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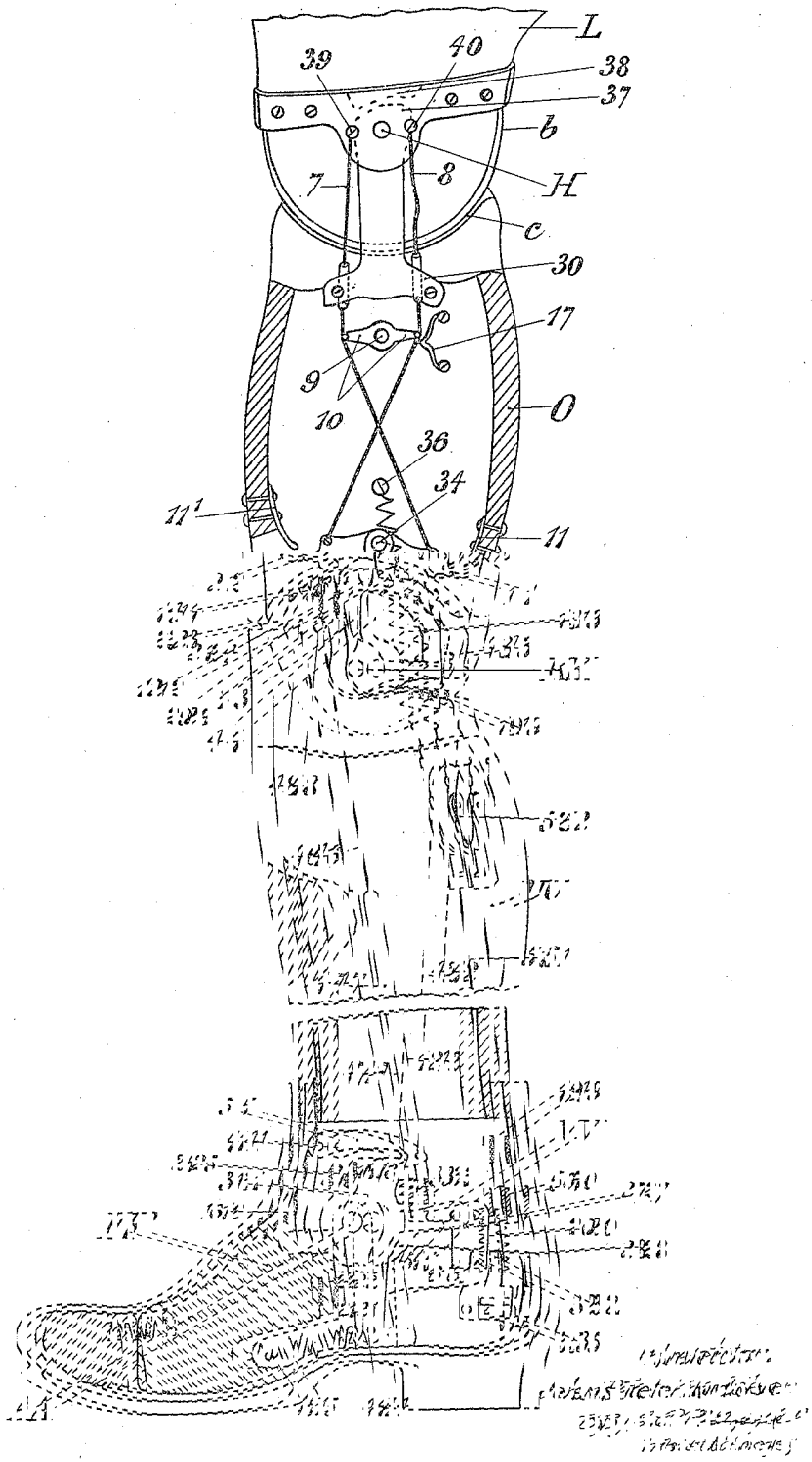
ARTIFICIAL LEG.

APPLICATION FILED MAY 11, 1920.

1,375,299. Patented Apr. 19, 1921.



UNITED STATES PATENT OFFICE.

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ARTIFICIAL LEG.

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Application filed May 11, 1920. Serial No. 380,491.

To all whom it may concern:

Be it known that I, JENS PETER KNUDSEN, a citizen of the Kingdom of Denmark, residing at Kædeby, in the Kingdom of Denmark, have invented new and useful Improvements in Artificial Legs, of which the following is a specification.

The present invention relates to artificial limbs and in particular to certain improvements in the knee and ankle joints, as hereinafter specified.

The heretofore known artificial limbs are but slightly bent in withdrawn position, and the foot, when relieved of the weight of the body, is essentially at right angles to the lower leg. In order that the limb, in such withdrawn position, can freely swing forward, without touching the ground, and that the wearer does not waddle too noticeably, it has to be shorter than the natural leg.

With the present invention the artificial limb is equally as long as the natural limb, and waddling of the wearer is avoided by the said artificial limb, when in withdrawn position, being more bent at the knee than was the custom with such limbs heretofore, and by the point of the foot, when swinging forward, bending upward, so that the withdrawn limb may freely swing forward without there being any danger of its striking the ground.

In the accompanying drawing the improved artificial leg is shown in side elevation and partly in section.

The limb shown in the drawing is intended for patients, when the natural limb has been amputated at the hip. This leg consists of the following parts:

A leather bandage L, which is strapped tightly around the loins and the hip, an upper leg or thigh limb O, a lower leg or calf limb U and a foot F. These parts are connected to each other by means of three hinges, viz, one at the hip, one at the knee and one at the foot-joint or ankle. The axis of the hip and foot joints are practically parallel to each other whereas the axis of the knee joint is, although also horizontal, disposed obliquely to said axis, so that when the lower leg is being withdrawn, it is first guided obliquely toward outside, so that the danger that the foot, when being swung forward, knocks against the ankle of the natural leg, is reduced. The leather bandage L is fitted with steel bands, which serve to maintain the form of the bandage and also to hold the hip joint H. To the lower edge of the leather bandage L is attached a circular curved flat steel band *b*, which, when the bandage is fitted, rests in a groove *c* corresponding to the band *b* and provided in the top surface of the upper leg O. To the top of the upper leg on its outside surface is attached a fitting 30 (shown broken off in the drawing), by means of which the upper leg is pivotally hung to the axis H of the hip. This fitting is provided with a cam 37, which, when the upper leg is moved backward, will bear against a stop 38 on the bandage fitting, so that the backward stroke of the upper leg in the hip joint is limited.

Through the upper leg is passed a spindle 9, on which tilting lever 10 is pivoted. By means of a spring 17 this lever is obliged, in known manner, to assume either of two extreme positions. The ends of the said lever are connected by means of metal cords 7 and 8 to screws 39 and 40. The cords 7 and 8 extend beyond the lever downward to two pawls 1 and 2, fitted on an axis 34 farther down in the upper leg. These pawls 1 and 2 alternately engage with two ratchet wheel sectors 3 and 4, turning on the knee joint axis K. The pawl 1 is held down toward the ratchet wheel sector 3 by means of a spring 11, but at such a distance from said ratchet wheel, that the latter may turn freely clockwise without any rattling noise being produced by the teeth of the wheel scraping along the pawl. When turned contrary to clockwise a flat spring 12, which is secured to the pawl 1 and bears tightly against the ratchet wheel 3, will bring the pawl 1 into engagement therewith and thereby prevent the turning of said wheel sector; a similar arrangement is provided for pawl 2 with reference to ratchet wheel 4. The ratchet wheel 3 is coupled by means of a coiled spring 14 to the lower leg U. Rubber stops 19 and 29 limit the swing of the ratchet wheel sectors.

The lower leg U is made of wood and hollow, and is at the top provided with bearings for the knee joint axis K and a recess for the ratchet wheels 3 and 4; below are provided the bearings for the foot joint axis A and an axis 41, on which is fitted a pawl 5 the tooth of which is in engagement with a lug 18 on a lever 31, swinging on the foot joint axis A. The point of the foot is not at right angles to the axis A, but oblique to

the same (the heel pointing inward); the reason for this arrangement and the advantages derived thereby shall hereinafter be specified.

The pawl 5 is connected by means of a cord 42 to a screw 43 on the ratchet wheel sector 4; when the lower leg swings forward, relatively to the upper leg, it is obvious that as soon as the ratchet wheel 4 is held by the pawl 2, the cord 42 will be drawn taut and will release the lug 18, and the elastic band 16 which connects the instep of the foot to the lower leg will bend the toe-part upward. The foot is hinged to the lower leg by means of a fitting 44, which passes under the foot and extends upward on both sides thereof.

On an axis 45 in the lower leg is pivoted a bell-crank V, the one end 6 of which may engage a stop 32 secured in the foot. This engagement occurs, when the weight of the body rests on the toes, by aid of spring 33. To the horizontal arm of the bell-crank V is attached a cord 46 which is passed through a piece of tubing 47 to a screw 48 on the outside of the upper leg, above and in front of the knee axis K. When the knee is bent, a pull will be exerted on the cord 46, whereby the pawl 6 is disengaged from the stop 32.

On lever 31 act two strong springs 15, one on each side, and between the heel and the lower leg are inserted two springs 20 of which only one is to be seen in the drawing, which springs are placed under tension, when a load bears on the heel.

To the heel is attached by means of an adjustable screw 35 a cord 51, to which a lug 49 is soldered, which, by abutting against a tubular stop 50 limits the upward turn of the toe and distributes the pressure of the body over the foot. The cord 51 is secured to a forked bearing 52, which by means of a sheave and rope pulls a spring 13 by a distance which is twice as long as the stroke of said forked bearing itself. The said spring 13 is secured by means of a screw 36 to the outside of the upper leg. The backward swing of the lower leg, relatively to the foot is limited by stops 27 and 28 on the lower leg and the foot, respectively. In front of the lever 31 is provided a rubber stop 22 fitted into the body of the foot, the movement of which is limited by the fixed stop 21. For the shorter arm of lever 31 is provided a rubber stop 25. The foot is made of wood, with the necessary recesses for the parts mentioned, and is inclosed in a leather boot. The toe is joined by aid of springs to the main body of the foot.

For more clearly explaining the nature of the present invention the operation of the artificial leg shall now be described.

Assumed the body is in forward movement; then the artificial leg will, at a given moment, be in a position behind the body, and the following will occur; the cord 7 is pulled taut, the lever 10 is swung over, the pawl 1 is lifted and the pawl 2 is lowered. The knee axis K, which is in front of the vertical plane through the hip joint H, is pressed back until the stops 23 and 24 meet. The weight of the body is now brought forward over the fore-part of the foot, and as the pawl 5 holds the lever 31, the foot moves into hooked position, viz. the tooth 6 engages the stop 32. By this movement a part of the work performed by the drop of the body is stored as energy in the springs 13 and 15, which are placed under tension, while the foot comes into hooked position. As the toe points outward, the weight of the body is simultaneously transferred to the natural leg, so that the artificial leg is partly relieved. The spring 13, is thereby able to bend the knee joint, while the point of the foot presses tightly against the ground. When the knee joint is bent so far that a line drawn through H and K passes beyond the toe, the position of the screw 48 with reference to the lower leg is changed in such a manner, that a pull is exerted on cord 46, so that the tooth 6 disengages the spring 15 and the energy still stored in 13, thus producing, while the leg is being bent, a setting off movement of the toe whereby the foot is lifted. When the lower leg is farthest turned backward relatively to the upper leg and then attempts to turn forward the pawl 2 will engage in the ratchet wheel 4, so that the lower leg can not be turned forward relatively to the upper leg. The gravity will now tend to draw the bent and lifted lower leg and foot downward, but thereby the cord 42 will be tightened and will disengage the pawl 5, and the foot will under action of the elastic band 16, again move into its hooked position. The knee is now greatly bent and the toe is pointing upward. The limb can, therefore, swing freely forward without there being any danger of its knocking against the ground or the ankle of the natural leg. By the forward swing of the thus bent leg the cord 8 will be tightened and the lever 10 will be tilted over, whereby the pawl 2 is lifted and the pawl 1 is lowered; the lower leg will then continue its movement around the axis of the knee until the knee is straightened out.

The lower leg is prevented from swinging back by being locked in the forward stretched position by means of the pawl 1 and the ratchet wheel sector 3. The heel of the artificial leg is now placed on the ground a little ahead of the center of gravity of the body. During the last forward swing, the spring 13 has, by pulling the cord 51 again moved the foot into its normal position and the elastic band 16 is stretched, while the pawl 5 is engaging the lug 18. The body

is now moved forward over the artificial leg and the next step is commenced. By the shown arrangement of the ratchet wheel sector 3 in the lower leg it has been obtained that, as, the said ratchet wheel sector may turn a little in both directions on the axis, both heel and toe may step on stones, without the equilibrium being disturbed, as small turnings of the foot will be compensated by small turnings of the ratchet wheel sector 3 and by that, the lever 31 acts on the springs 15 or on the rubber stops 22 and 25. The pawl 1 will, namely, at a slight turn, not immediately engage the first tooth of the ratchet wheel sector 3; if, for example, the toe steps onto a stone, the consequence will be that the pawl 1 moves one tooth forward in the ratchet wheel sector 3, so that the center of gravity of the body still remains in front of the plane of support; this cannot be obtained with limbs having a stiff knee. If the heel steps onto a stone, the pawl 1 will not advance, but the ratchet wheel sector 3 will be turned back, the spring 14 will, then, tighten and assist in stretching the knee when the leg is set forward.

If the toe is very slantingly turned upward, the tooth 6 will engage the stop 32 thus preventing, the springs 13 and 15 from bringing the body out of equilibrium.

I claim:

1. Artificial leg consisting of a rigid hip-bandage, an upper leg, means for hingedly securing said upper leg to said hip bandage, a lower leg, means for hingedly securing the lower leg to the upper leg, a foot and means for hingedly securing the foot to the lower leg, the hinge between the upper and the lower leg (the knee-hinge), being, at an upright position of the leg, somewhat in front of the vertical line through the hip-hinge and the foot-hinge, respectively.

2. Artificial leg consisting of a rigid hip-bandage, an upper leg, means for hingedly securing said upper leg to said hip-bandage, a lower leg, means for hingedly securing the lower leg to the upper leg, a foot and means for hingedly securing the foot to the lower leg, the hinge between the upper leg and the lower leg (the knee-hinge) being, at an upright position of the leg, somewhat in front of the vertical line through the hip-hinge and the foot-hinge, respectively, the axis of said knee-hinge, although likewise horizontal, the same as the axis of the hip-hinge and the foot-hinge, being not exactly at right angles to the symmetrical plane of the body, the toe of the foot pointing somewhat outward.

3. In an artificial leg composed of a hip-bandage, an upper leg, a lower leg and a foot, a hip-joint consisting of said hip-bandage, steel reinforcements thereon, a joint-axis supported therein, straps hinged thereon and extending downward to be attached to the upper leg, a flat steel band, bent to a semicircular curve and attached to said steel reinforcements, and in the upper end of the upper leg a groove, adapted to receive said flat steel band.

4. In an artificial leg composed of a hip-bandage, an upper leg, a lower leg and a foot, a knee-joint consisting of a joint-axis, to which upper leg and lower leg are hingedly attached, fitted on said joint-axis two ratchet-wheel sectors, a pawl for each of said ratchet-wheel sectors, each of said pawls coupled by a metal cord to said hip-bandage, said cords intermediately attached to a tilting-lever, a spring, adapted to hold said tilting lever in either of two extreme positions, springs limiting the stroke of said pawls, abutments limiting the bend of the knee-joint, the one of said ratchet-wheel sectors coupled by means of a coiled spring to the lower leg.

5. In an artificial leg composed of a hip-bandage, an upper leg, a lower leg and a foot, a foot-joint consisting of a joint-axis, to which the lower leg and the foot are hingedly attached, fitted on said joint-axis a double-armed lever, a pawl coupled by a metal cord to the free ratchet-wheel sector in the knee-joint and adapted to engage over the short arm of said double-armed lever, a coiled spring coupling the long arm of said double-armed lever to the body of the foot, abutments limiting the stroke of said double-armed lever.

6. In the foot of an artificial leg composed of a hip-bandage, an upper leg, a lower leg and a foot, a heel-piece, said heel-piece coupled by means of a metal-cord, a pulley-block and an expanding spring to the upper leg, means for adjusting the length of said metal cord, on said metal cord a stop, in the lower leg an abutment, adapted to engage said stop on the metal cord and partly take up the weight of the body, a bellcrank lever hinged to the lower end of the lower leg, the one arm of said bell-crank lever adapted to engage against said heel-piece, the other arm coupled by means of a spring and a metal cord to the upper leg.

7. In an artificial leg, a hip bandage, an upper leg portion connected thereto, a lower leg portion, a foot body attached to the latter, a toe piece connected by a compression spring to said foot body, a heel piece on said foot body, a cord connected at one end to said heel piece, a pulley block on the other end of the cord, a flexible and resilient support connected at one end to said lower leg portion and passing about the pulley of said block and attached at its other end to the upper leg portion, a stop on said heel piece adapted to engage said lower leg portion for partly taking up the weight of the body, and movable means carried in the lower leg

portion connected to the upper leg portion and arranged in the path of movement of said heel piece for engagement therewith.

8. In an artificial leg, a lower leg portion, a foot body pivoted thereto, and resilient means connecting the instep of the foot to the lower end of said lower leg portion in position to yieldably maintain the fore-part of said foot body elevated above the heel part thereof.

9. In an artificial leg, a hip bandage, an upper leg portion pivoted thereto, a lower leg portion pivoted to said upper leg portion, a foot body pivoted to the lower end of said lower leg portion, an elastic band secured at one end to the instep of said foot body and at its other end to said lower leg portion for normally urging the fore-part of said foot body in an elevated position above that of the heel part, and a resilient differential connection between the heel part of said foot body and said upper and lower leg portions.

In testimony, that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

JENS PETER KNUDSEN.

Witnesses:

P. HOFMAN-BANG, C. E.,

HENRY C. A. DAMM.