J. CONDELL.

ARTIFICIAL LEG.

No. 48,660. Patented July 11, 1865.

Fig. 1

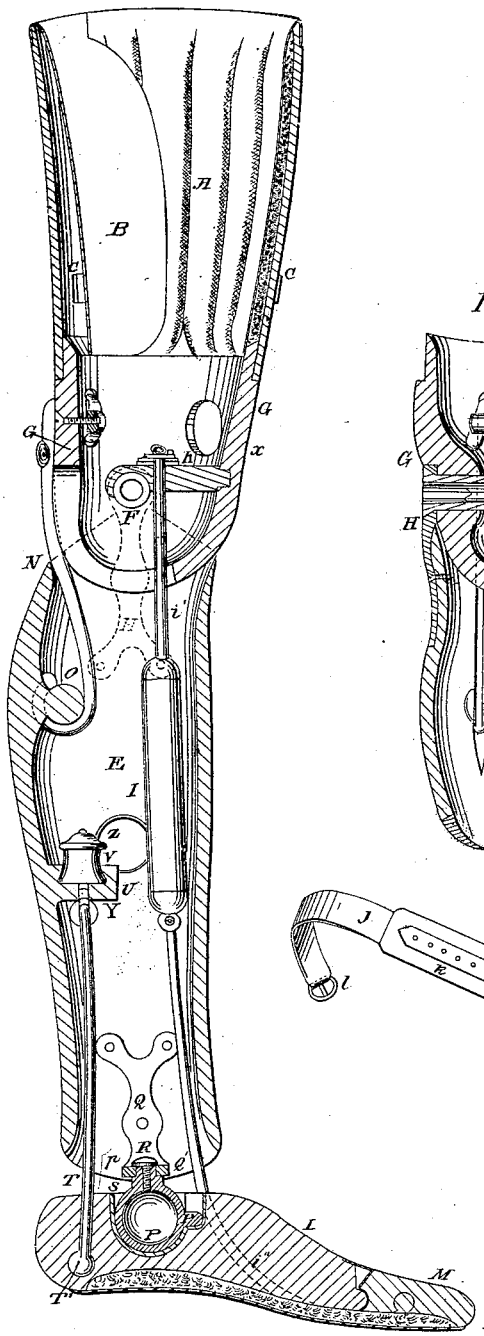

Fig. 2

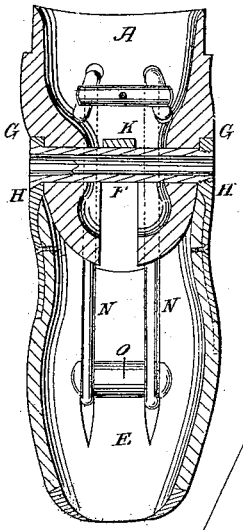

Fig. 3

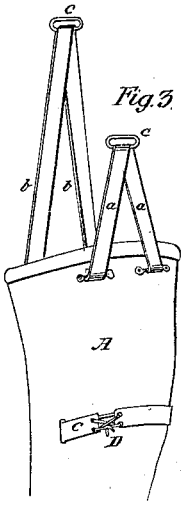

Fig. 5

Fig. 6

UNITED STATES PATENT OFFICE.

JOHN CONDELL, OF MORRISTOWN, NEW YORK.

IMPROVEMENT IN ARTIFICIAL LEGS.

Specification forming part of Letters Patent No. **48,660**, dated July 11, 1865.

To all whom it may concern:

Be it known that I, JOHN CONDELL, of Morristown, in the county of St. Lawrence and State of New York, have made certain new and useful Improvements in Artificial Legs; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, making part of this specification, in which—

Figure 1 is a longitudinal vertical section of the leg in a line from front to back as worn. Fig. 2 is a vertical section of the knee-joint and the parts immediately adjacent in a line from right to left as worn. Fig. 3 is an elevation of the socket or thigh-piece, which contains the stump, and showing the straps by which the artificial leg is held up to its position on the wearer. Fig. 4 is a view of the yoke and belts which pass around the trunk of the wearer and are secured to the straps on the socket. Figs. 5 and 6 show the appearance of the yoke and straps by which the artificial limb is supported on the wearer.

Similar letters of reference indicate corresponding parts in the several figures.

I claim to secure lightness, easy and noiseless motion, durability, and, as nearly as possible, an actual adherence to the natural appearance in flexure and extension.

The special points of improvement will be detailed, and, beginning with the superior portion, consist, first, in the method of adjusting the interior of the socket to the size of the stump; second, in the peculiar structure of the knee-joint and the devices for supporting the articulating bolt; third, the bridge-piece, the forward end of which is supported in a mortise in the frame, the other end being supported by the knee-joint bolt, the said bridge being the superior point of attachment for the extensor-spring; fourth, in the arrangement and adaptation of the ham-strings, which limit the forward motion of the leg; fifth, in the elastic attachment, which has its superior insertion at the bridge over the knee-joint, and, passing forward of the ankle-joint and under the instep, has its inferior attachment in the toe-piece; sixth, in the improved construction of the ankle-joint, wherein the foot is attached to the lower leg by means of a ball-joint whose socket is in the foot; seventh, in the adaptation and spring attachment of the heel-cord; eighth, in the adjustment and adaptation of the straps which connect the artificial limb with the suspensory-yoke; ninth, in the yoke or strap, which is so constructed as to bear upon the trunk and form a means of suspension for the limb.

To enable others skilled in the art to which my invention appertains to fully understand and use the same, I will proceed to describe its construction and operation.

A is the thigh or socket in which the stump of the limb is inserted. This socket is lined and padded, so as to give a soft and yielding surface to the stump. For the purpose of adjusting its capacity to the size of the stump it is provided with a plate, B, attached to the posterior upper edge and capable of being brought forward by drawing upon a strap, C, which is secured at the required tension by strings D, or otherwise. By this means the stump may be inserted and the plate B afterward fitted to the posterior portion of the thigh, so as to bring the required pressure upon it to hold it comfortably and give the stump the requisite command of the artificial limb. This is much better and more comfortable to the wearer than thrusting the stump down into a socket of the requisite tightness, as by the latter operation the skin of the stump is stretched and pushed up, which causes irritation. Another benefit derived from this is that as the stump shrinks and reduces in size the socket may be adjusted to fit it by the wearer himself.

The thigh is attached to the leg E by means of an articulating bolt or pintle, F, which I make hollow, and which passes through the sides of the frame G of the thigh, and also through the eyes of the metallic straps H H, which are firmly attached to the sides of the leg. (See Fig. 2.) The frame G is made thick at this point, so as to afford a good bearing-surface on the bolt which sustains the weight of the person.

The required degree of rigidity of the knee-joint is obtained by screwing up the bolt F, so as to make the motion under the influence of the stump and the spring more or less easy, so as to move with the required flexibility, resembling as nearly as possible the natural motion—that is, to throw forward or backward with an easy gentle motion, which is pleasant to the wearer, and graceful as it approximates to the natural.

This description, in connection with the drawings may be considered sufficiently explanatory of the method of pivoting the thigh and leg together, but the relative motions of the parts are induced, influenced, or controlled by a spring-extensor, I, and ham-strings N N, which I will proceed to describe.

The spring-extensor consists of the spring portion I, which may be considered the muscular contractile portion, and the tendons *i'* and *i''*, the former of which receives its insertion in the bridge-piece K, which is a block supported at two points. Its forward end is inserted into a mortise in the frame G of the thigh, as is clearly shown in Fig. 1, and its rearward end is supported by lapping upon the bolt F, the under side of the bridge-piece K being hollowed, so as to maintain its position on the bolt, slipping round on it as the leg is flexed or extended, the bolt being rigidly secured to the side pieces or metallic straps which form the extreme upper point of the leg, while the bridge-piece K is secured at one end in the frame of the thigh, and at the other oscillates around the axis of articulation. The other tendon, *i''*, passing downwardly from the muscle I, is bifurcated, and the two tendons pass down in front of the axle-joint, traverse passages through the foot L, and receive their inferior attachment in the toe-piece M.

The ham-strings N N are intended to check the forward motion of the leg relatively to the thigh, and to prevent the anterior upper edge of the leg from striking the rounded end or termination of the thigh-piece. These strings N N have but little elasticity and act as checks. They are inserted at their lower ends around a pin, O, which is firmly attached inside of the calf of the leg. Passing upward they occupy surface-grooves in the posterior lower portion of the thigh, and are inserted through holes in the frame G and secured. These strings or tendons are capable of being removed by the wearer as often as required, and of being adjusted with facility, so that any slackness or too great rigidity may be readily remedied.

The foot L is secured to the leg by means of a ball-and-socket joint, which admits of a rolling motion or certain amount of rotation around any horizontal axial line, but none around a vertical axial line. This limitation as to direction of rotation is caused by the stud P' on the ball P, which occupies a recess on the forward side of the socket, in which the ball is located. The amount or degree of rotation is limited by other means, which remain to be described after I have spoken of the way in which the ball, which is thus socketed in the foot, is secured to the leg.

Q is a plate, and Q' a bridge-piece connecting said plate Q with a similar one on the other side of the leg. These plates are rigidly and very firmly secured to the frame of the leg, as the weight of the body is, of course, frequently thrown upon this part.

The ball P has on its upper surface a neck, *p*, with a flange upon which the bridge Q' is clamped by the set-screw R.

The interior of the socket S and the recess on its side are lined with leather or other suitable yielding material, by which the required degree of rigidity is attained, which will enable the parts to work smoothly and avoid all the sudden jerking motions, which are unpleasant, unnatural, and deceptive to the wearer, inasmuch as he naturally does not expect to have to meet so quick a return motion.

The amount of friction of the joint, which, as in the knee, prevents the sudden return of the parts to their relative "normal position," as it may be called, is regulated in the ankle-joint by the amount of packing material which invests the ball in the socket.

The ultimate limit of the rotation of the ball in its socket might be said to be the collision of the parts on the end of the leg and the upper surface of the foot, or of the bridge Q or flange on the neck *p*, with the upper surface of the foot; but so great a motion is not desirable for several reasons—one is that it would pinch the clothing, and another is that it would bruise the parts, by means of elastic attachments consisting, first, of the extensor-spring I and its tendons, the forks of which extend into the foot, as has been described, and secondly, of the heel-cord or tendo Achilles T, which receives its lower insertion in the heel at T' and its upper insertion on a spring supported by a ledge or plate, U, whose upper side has a recess for the reception of the spring V. The recess is countersunk so as to increase its capacity to retain the spring, which, at its ultimate pressure, fills the recess. In this case the nut Z comes in contact with the ledge U, and the spring is preserved from bursting, which is a common accident to springs of this character, for which no provision of this kind is made.

The heel-cord T has a stopper, W, upon it, which latter bears upon the under side of the ledge U, being slipped upon and embracing the cord T. The end of the said cord is covered by a tube or metallic casing, Y, which is riveted upon it, and a nut, Z, is screwed upon it, so as to bear downwardly upon the spring and draw up the cord to the required degree of tension.

The purpose of the stopper W is to prevent the jumping up of the parts which rest upon the ledge U when the tension upon the cord T is relaxed in the act of rising upon the ball of the foot or in throwing the weight upon the heel with the leg inclined backwardly.

The elastic connections which I have thus described, consisting of the forward spring, I, and its tendons, and the heel-spring T, act at three different points around the vertical axis of the ball, which is the actual point of suspension and attachment of the foot to the leg, and are so adjusted as when the foot is not controlled by the motion of the wearer or by its own weight when raised to an oblique po-

sition, or by contact with the ground or other surface, to assume the position which is natural to it when the person is standing erect. This may be called its normal position, and any deviation from this is the effect of change of position of the leg, motion, or contact with exterior objects.

The toe-piece M, which receives the insertion of the tendons *i''*, is attached by a hinge-joint to the foot L, which admits of its upward motion when the weight is thrown upon the toes, and returning under the influence of the spring I when the pressure is removed.

I have endeavored to explain with clearness and exactitude the method of constructing my artificial leg, and have detailed the adjustment of the same. It remains to describe the method of suspending the same from the body and holding it upward to its place, which is a very important matter and a special feature in my invention. It is often the case, as experts and patients are well aware, that a leg is apt to become unsettled, and its grasp upon the stump deranged by sitting, rising, or turning upon that leg as an axis, and the features of my invention which remain to be explained have reference to the method of suspending the leg from the body.

a a, Fig. 3, is an elastic band which is attached to the upper front part of the socket, and *b b* is a similar strap of greater length and less power attached in a similar manner to the posterior portion of the socket. Each of these straps has a metallic keeper, *c*, by which the leg is suspended from the yoke which is shown detached in Fig. 4.

The leg shown is a left leg, and the description of the yoke applies to it. An expert will make the necessary modifications to meet the requirements of an artificial right leg.

The yoke or strap of webbing or other suitable material consists of two pieces, *e e' f f'*, united to a strap at *d*, and crossing each other at *g* form a loop, *e f*, and leave ends *e' f'* which terminate in buckle-straps *h j* respectively. This yoke is placed upon the person as follows, recollecting that we are speaking of the artificial left limb: The side on which the hole-straps are attached being outside, the right arm is passed through the loop *e f*, so that the point *g* is behind the right scapula, and the strap *e'* is passed over the left shoulder in front of the person, is run through the keeper *d* of the elastic strap *a*, and is then turned upward and buckeled to the strap *d* at *n*, the band *f'* passing down behind the person, the strap *j* is passed through the keeper *d* of the elastic strap *b*, and being passed upward is buckled to the strap *g* at *k*.

The position of the yoke on the wearer is shown in the front and rear views at Figs. 5 and 6.

Having described with clearness and precision, to the best of my ability, the construction of the artificial limb, I wish now to make a few remarks in regard to its operation, to show how the motions approximate to the natural and to contrast it with other devices previously made for the same purpose.

To begin with the superior portion, I require for the purpose of suspension a band which will not slip upon the shoulders, because in using the limb the motion of the shoulders may be made to assist very materially. When the artificial limb is thrown back (we will continue to speak of it as the left limb for the sake of convenience) the front strap, *a*, is extended, and as the leg is lifted to make the forward motion it is assisted by this strap. Any mere band over the shoulder without a rigid attachment at some point will slip back and forth with the motions of the leg and tend to slip off the shoulder, the remedy for which last trouble is a band across the chest, which is disagreeable and interferes with the expansion of the chest in breathing. These difficulties—namely, the lengthwise motion of the band or bands across the shoulder and the slipping off the shoulder—are both obviated by the device of the yoke, which retains the band upon the shoulder and prevents its slipping forward when the elastic strap *d* is drawn out in the backward motion of the artificial leg. The band *e'*, as will be seen, after passing through the keeper *c* of the strap *d*, is recurved upward and attached to the lower angle of the loop *e f*, passing across the abdomen, so as to prevent lateral displacement of the leg, maintaining the keeper *c* at substantially the same position at all times, the elasticity being resident in the strap *d*.

The same remarks apply in substance to the posterior support of the leg, which is by means of the strap *f' j*, it being recurved on itself and buckled to K. Its point of suspension may be said to be at *g*, which is practically rigid, being sustained by the band *e'* and by the loop *e f*.

The elastic strap *d* is shorter and more powerful than *b*, for this reason: When the artificial limb is thrown back the foot is in contact with the ground, and the forward motion of the body assists in deflecting the limb to the rear; but when it is raised it is desirable to assist the stump in throwing the limb forward, as it derives no assistance in its motion as in the former action, but depends upon an actual muscular exertion. The counterbalancing strength of the spring *a* has the effect of assisting this forward motion of the limb. The object is as nearly as possible to make the position of the anterior and posterior keepers *c* and *c* rigid, the flexibility residing in the springs *d* and *b*.

Proceeding downwardly in this review of the case, I do not think it necessary to add to what I have said in regard to the plate B, which adjusts the cavity of the socket to the size of the stump, nor further specify the action and purposes of the hamstrings; but I will explain the adaptation and peculiar action of the extensor-spring, which induces or influences the forward motion of the leg proper, which is defined to be the portion included between the knee and the ankle.

Here I wish to say that it is a common fault

in artificial lower limbs so to arrange the spring at the knee-joint that when the artificial leg is thrown forward it tends to bend and compels a sudden rearward motion of the stump as soon as the foot touches the ground to arrest the tendency to flex. It will be seen that as the superior insertion of the extensor-spring is at a point which rotates around the axis of the articulation of the knee the flexing of the limb increases the tension of the spring. It is necessary to recollect, in considering this spring, that the motions of three articulations are effected by it—namely, the knee, the ankle, and the toe-joint. These parts require to some extent a different power of spring, and yet it is necessary, as will be shown, that there should be an unanimity of motion. If, for instance, a spring of sufficient strength for the axle-joint were attached immediately to the frame G at *x*, it would make a stiff knee. It is necessary, therefore, to attach it in such a way that its power shall be applied to the extent required, and by inserting it into the bridge-piece K, which has a frictional bearing upon the bolt F and a moving bearing at *y*, the bridge-piece K becomes a lever of the third class, with the fulcrum on the bolt, the end of the moving lever at *y* being in the anterior portion of the frame G. The pressure of the bridge on the bolt, under the tension of the spring, equalizes the motion and makes a smooth noiseless movement of the leg, and avoids the jarring, twitching, or flopping incident to other artificial limbs, by which they are so readily detected as artificial. It is my aim to approximate as nearly as possible to vigorous nature, and not to the convulsive or spasmodic action of partial paralysis. The spring, being attached near the fulcrum, utilizes for the purposes of the knee-joint the great strength of spring, with but little elongation of the latter. When the leg is thrown forward in walking and the sole of the foot is placed upon the ground it increases the tension of the spring, so as to stiffen the knee-joint at the point of time when it is required, and as the body in moving forward brings the leg to a vertical position this additional tension is relaxed. The point of rest of the springs is when the limb is at right angles to the sole of the foot, which I have called its "normal position," as it is the one which it assumes when at rest, and not flexed by its weight by being held in an oblique or horizontal position. When one leg is crossed over the other the weight of the leg and foot has the effect of flexing the knee-joint, so as to assume a natural position.

I have thus traced downward to this point the peculiar operation of my artificial limb, and I believe I have shown with sufficient clearness the remaining portions involved in the structure and operation of the ankle and foot with the springs by which those motions are regulated, induced, or limited.

Having thus fully, clearly, and exactly described the nature, construction, and operation of my improvement in artificial legs, what I claim therein as new, and desire to secure by Letters Patent, is—

1. The adjustable pad B or plate within the socket, for the purpose of adapting the capacity of the socket to the stump, substantially as set forth.

2. The bridge-piece K, which is supported upon the frame G and upon the bolt F, and affording the superior point of attachment for the extensor-spring I *i' i''*, substantially as described.

3. The hamstrings N N, arranged substantially as described, and attached to the posterior portions of the thigh and leg, to act as checks to the forward motion of the leg, in combination with the arrangement for adjusting their tension.

4. The extensor-spring, consisting of the muscular or spring portion I, the tendon *i'*, and the bifurcated tendon *i''*, the insertion of the upper tendon being at the bridge-piece K, which bears upon the knee-bolt, and the lower insertion being in the toe-piece, substantially as described.

5. The construction of the ankle joint consisting of the socket in the foot and the ball P, attached by its neck, and the iron frame Q Q' to the leg, and having a stud upon it fitting its appropriate recess in the socket in the foot, so as to prevent vibration in a horizontal plane, while leaving the joint for free motion in vertical planes, as described.

6. The elastic straps *a b*, proportioned as to length and strength substantially as and for the purpose described.

7. The yoke, Fig. 4, which derives its rigidity and freedom from tendency to displacement from its ultimate point of axillary attachment, from whence the straps proceed over the shoulders, so as not alone to bring the weight upon the frame-work of the body, but also to enable the shoulders by their motion to influence the motion of the artificial limb.

JOHN CONDELL

Witnesses:
EDWARD H. KNIGHT,
OCTAVIUS KNIGHT.