(No Model.)

W. ANDREWS.

ARTIFICIAL LEG.

No. 563,247. Patented July 7, 1896.

Fig. 1.

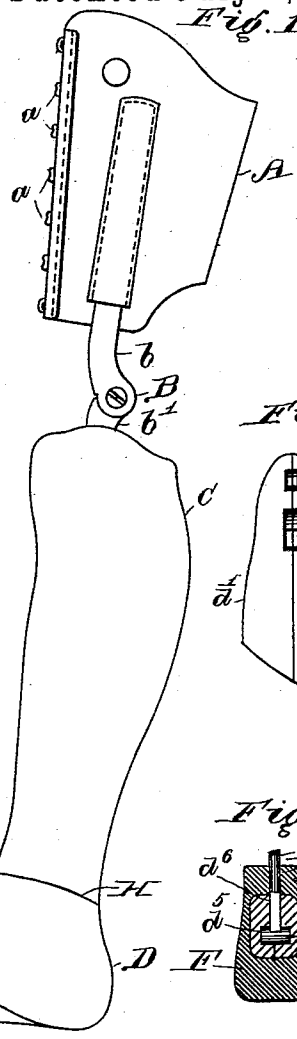


Fig. 2.

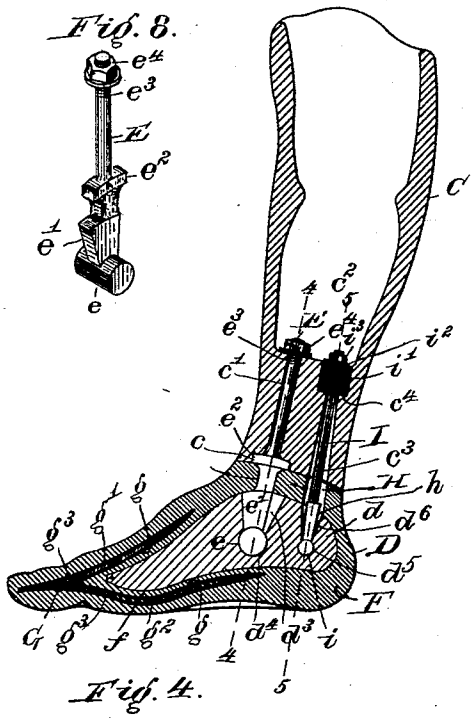


Fig. 8.

Fig. 6.

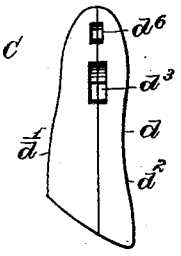


Fig. 4.

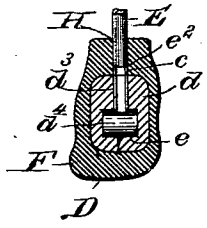


Fig. 5.

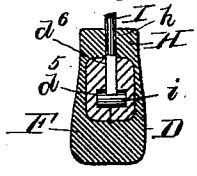


Fig. 3.

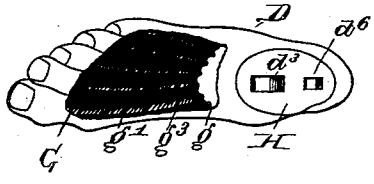
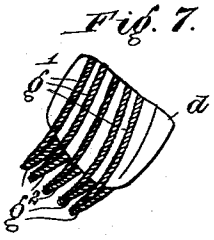


Fig. 7.



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ARTIFICIAL LEG.

SPECIFICATION forming part of Letters Patent No. 563,247, dated July 7, 1896.

Application filed April 15, 1892. Serial No. 429,281. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM ANDREWS, a citizen of the United States, residing at Lowell, in the county of Middlesex and Commonwealth of Massachusetts, have invented a certain new and useful Improvement in Artificial Legs, of which the following is a specification.

My invention relates to artificial legs; and it consists in the devices and combinations hereinafter described and claimed, the general objects of said invention being to connect the leg proper and the foot by a joint which requires no lubrication; to prevent the foot from turning laterally on the leg; to give a natural movement to the foot by interposing a cushion between the shell or leg proper and the core of the foot; to limit said movement and to vary the angle of the foot to the leg when the foot is raised from the ground; to impart the proper resistance and elasticity to the toe of the foot.

Said invention comprises the connection of the foot to the leg by a bolt pivoted in a slot in the core of the foot, the sides of said slot preventing a lateral movement of the core, and the front end of said slot limiting the pivoted movement of said bolt, said bolt having a T-shaped head, which enters a corresponding recess below said slot, and having an oblong shoulder which fits a corresponding recess in the lower end of the leg and prevents said leg and core from independent movement around the axis of said bolt. Said invention also comprises, in combination with the leg and core and their connecting ankle-joint, an inflexible inextensible heel-tendon pivoted to said core back of said ankle-joint and extending loosely through a hole into a socket, with which said leg is provided, and a nut which turns on the upper end of said heel-tendon within said socket to limit the movement of said ankle-joint; also the combination, with said leg, core, ankle-joint, heel-tendon, and nut, of an elastic cushion arranged between said leg and core. Said invention also comprises a toe-spring which extends above and below the core and beyond the toe of the core, together with an elastic envelop which surrounds said core and toe-spring; also the arrangement of a layer of elastic material between said core and toe-spring to allow a slight movement of the toe-spring on the core; also construction of the toe-spring of cords arranged at intervals from each other and embedded in hard rubber.

In the accompanying drawings, Figure 1 is an elevation of the inner side of an artificial leg provided with my improvements and adapted for amputations below the knee; Fig. 2, a central vertical section from front to back of the part of such artificial leg below the knee, showing the T-hinge and heel-tendon in side elevation, showing also the core and toe-spring in section; Fig. 3, a plan of the foot detached, omitting the T-hinge and heel-tendon, a part of the rubber envelop between the instep and the toes being removed to show the construction of the toe-spring; Fig. 4, a section on the line 4 4 in Fig. 2 of the foot, showing the lower part of the T-hinge in rear elevation; Fig. 5, a section on the line 5 5 in Fig. 2, showing the heel-tendon in rear elevation; Fig. 6, a plan of the core; Fig. 7, a diagram showing the toe-spring cords; Fig. 8, an isometric perspective view of the hinge-bolt.

The thigh-lacer or laced thigh-piece A, provided with buttons *a* to connect with a strap (not shown) which passes over the shoulder, the metallic hinge B, one part, *b*, of which is secured to the lacer A and the other part, *b'*, of which is secured to the shell or socket C or part of the artificial leg below the knee, and said shell C are of any usual construction and operation.

The foot D comprises a core *d* of inflexible material, as of fine hard wood, preferably maple, surrounded by a rubber envelop, as hereinafter described. The cord *d*, for convenience of construction, is formed in two parts d' d^2, separated longitudinally, and is provided with a slot d^3, which has vertical sides and extends from the top of the core into a cylindrical recess d^4 of greater length than the width of said slot d^3 and at right angles therewith, said recess and slot being preferably formed equally in the parts d' d^2.

A bolt E, shaped in cross-section like an inverted T, is inserted in said slot d^3, its cross-head *e* being cylindrical and having a running fit in said recess d^4. Above the recess d^4 the bolt E is wide enough to fill the slot d^3, but the front and back of said slot are up-

wardly divergent to allow said core to turn on the head e of said bolt, the front end of said slot acting as a stop to limit the forward movement of said bolt, which is extended forward, at e', within said slot to give a greater bearing-surface of said bolt on the sides of the slot and to assist in preventing the core d from turning on said bolt, the horizontal sections of said slot and of said bolt within said slot being rectangular.

At some distance above the core the bolt E is provided with an oblong shoulder e^2, preferably rectangular in cross-section, which enters and fits a corresponding recess c in the closed lower end of the leg or shell C and prevents said bolt from turning in said shell. Above the shoulder e^2 the bolt may be cylindrical and passes through a hole c' in the lower end of the shell up into the socket proper, c^2, or hollow of the shell C, and at its upper end is screw-threaded, at e^3, to be engaged by a nut e^4, which turns down against the bottom of said socket.

The parts of the core after the hinge-bolt E is in place are secured to each other by screws or cement before the envelop F is placed thereon.

The envelop F is of sponge-rubber and is applied by hand to the core and by hand caused to approximate the shape of a natural foot and is afterward compressed in a metallic mold in the usual manner to the desired shape and then vulcanized; but before the envelop is completed the toe-spring G is put in place, said spring being embedded in said envelop, as shown in Figs. 2 and 3. The sponge-rubber of the envelop being of a doughy consistency, a layer f thereof is applied to the core d and a layer of hard rubber (or rather a layer of rubber which, on being vulcanized, becomes hard and springy) is secured to said layer f of sponge-rubber from the instep of the finished foot nearly to the end of the toe thereof and thence back to or beyond the cross-head of the bolt E, and stout cords g' are then placed against said layer g of hard rubber at intervals from each other from the instep to the toe, and other similar cords g^2 are arranged at intervals to extend from about the middle of the hollow of the foot to the front or toe ends of said cords g'.

If desired, the cords g' g^2 may be continuous with each other. The cords g' g^2 are covered with another layer g^3 of hard rubber, or rubber which becomes hard by vulcanization, which is pressed against said cords and, by means of a hand presser-wheel, of usual construction, is forced into the spaces between the cords and into contact with the previously-applied layer of hard rubber, care being taken not to leave any bubbles of air between the layers g g^3. A sufficient amount of sponge-rubber is then applied all over the core and toe-spring and molded by hand to approximate the shape of a foot, which foot is then placed in a metallic mold and vulcanized in the usual manner.

It will be understood that each layer of rubber is connected to the adjacent layer or layers by rubber-cement in the usual manner and that the bolt E, detached from the leg or shell C, is placed in the vulcanizer with the foot.

The size and number of the cords g' g^2 will of course depend upon the person who is to wear the foot and the nature of his occupation.

The toe-spring G, above described, consisting of the cords g' g^2, embedded in the hard rubber g g^3, is very flexible within the necessary limits and very strong, not being so liable to be broken as where the rubber is arranged in layers separated by flaps of canvas or similar material, the shape of the spring being such that where the weight of the body is supported upon the toe the part of the spring above the core resists and limits the bending of the spring, while the cords g' g^2 make it almost impossible to draw the ends of the spring away from the toe of the foot.

An elastic cushion H is interposed between the lower end of the leg or shell C and the top of the core and for convenience this cushion, which is of sponge-rubber, is made in one piece with the envelop F, the top of said cushion H and the lower end of the shell C, which rests upon said cushion, being so shaped as to hold the foot in a natural position when raised from the ground. The cushion H fits the bolt E between the top of the core d and the shoulder e^2 and thus resists the upward movement of the toe or front part of the foot, as a whole, and prevents the bolt E from coming in sudden and violent contact with the front end of the slot d^3.

The greater part of the cushion H being in the rear of the bolt E and the leverage of the toe being much greater than that of the heel, because the former extends farther than the latter from the cross-head of the bolt E, it is found desirable to make a cavity or hole h vertically through said cushion, which allows the adjacent parts of said cushion to yield inwardly without changing the contour of said cushion, which follows the shape of the corresponding parts of the natural foot and leg.

The foot above described, connected only by the bolt E to the leg, leaves nothing to be desired in an artificial foot, provided the angle of the foot to the leg be first properly adjusted and sufficient care is taken to keep the heel of the shoe worn thereon always at the same proper height, a thing very difficult to accomplish. In order to regulate the angle between the foot and leg, as desired, raising the heel of the foot with reference to the toe of the same when the heel of the shoe is high, and lowering the heel of the foot when the heel of the shoe is low, I use the heel-tendon I, which is an inverted T-headed bolt, secured in the core before the envelop F is applied to the core, the cross-head i being cylindrical and fitting a corresponding recess d^5 in the parts d' d^2 of the core just as the cross-head of the bolt E is secured in said parts. From the cylindrical recess d^5 the

slot d^6 extends to the top of the core, and, like the slot d^3, has vertical sides and upwardly-diverging ends, to allow the tendon I to swing back and forth in said core. The sides of the tendon I may be flattened within the slot d^6 just as the sides of the bolt E are flattened. The tendon I passes up through the hole h in the cushion H, and through an upwardly-tapering hole c^3 in the shell C, and through an annular spring i', or hollow cylinder of rubber or similar elastic material, arranged in a recess c^4 at the bottom of the hollow c^2 of the shell C, and through a washer i^2 and nut i^3, which turns on the threaded upper end portion of said tendon I, so that by turning said nut on said heel-tendon the compression of the cushion H between the rear part of the core and the shell is varied, the toe being raised and the heel lowered by loosening or raising said nut and allowing the rear portion of said cushion to expand, and the contrary effect being produced by turning said nut down on said tendon and compressing said rear portion of said cushion.

When the heel-tendon I is used, it is not necessary or desirable to have the bolt E come into contact with the front end of the slot d^3, said tendon sufficiently limiting the movement of the foot on the leg, so that, in this case, the slot d^3 may extend farther forward, or the front extension e' of said bolt may be made shorter.

The T-shaped hinge-bolt E and heel-tendon I are formed from aluminium bronze that composition being preferred on account of its lightness and strength.

The hinge formed by the connection of the bolt E and the core and the bearing of the heel-tendon in said core are rendered smooth by the introduction of powdered plumbago into the recesses d^4 d^5 before the envelop is applied to said core, so that these joints wear smooth, require no subsequent lubrication, and always work easily and without noise.

The lower end of the shell always resting upon the cushion H, all around the outer edge of said cushion, prevents any dirt from getting into the slots d^3 d^6 and recesses d^4 d^5, and prevents the escape of the plumbago therefrom.

Before vulcanization the envelop F is covered with a thin layer F′ of close-grained white or flesh-colored rubber, the thinner the layer F′ the better, because of its specific gravity being greater than that of the sponge-rubber. The layer F′ protects the sponge-rubber of the envelop and increases the durability of the foot, besides improving the appearance of the same, and may be buffed to give a uniform surface and a velvety appearance and touch to the foot.

I claim as my invention—

1. The combination of the leg, the core, provided with a slot, a rod or bolt secured in said leg and pivoted in said slot and prevented from a lateral movement in said core by the sides of said slot, said bolt being limited in its motion on its pivot by the front end of said slot, as and for the purpose specified.

2. The combination of the leg, the core, provided with a recess and with a slot, extending from said recess to the top of said core, a bolt, secured to said leg and movable in said slot and having a T-shaped head to enter said recess below said slot, as and for the purpose specified.

3. The combination of the leg, the core, provided with a slot, a rod or bolt secured in said leg and pivoted in said slot and prevented from a lateral movement in said core by the sides of said slot, said bolt being provided with an oblong shoulder which enters and fits a corresponding recess in the lower end of said leg, to prevent said leg and core from turning with respect to each other, around the axis of said bolt, as and for the purpose specified.

4. The combination of the leg, provided with a socket, the core, provided with a slot, an ankle-joint connecting said leg and core, an inflexible inextensible heel-tendon, pivoted to said core back of said ankle-joint, and extending loosely through a hole with which said leg is provided into said socket, and a nut, turning on the upper end of said heel-tendon, within said socket, to limit the movement of said ankle-joint, as and for the purpose specified.

5. The combination of the leg, provided with a socket, the core, provided with a slot, an ankle-joint connecting said leg and core, an elastic cushion interposed between said leg and core, a heel-tendon, pivoted to said core, back of said ankle-joint, and extending loosely through a hole, with which said leg is provided, into said socket, and a nut, turning on the upper end of said heel-tendon, within said socket, to limit the movement of said ankle-joint, as and for the purpose specified.

6. The combination of the core, a toe-spring, extending from a point above said core beyond the toe or front end of said core and backward below said core, and an elastic envelop, inclosing said core and toe-spring, as and for the purpose specified.

7. The combination of the core, a toe-spring, extending from a point above said core beyond the toe or front end of said core and backward below said core, a layer of yielding material, arranged above and below said core and separating said core and toe-spring and an elastic envelop, inclosing said core and toe-spring, as and for the purpose specified.

In witness whereof I have signed this specification, in the presence of two attesting witnesses, this 11th day of April, A. D. 1892.

WILLIAM ANDREWS.

Witnesses:
ALBERT M. MOORE,
MYRTIE C. BEALS.