No. 675,912. Patented June 11, 1901.

H. WENNEBORG, JR.

ARTIFICIAL LIMB.

(Application filed May 7, 1900.)

(No Model.) 2 Sheets—Sheet 1.

FIG. 1.

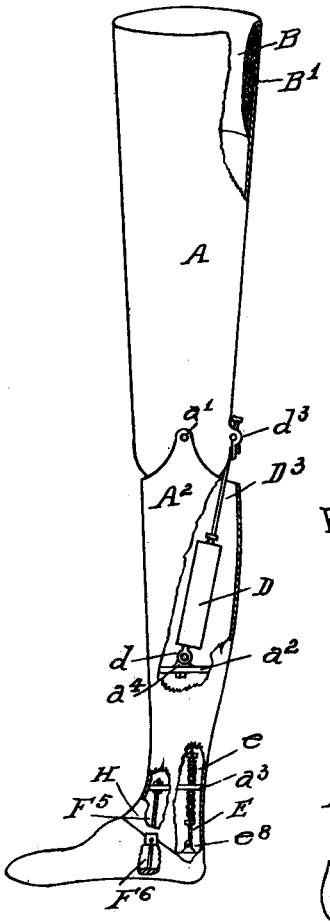


FIG. 5.

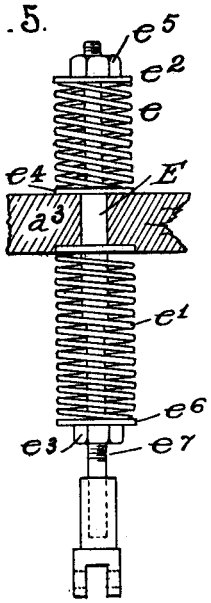


FIG. 2.

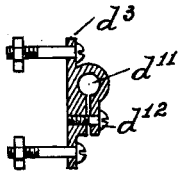
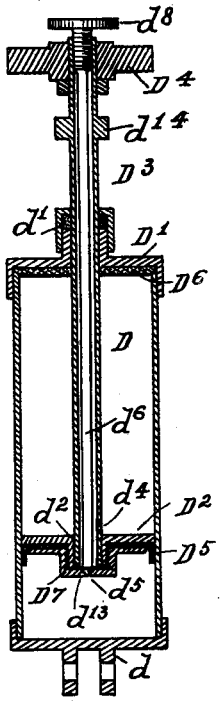


FIG. 3.



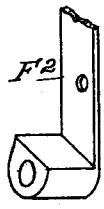


FIG. 7.

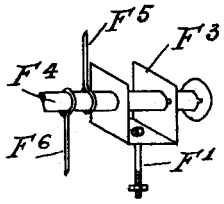


FIG. 6.

FIG. 4.

WITNESSES.

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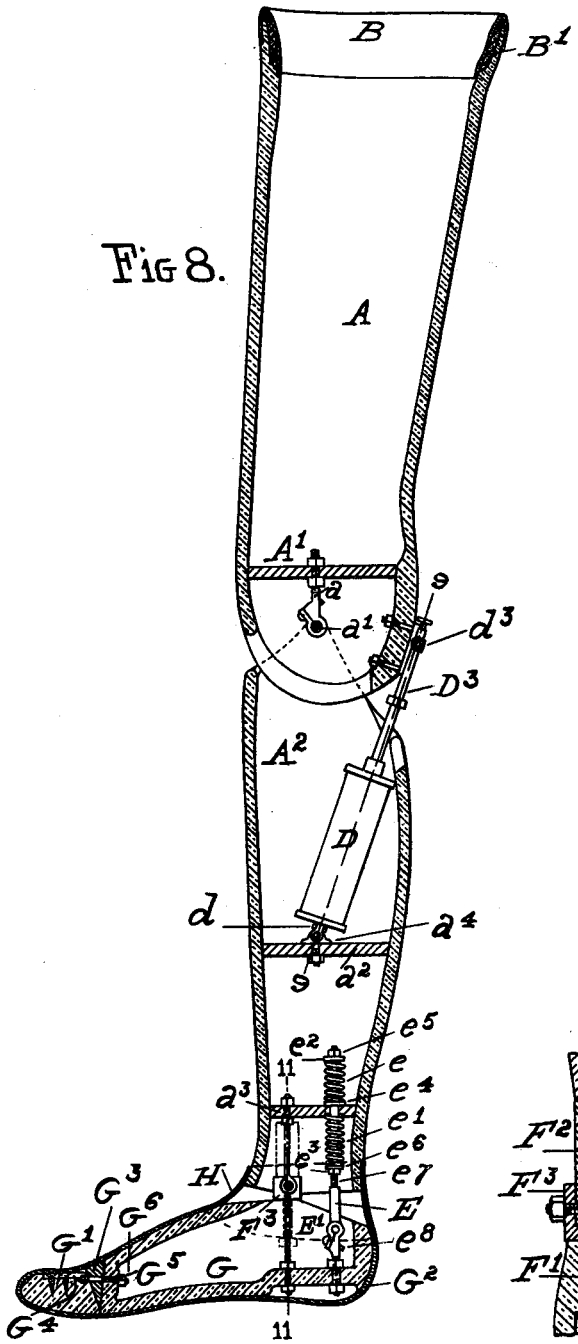
(No Model.) 2 Sheets—Sheet 2.

Fig. 8.



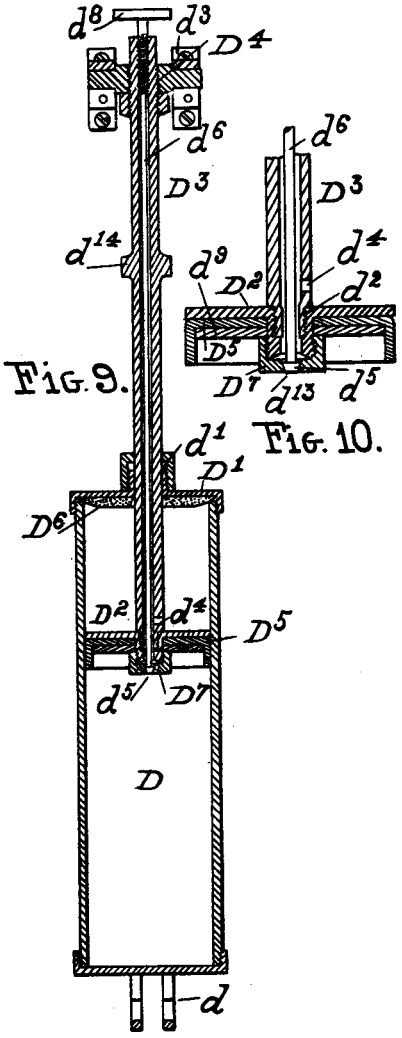


Fig. 9.

Fig. 10.

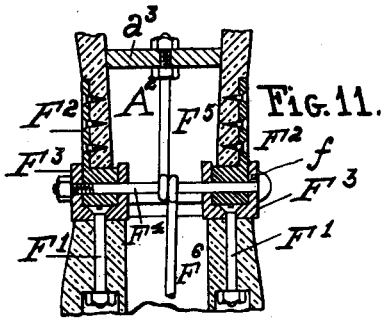


Fig. 11.

WITNESSES

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UNITED STATES PATENT OFFICE.

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ARTIFICIAL LIMB.

SPECIFICATION forming part of Letters Patent No. 675,912, dated June 11, 1901.

Application filed May 7, 1900. Serial No. 15,863. (No model.)

To all whom it may concern:

Be it known that I, HENRY WENNEBORG, Jr., a citizen of the United States, residing at 609 Calhoun avenue, Springfield, in the county of Sangamon and State of Illinois, have invented a new and useful Artificial Limb, of which the following is a specification, which is sufficiently full, clear, and exact to enable others skilled in the art to which it appertains to make and use my said invention.

My invention relates to artificial limbs such as are used as substitutes for human limbs; and the general purpose of my invention is to provide a limb combining lightness and strength, which may be worn with comfort, and which is so constructed and arranged as to relieve or prevent unpleasant jarring or noise in the use of the limb. Having in view this general purpose, the more specific purposes of my invention are to provide an air-cushion between moving members of an artificial limb, to provide an air-cylinder and piston of improved construction, to provide means for regulating the flow of air within the air-piston, to provide simple and effective means for flexibly connecting the cylinder and the piston with the cooperating members of the limb, to provide an improved hinged connection between different mechanisms of the limb and adjustable to take up wear, to provide a foot of improved construction, to provide novel and effective means for connecting the foot with the shank member of the limb, and to provide an improved crown-socket so constructed that it will readily conform to the stump on which the limb is worn and under unusual pressure will yield, so as to prevent unpleasant concussion.

With these ends in view my invention consists of the novel features of construction and combination of parts shown in the annexed drawings, to which reference is hereby made, and hereinafter particularly described, and finally recited in the claims.

Referring to the drawings, Figure 1 is a side elevation of an artificial limb embodying my improvements, parts of the limb being shown as broken away in order to more clearly illustrate the construction and relation of the parts. Fig. 2 is an enlarged detached longitudinal sectional view of one of the hinge-blocks on the thigh member of the limb. Fig. 3 is an enlarged longitudinal section through the air-cylinder and connected parts, taken on the median line of the air-cylinder. Fig. 4 is an enlarged detached side elevation and partial sectional view of the eyebolt connecting the air-cylinder with the bridge in the shank member of the limb. Fig. 5 is an enlarged detached rear elevation of the double-acting spring connection between the shank and the heel of the foot member. Fig. 6 is an enlarged detached perspective view of one member of the hinge connection between the shank and the foot of the limb. Fig. 7 is an enlarged detached perspective view of one of the hinge-blocks connecting the shank with the foot. Fig. 8 is an enlarged vertical longitudinal section through the limb. Fig. 9 is an enlarged section through the air-cylinder on the line 9 9 of Fig. 8. Fig. 10 is an enlarged partial axial section through the cylinder and the piston and shows the valve on its seat in the lower part of the piston. Fig. 11 is an enlarged partial vertical section on the line 11 11 of Fig. 8.

Similar letters of reference designate like parts in the several views of the drawings.

In the drawings I have shown my invention as applied to a leg. It may, however, with such slight modifications as will readily occur to those skilled in the art, be applied to an arm without departing from the spirit of my invention.

The limb may be made of wood, light metal, or any other suitable material.

The limb herein shown and described consists of three members, which for convenience in description I will designate as the "thigh member," the "shank," and the "foot," respectively.

The thigh member A is of the usual well-known form and is surmounted by a crown-socket B, which will be hereinafter described. Near the lower extremity of the member A is a transverse bridge A'. A vertical bolt *a* extends centrally through the bridge A', and the shank member A^2 oscillates on a hinge *a'* at the lower extremity of the bolt *a*. By turning the nut on the bolt *a* the bolt may be raised or lowered to produce proper adjustment of the part A^2 relative to the part A'. The hinge *a'* is adjustable to compensate for wear, as hereinafter explained.

The shank member A^2 is hollow and has

two transverse bridges a^2 and a^3. A hinge-block a^4 is secured on top of the bridge a^2, and the lower end of the air-cylinder is pivotally connected with said block. The air-cylinder D is preferably made of metal, and an adjustable hinge d at the lower end of the cylinder fits and turns in the fork of the plate a^4. A cylinder-head D′ screws on top of the cylinder and is provided with a gland d', adapted to receive packing. A gasket D^6, of rubber or other suitable material, surrounds the stem of the piston and fits under the cylinder-head between the cylinder-head and the upper end of the cylinder. A piston D^2, pierced by a central hole d^2, slides freely within the cylinder. A tubular stem D^3 has one end connected with the piston D^2 and the other end connected with a trunnion-block D^4, which is in turn connected with the member A by adjustable hinges d^3. A hexagonal part d^{14} on the piston-rod D^3 is adapted for the use of a wrench in turning the rod D^3, so as to screw the rod up or down in the trunnion-block D^4, as may be necessary for the proper adjustment of the parts. The stem D^3 is pierced by a hole d^1, opening into the interior of the cylinder. A valve d^5 at the lower extremity of a valve-stem d^6 slides in the tubular piston-stem D^3. A cap D^7 screws upon the lower end of the hub of the piston D^2 and has a central tapering hole d^{13}, in which the valve d^5 seats. The upper part of the valve-stem d^6 is threaded and turns in a corresponding female screw in the upper end of the stem D^3 and has at its upper extremity a handle d^8, by which the stem may be turned to move the valve d^5 so as to open or close the port d^{13}. On the under side of the piston D^2 is a packing-disk D^5, of rubber, leather, or other suitable material, held in place by a disk and secured by the cap D^7 or other suitable securing device. When the limb is turned at the knee-joint, the downward movement of the member A or the upward and rearward movement of the member A^2 causes the piston D^2 to descend within the cylinder and compress the air within the cylinder below the piston, the degree of compression being controllable by adjusting the valve d^5 to diminish or increase the flow of air through the port d^{13}. If the valve d^5 is set to completely close the port d^{13}, the air may be compressed to such extent as to completely stop the downward movement of the piston; but if the valve be left slightly open air will flow from the part of the cylinder below the piston through the ports d^{13} and d^4 to the part of the cylinder above the piston, the gradual flow of air through the ports serving to permit a gradual downward movement of the piston to its downward limit without noise or jar.

By reason of the construction shown and described the wearer of the limb may by adjusting the valve d^5 graduate and control the movement of the piston to meet his own preferences as to the action of the limb, making the action tardy or quick, as he may prefer.

When the valve-stem is screwed down, so as to cause the valve d^5 to seat in the opening d^{13}, air cannot pass through the opening. Hence as the piston descends the air under the piston becomes compressed, so as to form an air-cushion, and when the downward pressure on the piston ceases the compressed air under the piston reacts to raise the piston. It will be seen then that after the bending of the limb at the knee the air-pressure under the piston is utilized to return the shank member to its initial position. During the upward movement of the piston air flows from the upper portion of the cylinder not only through the ports d^4 and d^{13} into the lower portion of the cylinder, but also around the gasket D^5, which yields to permit downward passage of air. Hence it will be seen that the downward passage of air is more rapid than its upward flow. Whether the piston moves upward or downward there is always an air-cushion within the cylinder, which serves to prevent concussion of the parts and also serves to prevent jar or shock to the wearer.

The employment of an air-cushion between coöperative members of a limb is of great practical advantage, because it not only prevents jarring, but it is absolutely noiseless and may be adjusted to a nicety, according to the wishes of the wearer.

For the purpose of connecting the foot yieldingly with the shank I preferably employ means which I will now describe.

A rod E passes vertically through and is slidable in a hole in the bridge a^3. The upper part of the rod E is of somewhat less diameter than its lower part. A spring e surrounds the upper part of the rod, and its lower end abuts against a washer e^4 on the shoulder of the rod, and its upper end abuts against a washer e^3 near the upper extremity of the rod. The tension of the spring e is adjustable by a nut e^5 on the upper part of the rod. A spring e' surrounds the enlarged part of the rod, and its upper end abuts against the under side of the bridge a^3, and its lower end abuts against a washer e^6, which rests on a nut e^3 on the screw-threaded part e^7, and the nut may be turned to adjust the tension of the spring e'. At the lower extremity of the rod E is an adjustable hinge member e^8, which is secured in any suitable manner to the heel part of the foot. When weight is thrown on the heel of the foot, the spring e' is compressed, and when the weight is removed the spring reacts to depress the heel. When the shank member is turned forward and downward on the connection between the shank and the foot, this movement compresses the spring e, and when the pressure is removed the spring reacts to restore the members to their initial position.

The washers e^3 and e^6, against which the springs e and e' abut, are preferably of sound-deadening material, such as rubber or the like, so as to prevent rattling of the parts.

From the foregoing it will be seen that the

springs e and e' form a yielding connection between the foot and the shank and the tension of the springs may be adjusted according to the circumstances of each individual case, a harder adjustment being required for a heavy person than would be necessary for a lighter person.

The foot consists of a heel part G and a toe part G′, the whole of the foot having an elastic covering G^2, of leather or rubber or other suitable material, which forms a hinge connection between said parts, said hinge connection being at the bottom of the foot. This feature is of great practical advantage, for the reason that it prevents wear of the sock by the toe part turning away from the heel part and rubbing on the sock, as would be the case if the hinge connection were placed higher up in the foot. The toe portion G′ is separated from the heel portion G by a wedge-shaped cushion G^3, of rubber or other yielding material. A hinge member G^4 is secured to the part G′. A bolt G^5 extends through the front end wall of the part G and has one end pivotally connected with the hinge member G^4. A nut G^6 on the end of the bolt G^5 may be turned to compress or relax the cushion G^3 or to raise or lower the point of the toe, according to the preferences of the wearer. A hard-leather crown H extends entirely around and projects above the upper part of the foot and is secured thereto by screws or other suitable securing devices. The lower extremity of the shank member fits within the crown H, and the crown makes a neat and substantial covering for the joint between the two members, which effectually prevents the clothing from being caught in the joint.

The shank and foot may be connected by any suitable hinge permitting forward and rearward oscillative movement of the parts. I prefer, however, to use a hinge connection which I will now describe. Hinge members F^2 are secured on the outside of the member A^2, one on each side thereof and in line with each other. Socket-plates F^3 extend longitudinally on the upper extremity of the foot and are held in place on the foot by bolts F′. A bolt F^4 extends through the members F^2 and F^3, and the members F^2 turn on the bolt. Eyebolts F^5 and F^6 surround the bolt F^4 and serve to take up the wear in the ankle-joint, so as to prevent rattling of the joint. The bolt F^5 extends upward through the bridge a^3 and may be adjusted up or down through the bridge by turning the nuts on the bolt. The bolt E^6 passes through the foot and is similarly adjustable by turning of the nuts on the bolt.

The hinge members d^3, a, a^1, and e^8 and the hinge member of the bolt G^5 are all exactly alike in construction. Hence a description of one will suffice for all. The hinge member d^3 consists of an upper part and a lower part, separated by a narrow space for a part of their length, but formed of a single piece of metal and having an eye d^{11}, (see Fig. 2,) through which the pivotal bolt passes. A bolt d^{12} passes through both parts of the hinge member, and by screwing down the bolt the parts may be drawn together, so as to take up any play of the hinge member on the pivotal bolt. The crown-socket extends entirely around the upper part of the limb and consists of an inner part B′, of sponge-rubber, and an outer covering B, of soft leather, connecting the part B′ with the upper extremity of the member A. The outer covering B may be connected with the part A in any suitable manner, either by tacking it thereto or cementing it thereon, so as to leave a smooth surface on the inside of the member, forming a socket in which the stump of the limb of the wearer will fit snugly in such manner as to prevent longitudinal movement of the stump in the socket under ordinary conditions, but so as to yield slightly and prevent too severe binding of the stump in the socket in case any sudden and unusual weight is thrown upon the limb.

I am aware that elastic connections between different members of artificial limbs are in common use. I therefore do not claim, broadly, that feature of construction.

What I do claim as my invention, and desire to secure by Letters Patent, is—

1. In an artificial limb the combination of limb members having a hinge connection with each other and an air-cushioning device mounted on one of said limb members and connected with and operative by the hinge action of the other of said limb members, as set forth.

2. In an artificial limb the combination of two limb members having a hinge connection with each other, an air-cylinder mounted on one of said limb members, a perforated piston slidable in said air-cylinder and a piston-stem connected with the other of said limb members and adapted to reciprocate said piston by the turning of the limb members on their hinge connection; substantially as set forth.

3. In an artificial limb, the combination of a thigh member, a shank pivotally connected with said thigh member, an air-cylinder mounted to oscillate in said shank member, and a piston slidable in said air-cylinder and having a piston-rod pivotally connected with said thigh member, substantially as set forth.

4. An air-cylinder, a perforated piston slidable in said cylinder, a tubular piston-stem having a port, and a valve slidable in said tubular piston-stem and adapted to control the flow of air through said port; in combination with an artificial limb member on which said cylinder is mounted to oscillate and a coöperating limb member connected with and adapted to reciprocate said piston-stem; substantially as set forth.

5. An air-cushioning device for artificial limbs consisting of a cylinder, a perforated piston slidable in said cylinder, a tubular stem connected with said piston, a cylinder-head

having a gland in which said tubular piston-stem slides, a gasket between said cylinder and said cylinder-head, a valve slidable in said tubular piston-stem and a screw on the stem of said valve for adjusting same, substantially as set forth.

6. A hinge connection for artificial limbs consisting of a trunnion and adjustable hinge members in which said trunnion turns, in combination with an air-cylinder and a piston slidable in said cylinder and having a stem connected with said trunnion, substantially as set forth.

7. A yielding connection for artificial limbs consisting of a single-shouldered and screw-threaded rod, a spring surrounding said rod above the shoulder thereof, a spring surrounding said rod below the shoulder thereof and nuts for adjusting said spring in combination with a shank member having a bridge in which said rod is slidable, and a foot member hinged to said shank member and connected with said rod, said springs acting oppositely to oscillate said foot member both upwardly and downwardly, as set forth.

8. In a foot member for artificial limbs, the combination of a heel part, a toe part, an elastic covering forming a hinge connection between said parts, a wedge-shaped cushion interposed between said parts and a bolt passing through said cushion and connecting said parts and adapted to vary the inclination of the toe part relative to the foot part, as set forth.

9. An air-cushioning device for artificial limbs consisting of a vessel adapted to contain air under pressure, means adapted to increase the air-pressure alternately at opposite extremes of said vessel, and means adapted to gradually and automatically restore equilibrium of the air within said vessel; in combination with limb members having a hinge connection with each other and with which said air-cushioning device is operatively connected, substantially as set forth.

In witness whereof I have hereunto subscribed my name in the presence of two witnesses.

HENRY WENNEBORG, JR.

Witnesses:

SANFORD C. PRUITT,

SAML. D. SCHOLES.