Dec. 13, 1949 P. M. GETTMAN ET AL 2,490,796

ARTIFICIAL BODY MEMBER

Filed Oct. 27, 1947 3 Sheets-Sheet 1

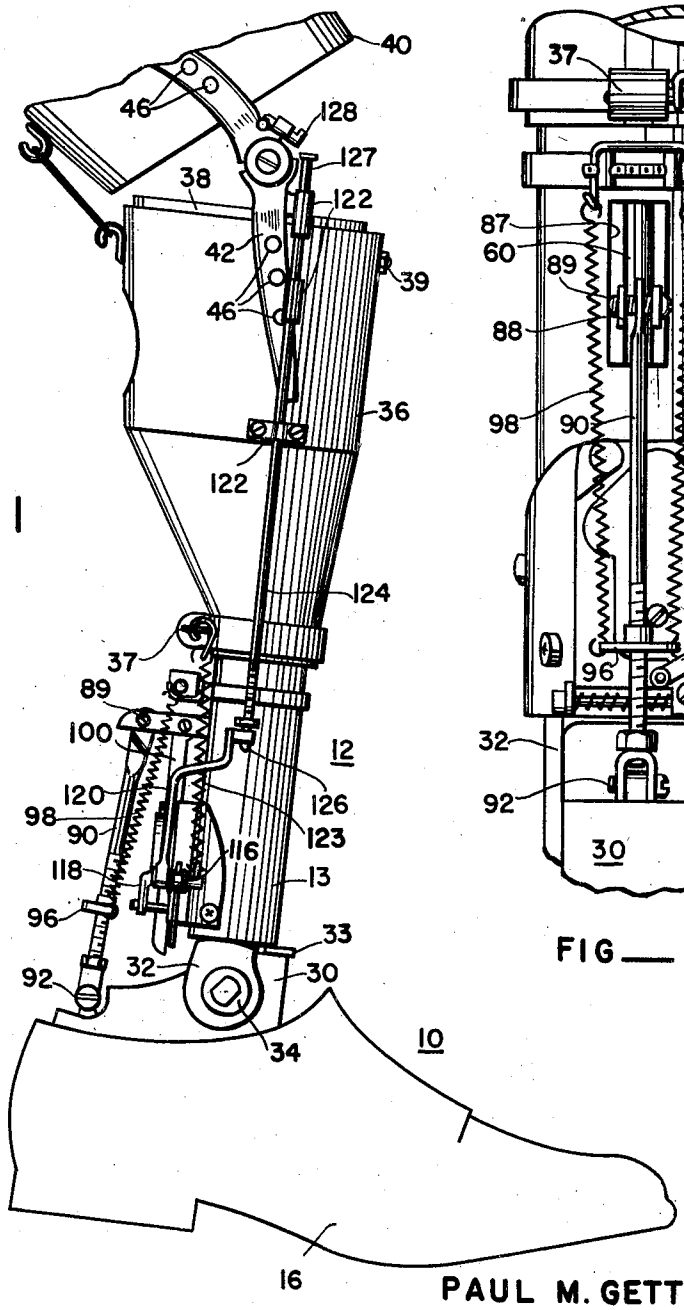



FIG. 1




FIG. 2

PAUL M. GETTMAN &
WILLIAM T. FULTON
Inventors

By Smith & Tuck

Attorneys

Dec. 13, 1949 P. M. GETTMAN ET AL 2,490,796

ARTIFICIAL BODY MEMBER

Filed Oct. 27, 1947 3 Sheets-Sheet 2

FIG_3

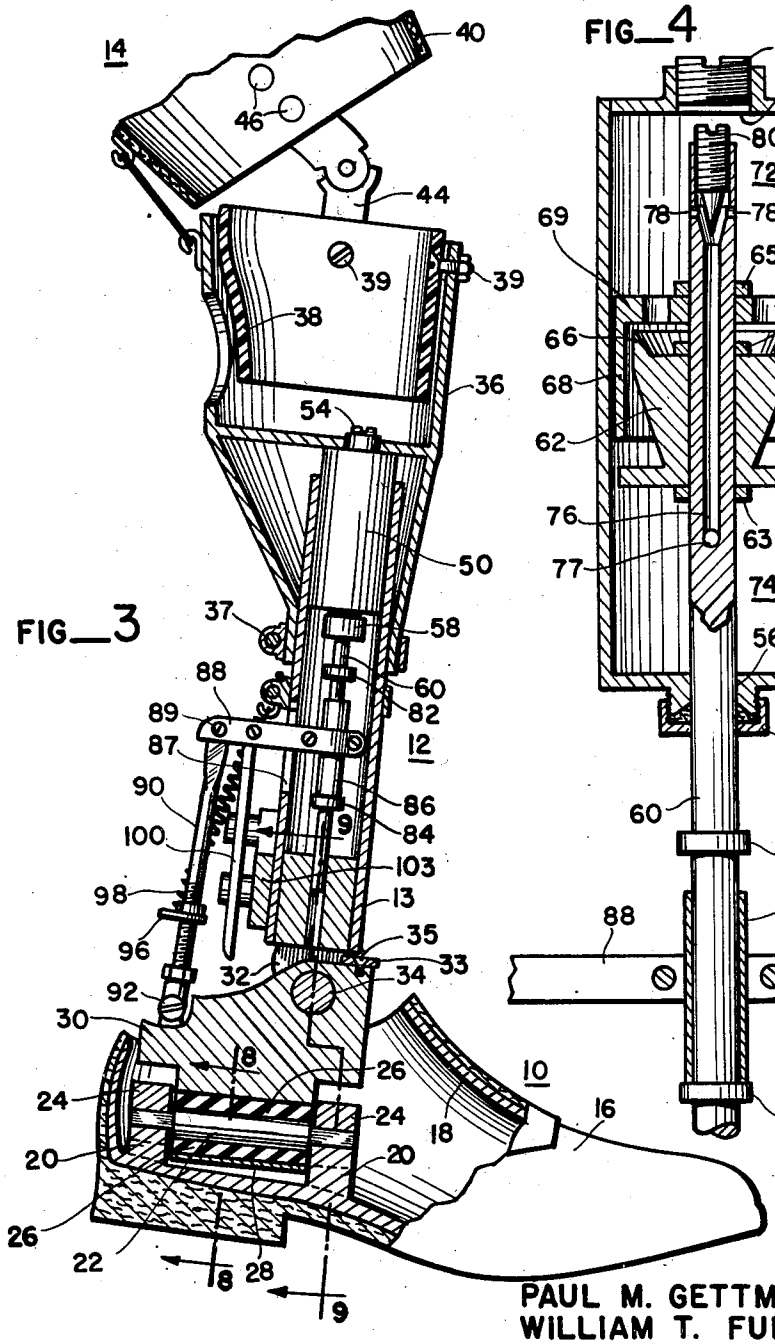



FIG_4




PAUL M. GETTMAN &
WILLIAM T. FULTON
Inventors

By Smith & Tuck

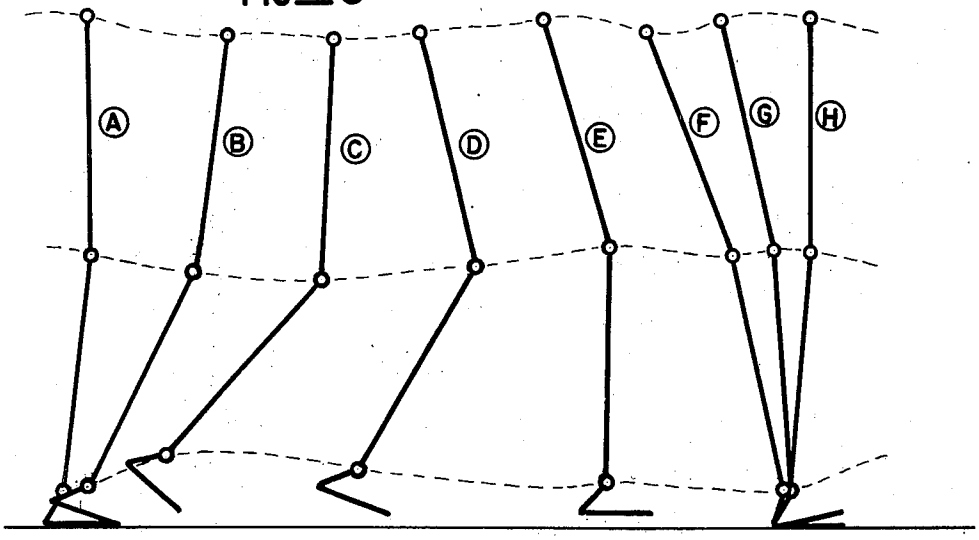
Attorneys

Dec. 13, 1949 P. M. GETTMAN ET AL 2,490,796

ARTIFICIAL BODY MEMBER

Filed Oct. 27, 1947 3 Sheets-Sheet 3

FIG_5



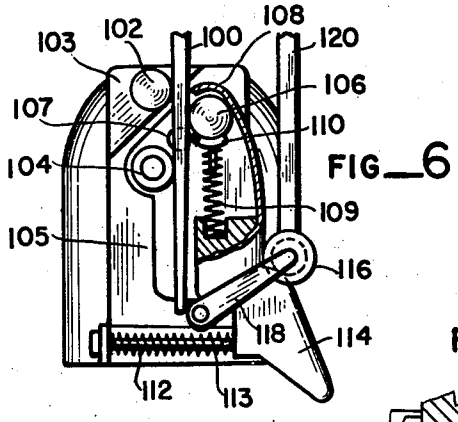




FIG_6

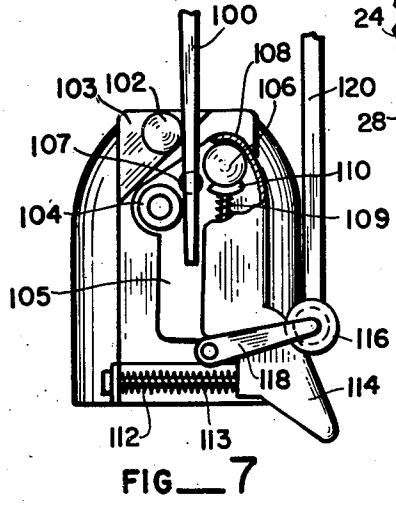



FIG_7

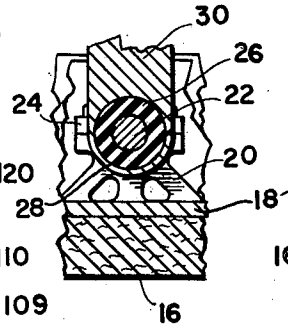



FIG_8

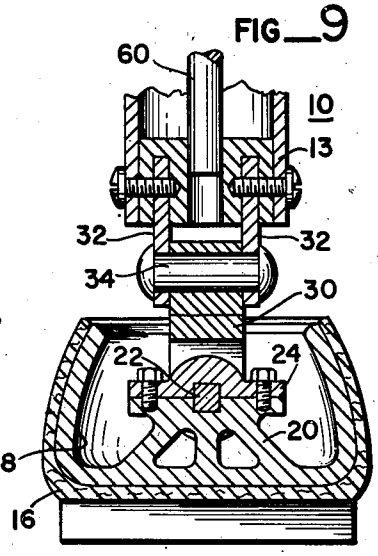



FIG_9

PAUL M. GETTMAN &
WILLIAM T. FULTON
Inventors

By Smith & Tuck

Attorneys

Patented Dec. 13, 1949 2,490,796

# UNITED STATES PATENT OFFICE

2,490,796

## ARTIFICIAL BODY MEMBER

Paul M. Gettman and William T. Fulton, Tacoma, Wash.

Application October 27, 1947, Serial No. 782,276

8 Claims. (Cl. 3—2)

1

This invention relates to improvements in an artificial body member and, more particularly, to an artificial leg for amputees.

It is a common complaint with persons using artificial legs that the legs are stiff and non-lifelike, both during walking and sitting; that they are difficult to get accustomed to because of such conditions; that they will tend to throw the wearer down when the foot strikes upon an unusual hump or stone in the path; and that they do not properly receive the wearer's weight when the foot touches the ground, leaving him with a great feeling of insecurity and a consequent high degree of nervous strain. Such complaints flow from the action of prior art legs during use, and seem to be due to unnatural action obtained artificially at the knee and ankle joints.

For example, some legs tend to bend in at the knee and so produce upon the wearer an impression that he is falling. Other leg and foot arrangements compel the foot to contact the ground with the heel disposed at an abrupt angle, and with the toe raised to a marked degree. As a result, the wearer, for the instant, has only a point-contact, and an extremely small one at that, with the ground, and then he must rock forward onto the foot and sole before his stability is restored. Artificial legs, in most cases, are most apparent to the casual observer, and are a constant source of concern to the wearer. Such is particularly true when the wearer is seated and the artificial foot appears cocked in a very unnatural manner and tends to attract attention for that reason. A study of the natural human leg, during walking, reveals that during the stride the knee bends and the lower leg swings primarily about a horizontal pivot; the ankle, however, has two main degrees of movement: one about a horizontal lateral pivot and the other about a horizontal axial pivot; in addition, there is a certain torsional movement in the ankle. It is a result of failure to provide for all these movements, which have been described as a "screwing action," that causes the user of an artificial leg great concern, with both physical and mental discomfort. It is therefore a prime object of this invention to overcome these conditions in the provision of this artificial leg.

In simulation of natural walking, it being noted that the foot normally approaches the ground flatly to receive and support the body weight, it is another object of this invention to provide means in an artificial leg whereby there is a leveling-off action of the artificial foot, as it is swung ahead of the knee to the forward portion

2

of the stride, and to do so in a natural, lifelike manner, without discomfort to the wearer or requiring him to go through contortions that are difficult or embarrassing.

Still another object of the invention is the provision of an artificial leg that will accomplish the foregoing objects, but which is simple to construct, durable for a long life of hard usage, and which will at all times afford to the wearer confidence and a feeling of safety.

The foregoing objects and others ancillary thereto we prefer to accomplish as follows:

According to a preferred embodiment of our invention, we have devised a foot portion that is pivotally associated with a lower leg portion for movement in a fore-and-aft swinging motion and a lateral pivotal motion and, in addition, may be twisted or rotated about the vertical axis of the lower leg. Resilient pivot means is employed to restrain lateral pivoting of the foot and to insure its ordinary return to the neutral or normal position. Also, fore-and-aft swinging motion of the foot relative to the lower leg is dampened by the use of a hydraulic or fluid-pressure double-acting cylinder means, coupled by a link to the foot portion in rearward offset relation to the axis of pivotal motion. A releasable clutch associated with said link permits the retention of the foot in a desired fore-and-aft position during walking, and means for releasing the clutch is mounted between the lower leg and the usual upper leg socket portion, and is operable during walking when the leg portions are substantially aligned. In the hydraulic dampening means, there is a double acting piston which permits the passage of fluid under pressure from one chamber to another, on opposite sides of the piston, and which may be adjusted according to the requirements of the wearer to increase or decrease the dampening effect. Biasing means is included to tend to maintain the toe of the foot cocked-down when it is unclutched and free to so move with respect to the fore-and-aft pivotal connection.

The novel features that we consider characteristic of our invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings, in which:

Fig. 1 is a view in side elevation of the artificial leg of this invention;

Fig. 2 is an enlarged rear view in elevation of the lower leg portion of the assembly of Fig. 1;

Fig. 3 is a vertical, medial, sectional view of the leg of Fig. 1;

Fig. 4 is an enlarged, vertical, sectional view of the fluid pressure dampening means employed in the artificial leg;

Fig. 5 is a schematic view illustrating certain of the movements obtained during locomotion with the leg of this invention;

Figs. 6 and 7 are enlarged face views of the releasable clutch means employed in the leg and showing respectively the clutched and released position of such means; and

Figs. 8 and 9 are cross sectional views taken on lines 8—8 and 9—9, respectively, of Fig. 3.

The artificial leg of this invention comprises three main elements, namely the foot portion 10, the lower or intermediate leg element 12, and the upper leg element 14. These elements are coupled together and arranged so that various degrees of movement may be had by the user in life-like simulation of a natural leg.

Referring to Figs. 1, 3, 8, and 9, wherein is shown the details of the foot 10, it will be seen that within shoe 16 is fitted a metallic, or other rigid, foot-form 18 that is hollow and has upstanding supporting bosses 20, 20, which are spaced apart to cradle the square-ended pin 22. Retainer caps 24, having square half-recesses which co-operate with similar half recesses in the bosses 20, receive the square ends of pin 22 and retain it against revolving in the foot. Pin 22 has fused or welded thereto a rubber, or otherwise resilient, bushing 26 that is tightly encircled by a fused-on bushing 28 forming an integral part of ankle block 30. By this structure the ankle block is resiliently coupled to the foot-form for movement about the axis of pin 22 in a radial manner. Also the ankle block may be twisted about a vertical axis passing perpendicularly through the axis of pin 22 to afford an aid to the "screwing" motion desirable in simulation of normal walking motions. Such twisting is possible through lateral compression and expansion of the resilient bushing 26.

The lower leg portion 12 has a pair of depending ears 32, forming a fork that straddles the ankle block, and a pivot pin 34 passes through the ankle block and the ears of said fork to thereby couple the lower leg and foot together, while permitting a fore-and-aft swinging motion of the foot relative to the leg about the axis of pin 34. A shim 33, secured by screw 35, to the ankle block under the forward edge of the tube 13 of leg portion 12, determines the degree that the lower leg may overturn the foot before the two elements must move together. On the upper end of tube 13 is mounted the housing 36, which receives the socket 38 that is shaped to fit the leg stump of the amputee when the device is in use. Socket 38 is held in place by screws 39 and is usually formed of a material that is readily molded to the shape of the wearer's stump to provide a comfortable fit. Housing 36 may be variably positioned on tube 13 by compression clamp 37 that encircles the lower end of the housing and compresses it to tube 13.

The upper leg portion 14 includes the tapered socket 40, which receives that portion of the wearer's stump that is above the knee. Socket 40 is pivotably coupled to housing 36 by hinges 42 and 44, the arms of each of which are rigidly secured to the elements so joined by rivets 46.

Within lower leg 12 is mounted a fluid-pressure dampening means comprising the hollow cylinder



50, having access opening 52 on the upper end closed by screw plug 54, and the passage 56 including the compression gland 58 that permits movement, under sealed conditions, of piston rod 60. A fixed piston 62 is secured between collars 63 and 64 on rod 60, and has a rather sharp upper annular edge 66 of lesser diameter than the internal diameter of the cylinder 50. An inverted cup-shape movable piston 68 is superposed upon and surrounds piston element 62, and is movable with respect thereto, between the fixed collars 64 and 65, so that the inner face of the cup wall 69 closes with or separates from the annular edge 66. Ports 70 in wall 69 are located within the diameter of annular edge 66 and permit fluid, in this case oil, to flow to chamber 72 from the upper face of piston 62. The outer periphery of the latter is of less diameter than the inner wall of cup 68 and is spaced therefrom, so that when piston 68 is moving downward oil will flow from lower chamber 74 upward, around piston 62 within cup 68, over the edge 66, and out through ports 70 to chamber 72.

An axial passage 76, having lower outlet 77, and upper outlets 78, is formed in rod 60 which extends above cup 68 and into chamber 72. A needle pointed screw 80, mounted in the upper end of rod 60, permits the adjustment of the amount of oil that may move through ports 78. Access for such adjustment is had by removing plug 54.

On its lower extension, rod 60 has spaced apart collars 82, 84, between which is mounted the slide bushing 86 that is of less length than the space between the collars. A lateral arm 88, coupled to bushing 86, extends rearward through opening 87 from rod 60 and the slide bushing, and is pivotally coupled at 89 to link 90, which is also pivotally coupled by pin 92 to the ankle block 30 at the rear of pin 34. A cross yoke 96 is threadedly mounted on link 90 intermediate its ends. Between an upper position on tube 13 and the arms of yoke 96, are positioned tension springs 98, which tend to pull the heel of foot 10 upward, and consequently, to depress the toe. Such tilting action, however, is restrained by unidirectional releasing clutch means. A blade 100 depends from arm 88 alongside the fixed boss 102 and swinging boss 104 on one side, and the upwardly urged slidable boss 106 on the other side. Boss 102 is outstanding from base plate 103 carried by tube 13. Boss 104 is mounted on swinging plate 105 that pivots on pin 107. A curved overhanging wall 108 on plate 105 receives boss 106, which is pressed there against by spring 109 and shoe 110. When the bosses are as seen in Fig. 7, the clutch is released, and blade 100 is free to move upward under the influence of springs 98. When the bosses are as seen in Fig. 6, blade 100 is gripped by the bosses and restrained from such movement.

Plate 105 is normally urged to the position of Fig. 6 by spring 112 on pin 113, and is moved against the spring by pressure applied to the integral cam 114 by roller 116 on crank arm 118 which action is had when downward pressure is delivered through bar 120, against spring 123.

In suitable guides 122, slide rod 124 is mounted on leg 12, between hinge 42 and the upper end of bar 129, to which the rod is coupled at 126. The upper end 127 of rod 124 is located to be contacted by abutment member 128 carried by the upper arm of hinge 42, so that, when the upper and lower leg elements are brought into substantial alignment, downward pressure will be placed upon rod 124, bar 120 and roller 116, to cause the latter to swing with pivoted crank arm 118 and

exert pressure against cam 114 to move boss 104 away from contact with blade 100. Such action releases blade 100, and permits the springs 98 to exert a pull upward on the rear of foot 10, and to cause the toe to tilt down. Initial movement like this is possible without movement of the piston in chamber 50, because of the sliding of bushing 38 on rod 60 against the upper stop collar 82.

Referring to Fig. 5, wherein is shown schematically a series of positions assumed by a leg during walking, A designates the leg in weight-supporting relation to the foot, with the foot on the ground. As the weight moves forward in the beginning of a stride, it moves faster than the knee joint, and substantially faster than the ankle joint, which is cocked through the concentration of pressure on the toe. In this mechanism, this amounts to an application of pressure through link 90 to the piston rod 60 to draw the piston downward, such movement being dampened by the bleeding action of the oil through the passages 70 to chamber 72. At the same time, blade 100 is gripped in the clutch means between the various bosses, since with the knee bent, the cam presser roller 116 is being pulled upward from the cam by the spring shown in Fig. 2.

Continued forward motion results in a further, but lifelike, lag in the ankle, accompanying a slight accelerated motion of the knee, as in position C of Fig. 5. The upper leg is swinging somewhat as a pendulum and this action results in motion of the lower leg from position B through stages C, D, and E, in the latter of which the lower leg is coming more into alignment with the upper leg. Such alignment as has been described results in a release of the clutch means acting on blade 100, and under the action of springs 98, the toe drops and the heel raises in a leveling-off action of the sole of the foot, 10.

Between stages E and F, the foot swings further forward, moving faster than the upper leg, as is indicated, and the amputee then shifts his weight to apply it to the artificial leg. The heel, still being slightly cocked because of the piston dampening means acting as a check on such movement, contacts the ground, whereupon further pressure is applied to link 90, arm 88 and piston rod 60, to cause an upward thrust on the piston and the oil in chamber 72. Through the bleeding of oil out of chamber 72, by way of passage 76, a slow or restraining action is had. The amputee then again swings his weight over the ankle pivot, as in stages F, G, and H, and the cycle of the stride has been completed.

Should the foot on approaching the ground come upon a stick or stone, any twisting will be accommodated by the swinging of the ankle block about the axis of pin 22, or twisting with respect thereto.

By means of the mechanism that has been described, it is possible for an amputee to walk with a normal, screwing or twisting action in the ankle, and the normal hinging actions in both ankle and knee. The action is very lifelike to view and is most comfortable and normal to the wearer of such a leg and is fully satisfactory in use for long periods of time.

While we have shown and described particular embodiments of our invention, it will occur to those skilled in the art that various changes and modifications may be made without departing from the invention, and we therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of our invention.



Having thus described our invention, we claim:

1. An artificial leg, comprising: a lower leg element including a foot portion pivotally coupled, between its ends, thereto; an upper leg element freely hinged to the lower leg element and provided with means for securing said upper leg element in place on the stump of a wearer; a fluid pressure cylinder and double-acting dampening piston mounted in said lower leg element, said piston having a piston rod extending therefrom longitudinally of the lower leg element; a pair of spaced apart stops on said piston rod; an arm associated with said piston rod and slidable between said stops, said arm outstanding rearwardly from said piston rod; a link between said arm and said foot portion to the rear of its pivotal connection with said lower leg element; spring means coupled to said link and lower leg element to impart an upward bias to the heel of said foot portion; a clutch blade carried by said arm; clutch means operable on said blade to retain the same against upward urgence of the biasing means; said clutch means including an opening cam, a presser member to act on said cam and having an extension to near said hinge joint, and an abutment carried by the upper leg element to press upon said presser member and operate thereon by approximate alignment of the upper leg with the lower leg element during walking.

2. An artificial leg, comprising: a lower leg element including a foot portion pivotally coupled, between its ends, thereto; an upper leg element freely hinged to the lower leg element and provided with means for securing said upper leg element in place on the stump of a wearer; a reciprocable member associated with the lower leg element for longitudinal movement thereof; a link coupled between said reciprocable member and a point on said foot-portion to the rear of its pivotal connection with the lower leg element; means for upwardly biasing said link; dampening means reciprocally operable longitudinally of the lower leg element and having a lost motion coupling with said reciprocable member; clutch means associated with said link and operable to retain the same against upward urgence of the biasing means, and clutch releasing means operable by approximate alignment of the upper leg with the lower leg element during walking.

3. An artificial leg, comprising: a lower leg element including a foot portion pivotally coupled, between its ends, thereto; an upper leg element freely hinged to the lower leg element and provided with means for securing said upper leg element in place on the stump of a wearer; a reciprocable arm rearwardly outstanding between the ends of said lower leg element and associated therewith for longitudinal movement; a link coupled between said arm and a point on said foot portion to the rear of its pivotal connection with the lower leg element; means for upwardly biasing said link; fluid pressure dampening means reciprocably operable longitudinally of the lower leg element and having a lost-motion coupling with said reciprocable arm; clutch means associated with said arm and operable to retain the same against upward urgence of the biasing means; and clutch releasing means operable by approximate alignment of the upper leg element with the lower leg element during walking.

4. An artificial leg, comprising: a lower leg

element, a foot portion, an ankle block pivoted to said lower leg portion to swing fore and aft thereof, said ankle block having an elastic torsional coupling with said foot portion, an upper leg element freely hinged to the lower leg element and provided with means for securing the upper leg element in place on the stump of a wearer; a reciprocable member associated with the lower leg element for longitudinal movement thereof, a link coupled between said reciprocable member and a point on said ankle block to the rear of its pivotal connection with said lower leg element, means for upwardly biasing said link, dampening means reciprocably operable longitudinally of the lower leg element and having a lost-motion connection with said reciprocable member, clutch means associated with said link and operable to retain the same against upward urgence of the biasing means, and clutch releasing means operable by approximate alignment of the upper leg element with the lower leg element during walking.

5. An artificial leg, comprising: a lower leg element including a foot portion pivotally coupled, between its ends, thereto; an upper leg element freely hinged to the lower leg element and provided with means for securing said upper leg element in place on the stump of a wearer; a double-acting fluid pressure dampening means attached at one operating end to said lower leg element, a connector member having lost-motion connection with the other operating end of said dampening means, a link between said connector member and the foot portion at a point to the rear of its pivotal connection with the lower leg element, means for upwardly biasing the link, clutch means associated with said link and operable to retain the same against the upward urgence of the biasing means, and clutch releasing means operable by approximate alignment of the upper leg element with the lower leg element during walking.

6. An artificial leg, comprising: a lower leg element including a foot portion pivotally coupled, between its ends, thereto; an upper leg element freely hinged to the lower leg element and provided with means for securing said upper leg element in place on the stump of a wearer; a double-acting fluid pressure dampening means attached at one operating end to said lower leg element, a connector member having lost-motion connection with the other operating end of said dampening means, an arm rearwardly outstanding between the ends of the lower leg element and carried by said connector, a link between said arm and the foot portion at a point to the rear of its pivotal connection with the lower leg element, means for upwardly biasing the link, clutch means associated with said link and operable to retain the same against upward urgence of the biasing means, and clutch releasing means operable by approximate alignment of the upper leg element with the lower leg element during walking.



7. An artificial leg, comprising: a lower leg element including a foot portion pivotally coupled, between its ends, thereto; an upper leg element freely hinged to the lower leg element and provided with means for securing said upper leg element in place on the stump of a wearer; a double-acting fluid pressure dampening means attached at one operating end to said lower leg element, a connector member having lost-motion connection with the other operating end of said dampening means, an arm rearwardly outstanding between the ends of the lower leg element and carried by said connector, a link between said arm and the foot portion at a point to the rear of its pivotal connection with the lower leg element, means for upwardly biasing said link, an element to be clutched and carried by said arm, clutch means associated with said lower leg element and operable to grip said element to be clutched to retain the same against the upward urgence of the biasing means, and clutch releasing means operable by approximate alignelement during walking.

8. An artificial leg, comprising: a lower leg element including a foot portion pivotally coupled, between its ends, thereto, and biased to the uncocked position, an upper leg element freely hinged to the lower leg element and provided with means for securing the upper leg element in place on the stump of a wearer, releasable means for retaining cocked the joint between the foot portion and the lower leg portion during the swing of the leg from the beginning of a stride, means for releasing said releasable means to permit lowering of the toe of the foot portion before the end of the stride, and compressible means to retard cocking of the foot relative to the lower leg portion during the time the foot is bearing the wearer's weight and resting on the ground as in walking.

PAUL M. GETTMAN.
WILLIAM T. FULTON.


REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 2,020,423 | Lofts | Nov. 12, 1935 |

FOREIGN PATENTS

| Number | Country | Date |
|---|---|---|
| 530,623 | France | Oct. 6, 1921 |

OTHER REFERENCES

Research Reports on Artificial Limbs, Committee on Prosthetic Devices, National Research Council, page 24.