 engages the upper surface of that sleeve. The opening of the valve 77, 78 is then just small enough to provide for a slow jacknifing of the prosthesis as it is suitable for walking downstairs or downhill. If the amputee wants to lock the brake entirely, he shifts his center of gravity somewhat forwardly and/or presses his stump backward. The strong force on the Bowden wire 104 overcomes the bias of the spring 114 and the valve stem 76 continues to move downward until valve 77, 78 is closed completely. As soon as the force which the amputee applies will be lessened the valve stem shifts back until the upper surface of the sleeve 114 again engages the casing 110. Further upward movement will only occur if the amputee exerts force in the opposite direction which is strong enough to overcome the friction of the sleeve 113. Thus in particular types of gait, for instance, in ascending or descending stairs or inclines, the amputee is able to lock or unlock the knee brake at the right moment by shifting his pelvis and thereby his center of gravity forward or backward. He also may decide by the degree of shifting whether the knee motion will be locked completely or will only be braked, the latter due to a partial closing of the valve 77, 78.

Since the movement of the valve stem 76 is braked by the braking sleeve 111—113 on its top end the valve stem tends to maintain its momentary position even if the leg is lifted from the ground floor and the amputee is no longer able to put weight on the prosthesis. He may, however, change the position of the valve stem without touching the ground floor by short jerkwise forward and backward motions of the stump.

To understand this invention more thoroughly it is believed that the purpose of the structure as it directly relates to the amputee's body should be brought out. Referring again more particularly to Fig. 1, the thigh bone 13 makes a hip joint with the amputee's body pelvic girdle at 120. It has been found that the center of gravity of the body of the amputee is in a region of the body somewhat above the hip joint as indicated by the reference character 121. The location of the ischium bone is designated in dotted lines and indicated by the reference character 122. In accordance with the present invention, the center of the gravity of the amputee's body relative to a transverse axis, which is herein designated by the reference character 123 located in the area between the hip joint and the ischium bone, will be utilized to control the knee brake. The adjustable screws 55 are manipulated to rotate the guiding elements 53 until the ball tracks 56 are tangent to a circle whose center lies on a transverse axis 123. The guiding element 53 will be rotated accordingly. In this condition, the amputee causes a shift in the knee element to control the knee brake by the natural shift of his body and only the normal muscular action in the stump. If the transverse axis were moved outside the area between the hip joint and the tuber of the ischium bone by changing the ball tracks 56, 64 counterclockwise or clockwise respectively, torques would be imposed on the stump and considerable muscular efforts would be required to

shift the knee and thigh elements to control the knee brake. It is an important feature of this invention to establish a transverse axis and to guide two or more points of the lower part of the stump socket along orbits or tangents of such orbits as shown and described, or along curves which run approximately on these tangents or approximately on the orbits themselves, the center of the orbits or curves lying on the transverse axis, to avoid any undesirable torques being placed on the stump.

An amputee wearing such an artificial leg will be able to walk quite naturally. When the artificial leg is placed forward for a step, the shank will be swung forward in line with the thigh and the weight will be first placed on the heel. The stiff bumper **37** causes a bending moment on the shank to carry the knee element forward. The center of gravity of the wearer's body is sufficiently anterior to the transverse axis **123** to create a turning moment on the stump tending to rotate the stump counterclockwise about the transverse axis **123** that causes a shift in the saddle member **50** to pull the Bowden wire **104** to set the valve **77** well on the valve seat **78** to fluidly lock the piston **70** in the cylinder preventing knee bending. However, due to some elasticity of the straps **26**, a slight knee bend, common in natural walking, is permitted since only a slight elongation of the straps **26** allows the knee to bend in accordance with the elasticity of the straps in view of the pivoted points **17**, **23** and **27** being in substantially or approximately a straight line. As the body passes over this leg and full body weight is on it, the knee may be flexed more in a manner natural of walking which eliminates the necessity of "pole vaulting" over this leg. When the body weight is shifted to take a step with the good leg, the artificial leg will be posterior to the wearer's body, the weight of the body will move up on the ball of the foot and the kinetic energy stored in the straps **26** will tend to straighten the knee joint prior to the weight being taken off this leg. This provides a slight forward thrust that is muscularly accounted for in a natural limb. Upon carrying the leg forward for a step, the thigh part shifts forward with respect to the knee element causing counterclockwise rotation of the bent lever **100** to lift the valve **77** from its seat **78** and fluidly unlock the cylinder to release the knee for free movement. The swing of the thigh forward causes sufficient knee bending to allow the foot to clear the floor, particularly by means of pantograph elements **19**, **23**, **30**, and **33**, for the succeeding step when the knee will again be locked as before for the step. If for any reason the knee locking means fails ,the screw **42** may be run outwardly to release the compressive forces on the heel bumper and decrease the bending moment on the knee joint occurring on heel contact.

Due to the different characteristics of walking of different people, the spacial location of the transverse axis **123** can be located for the particular convenience of the amputee and for amputees of different height.

The guiding between the thigh part and the knee element **15** can be done, according to this invention, in various ways. One modification is shown in Figs. 4 and 5 wherein like elements of like reference characters and corresponding elements of the reference characters are primed. Saddle member **50'** attached to the socket **11** has depending L-shaped portions **51''** in which are rectangularly shaped blocks **150** that are slidable along slots **151** in the foot portion of the L-shaped structure **51'**. An adjustable screw **152** is rotatable and axially immovable in each of the portions **51'** and is threaded through the block **150** to impart movement to the block **150** along the adjustable screw. Plates **21'** have overhanging portions **155** above the L-shaped portions **51'** and an eyelet **156** threaded or otherwise fastened to the overhanging portions **155**. A link **157** passes through each eyelet **156** and through a corresponding eyelet **158** on the block **150**. In this manner, the four blocks **150** in the knee element can be adjusted to fix the transverse axis in the wearer's body for the purpose set forth in the description of Figs. 1, 2 and 3.

The guiding elements may take the form of swinging elastic steel bands, ball bearing sectors, swinging levers, or a number of ways of construction which would be considered possible by a mechanic skilled in the art in view of applicants' disclosure in Figs. 1, 2 and 3. However, applicants show some of the preferred forms, another form being shown in Fig. 6 wherein the member **50''** attached to the socket **11** has elastic bands **160**, as strip steel, fastened to the member **50''** by screws **161**. The lower ends of these bands **160** are attached by rivets or the like to blocks **162** adjustably movable in slots **163** by adjustable screws **164** in the members **21''**. The Bowden wire **104**, **105** can be connected to the relatively movable parts **50''** and **21''** in any well known manner to provide control of the knee brake.

It is to be understood that many modifications and changes may be made in the various elements and features of applicants' invention to carry out the principles and functions attained by applicants' disclosure and applicants desire to be limited only by the scope of the appended claims.

We claim:

1. A voluntarily controlled thigh prosthesis comprising a leg having a shank part including foot, and thigh parts consisting in an upper socketed element and a lower knee element, said knee element being connected by a knee joint with said shank part and said socketed thigh element being slightly turnable relative to said knee element about a transverse axis which lies near the hip joint and more particularly in the area between the natural hip joint and the tuber of the ischium bone of the wearer; and a controllable knee brake, said knee brake being associated by mechanical means with said knee element and said shank part, and means by which said relative turnable movements between said socket thigh elements and said knee element are operative to control said knee brake.

2. A voluntarily controlled thigh prosthesis as set forth in claim 1 wherein said knee element supports guiding elements connected to said socketed thigh element to guide said socketed thigh element with respect to said knee element about said transverse axis.

3. A voluntarily controlled thigh prosthesis as set forth in claim 2 wherein said guiding elements consist of more than one complementary ball track in said knee element and a companion complementary ball track in said socketed thigh element, each composite ball track containing at least one ball having limited rolling movement therein, said composite ball tracks being angularly adjustable to position said transverse axis.

4. A voluntarily controlled thigh prosthesis as set forth in claim 1 wherein said means, by which

said relative turnable movements are operative to control said knee brake, contain friction elements for frictionally maintaining control positions until a minimum force is exerted to change them.

5. A voluntarily controlled thigh prosthesis as set forth in claim 1 wherein said means, by which said relative turnable movements are operative to control said knee brake, contain an elastically overridable stop which is adjustable and determines by its adjusted position a yielding rate of the knee brake which is convenient for the amputee in walking downstairs and downhill and the overriding of which enables the amputee to lock the brake fully.

6. A voluntarily controlled thigh prosthesis as set forth in claim 1 wherein said mechanical means associated with said knee element and said shank part includes an elastic element for resiliently absorbing shocks on said prosthesis in any angle of the locked knee joint.

7. A voluntarily controlled thigh prosthesis as set forth in claim 1 wherein said shank part and foot part are connected by an ankle joint, said ankle joint having a relatively stiff disengageable heel bumper for producing a forward movement of said knee element whenever the heel contacts the floor effecting said relative turnable movement between said socketed thigh element and said knee element.

8. A voluntarily controlled thigh prosthesis as set forth in claim 1 wherein said controllable knee brake is a hydraulic cylinder having piston and cylinder operating elements, said hydraulic brake having a valve means controlling the flow of hydraulic fluid to opposite sides of said piston element, the valve means having an actuator operatively connected to said socketed thigh element and knee element to control said hydraulic brake in accordance with relative socketed thigh element and knee element movements.

9. A voluntarily controlled thigh prosthesis as set forth in claim 1 wherein said shank part and foot part are connected by an ankle joint, and said mechanical means associating said knee brake with said knee element and said shank part includes a kinetic arrangement connecting said foot part with said knee element for producing interdependent knee and ankle movements.

10. A thigh prosthesis comprising a socketed thigh part, a knee element, a shank part and a foot part, said shank part being journaled to said foot part at an ankle joint and journaled to said knee element at a knee joint; guiding elements interconnecting said socketed thigh part with said knee element to provide limited turnable movement of said thigh part about a transverse axis situated in a wearer's body, said guiding elements being slidably adjustable to position said transverse axis in the area of the wearer's body near the hip joint and more particularly between the natural hip joint and the tuber of the ischium bone to enable the wearer to effect rotation of said thigh part in a predetermined direction with respect to said knee element by selective shifting of the body center of gravity and little muscular efforts of the stump; a hydraulic knee brake interconnecting said thigh and shank parts, said knee brake being under the control of an actuatable element; transmission elements to transmit said relative turnable movement of said thigh part with respect to said knee element to said actuatable element of said knee brake wherein natural leg movements may be performed at the will of the wearer by a selective body center of gravity shift and little muscular efforts of his stump.

11. A thigh prosthesis as set forth in claim 10 wherein said guiding elements comprise four pairs of companion roller tracks on said knee element and lower thigh part, and roller means in each pair of roller tracks.

12. A thigh prosthesis as set forth in claim 10 wherein said guiding elements comprise four links suspending the lower end of said thigh part on said knee element.

13. A thigh prosthesis as set forth in claim 10 wherein said guiding elements are four swinging elastic bands suspending the lower ends of said thigh part on said knee element.

14. A thigh prosthesis as set forth in claim 10 wherein said transmission elements transmitting said relative turnable movement to said actuatable element contain friction elements for frictionally maintaining control positions unless a minimum force is exerted to change them.

15. A thigh prosthesis as set forth in claim 10 wherein said transmission elements transmitting said relative turnable movement to said actuatable element contain an elastically overridable stop which is adjustable and determines by its adjusted position a yielding rate of said knee brake which is convenient for the amputee in walking downstairs and downhill and the overriding of which enables the amputee to lock the brake fully.

16. A thigh prosthesis as set forth in claim 10 wherein the interconnection of said knee brake and said thigh and shank parts incorporate elastic elements providing slight knee bends during knee brake engagement to absorb walking shocks, and wherein said ankle joint contains a relatively stiff disengageable heel bumper to initiate said slight knee bends whenever the heel contacts the floor.

17. A thigh prosthesis as set forth in claim 10 wherein said interconnection of said knee brake and said thigh and shank parts include a kinetic arrangement connecting said foot part with said knee element for producing interdependent knee and ankle movements.

18. A thigh prosthesis comprising a socketed thigh part, a knee element, a shank part and a foot part, said shank part being journaled to said foot part at an ankle joint and journaled to said knee element at a knee joint; guiding elements interconnecting said socketed thigh part with said knee element to provide limited turnable movement of said thigh part about a transverse axis situated in a wearer's body, said guiding elements being slidably adjustable to position said transverse axis in the area of the wearer's body near the hip joint and more particularly between the natural hip joint and the tuber of the ischium bone to enable the wearer to effect rotation of said thigh part in a predetermined direction with respect to said knee element by selective shifting of the body center of gravity and little muscular efforts of the stump; a hydraulic knee brake interconnecting said thigh and shank parts, said knee brake being under the control of an actuatable element containing friction elements for frictionally maintaining control positions unless a minimum force is exerted to change them; transmission elements containing an elastically overridable stop which is adjustable to transmit said relative turnable movement of said thigh part with respect to said knee element to said actuatable element of said knee brake wherein natural leg movements may be performed at the

will of the wearer by a selective body center of gravity shift and little muscular efforts of his stump and the adjustable overridable stop determines by its adjudged position a yielding rate of said knee brake which is convenient for the amputee in walking downstairs and downhill and the overriding of which enables the amputee to lock the brake fully.

19. A thigh prosthesis as set forth in claim 18 wherein the interconnection of said knee brake and said thigh and shank parts incorporate elastic elements providing slight knee bends during knee brake engagement to absorb walking shocks, and said ankle joint contains a relatively stiff disengageable heel bumper to initiate the slight knee bends whenever the heel contacts the floor.

20. A thigh prosthesis as set forth in claim 18 wherein said interconnection of said knee brake and said thigh and shank parts include a kinetic arrangement connecting said foot part with said knee element for producing interpendent knee and ankle movements.

21. A thigh prosthesis as set forth in claim 20 wherein said interconnection of said knee brake

and said thigh and shank parts further include elastic elements providing slight knee bends during knee brake engagement to absorb walking shocks and said ankle joint contains a relatively stiff disengageable heel bumper to initiate slight knee bends whenever the heel contacts the floor.

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