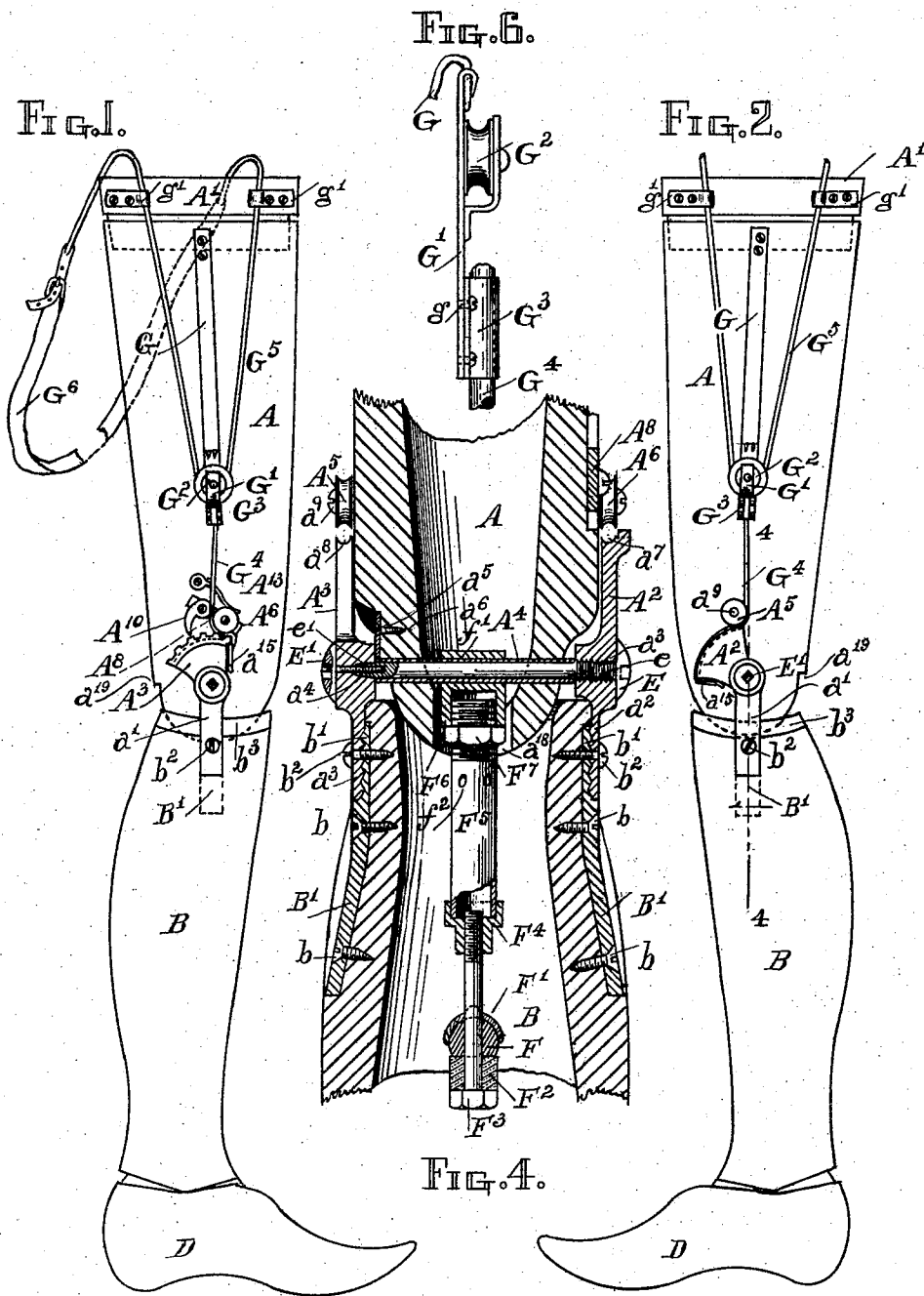


H. WENNEBORG, JR.
ARTIFICIAL LIMB.

APPLICATION FILED JAN. 6, 1904.

NO MODEL.

2 SHEETS—SHEET 1.



Witnesses.
Victor Georg.
Harry G. Welch.

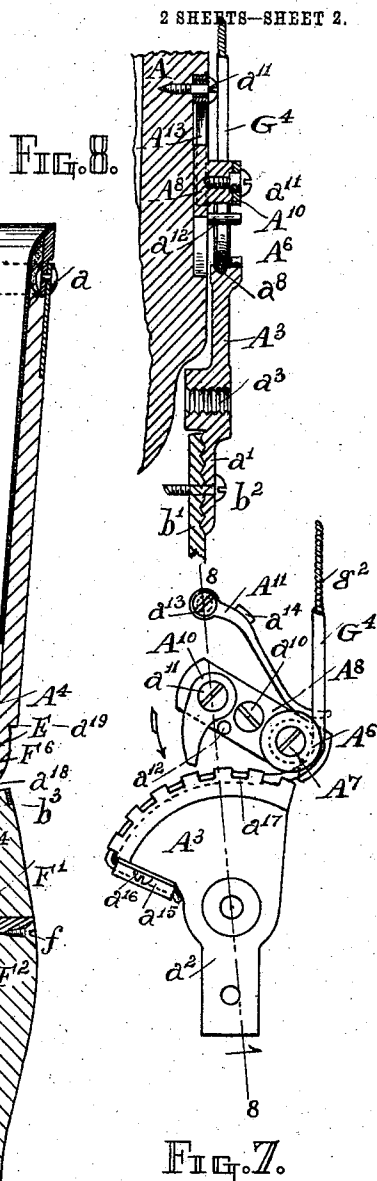
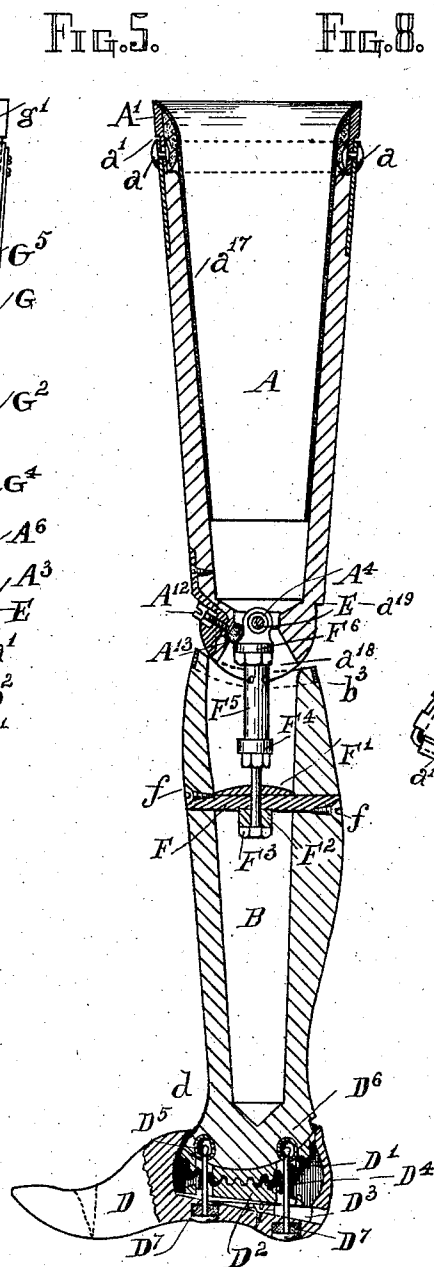
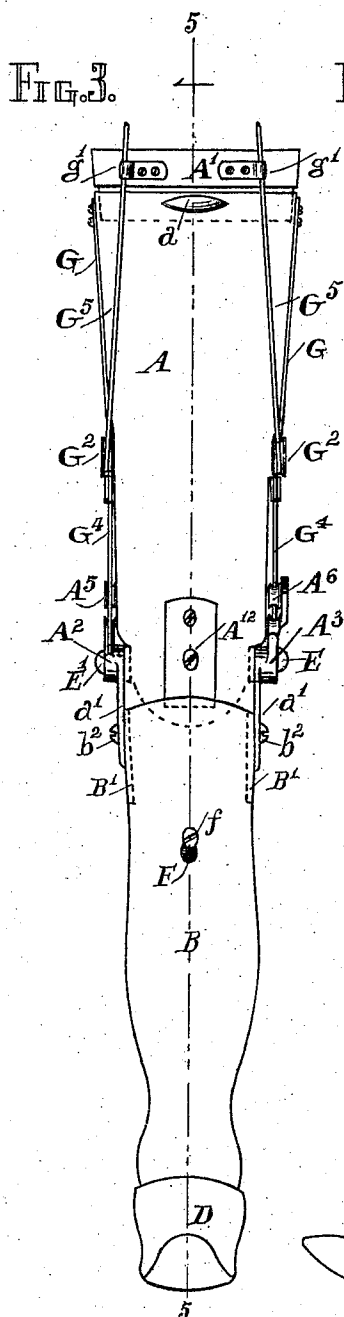
Inventor.
HENRY WENNEBORG, JR.
By Atty N. DuBois.

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UNITED STATES PATENT OFFICE.

HENRY WENNEBORG, JR., OF SPRINGFIELD, ILLINOIS.

ARTIFICIAL LIMB.

SPECIFICATION forming part of Letters Patent No. 772,318, dated October 11, 1904.

Application filed January 6, 1904. Serial No. 187,927. (No model.)

To all whom it may concern:

Be it known that I, HENRY WENNEBORG, JR., a citizen of the United States, residing at Springfield, in the county of Sangamon and State of Illinois, have invented certain new and useful Improvements in Artificial Limbs, of which the following is such a full, clear, and exact description as will enable others skilled in the art to which it appertains to make and use my said invention.

My invention particularly relates to that class of artificial limbs which are employed when the amputation is above the knee.

The purpose of my invention is to provide an artificial limb so constructed and arranged that the knee action, both forward and rearward, is under control of the wearer through the instrumentality of suspenders passing around the shoulders of the wearer and so adjusted that the shrugging of the shoulder on the side of the amputation will cause rearward movement of the shank member of the limb and shrugging of the other shoulder will cause forward movement of the same member.

With this end in view the more specific purposes of my invention are to provide a knee-joint of improved construction; to provide improved means for connecting the limb members at the knee, so that they may be disconnected without injury to the covering of the members; to provide improved means for stopping forward movement of the shank member; to provide means for limiting rearward movement of the shank member; to provide means for adjusting the angle of inclination of the shank member with respect to the thigh member; to provide a bridge of improved construction; to provide a safety device to prevent doubling up of the limb or movement of the limb in a direction opposite to that intended by the wearer; to provide means to permit slight lateral oscillation of the limb; to provide suspenders of improved construction and improved means for connecting them with the limb; to provide an improved ankle connection so constructed that the foot has a rolling action on the lower end of the shank with a decrease of the leverage exerted by the foot as the foot turns on the

shank, thereby avoiding undue strain on the bolt connecting the heel with the shank member, and to provide other minor details of construction shown in the drawings and hereinafter described.

With these ends in view my invention consists in the novel features of construction and combinations 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, in which similar reference-letters designate like parts in the several views, Figure 1 is an elevation of a limb designed for a left amputation as viewed from the right. Fig. 2 is a side elevation of the same limb as viewed from the left. Fig. 3 is a front elevation of a limb for a right amputation. Fig. 4 is an enlarged partial vertical section on the line 4 4 of Fig. 2. Fig. 5 is a vertical section on the line 5 5 of Fig. 3. Fig. 6 is an enlarged side elevation of one of the pulley-plates connected with the elastic straps. Fig. 7 is an enlarged side elevation of the safety device. Fig. 8 is an oblique section on the line 8 8 of Fig. 7.

The limb shown in the drawings consists of a thigh member A, a supplemental thigh member A', a shank member B, and a foot member D. The stump of the amputated limb passes through the member A' and rests in the socket of the member A. A leather lining *a*' extends upward inside of the member A and extends upward through the member A' and serves as a cushion for the stump and also to prevent the possibility of pinching the flesh of the stump between the members A and A'. Pivots *a* connect the member A with the member A', so that the member A may have slight lateral oscillation on the member A', the extent of the oscillation being limited by a stop *a*', running around the member A', against which the upper end of the member A strikes.

The oscillation of the member A on the member A' is very slight, being barely sufficient to equalize the pressure of the member A' all around the stump. For example, if the wearer were to lean slightly, say, to the right if the upper member of the artificial limb were rigid

the movement of the stump to the right would cause undue pressure against the flesh on the right side and, furthermore, would tend to lift the limb somewhat out of the socket on the opposite left side, the upper edge of the artificial limb serving as a fulcrum on which the stump would turn. This would produce pressure on the right side of the stump which would be very uncomfortable to the wearer. By connecting the member A' so that the member A may oscillate slightly thereon the stump always remains firmly in position and in contact all around the rim of the member A', thereby avoiding any undue local pressure which would result in discomfort to the wearer.

Metal plates B' are secured on and near the upper end of the shank member by screws b' or other suitable securing device. Serrations extend across the upper member b' of the plate B' and match similar serrations on the downwardly-extending parts a² and a³ of the plates A² and A³, respectively. Screws b² pass through the parts b', a², b', and a³ and connect them firmly together on the shank member B. The plate A² has an internally-screw-threaded part a³. This construction and arrangement of the plates B', A², and A³ permits the removal of the parts A² A³ without disturbing the rawhide covering which surrounds the lower part of the plates B' and facilitates the adjustment and operation of the parts forming the knee-joint.

The plate A³ has a tapering hole a⁴, and a tube A⁴ has an integral upwardly-extending flange a⁵. The tube A⁴ extends transversely through the member A and is secured to the member by a screw a⁶ passing through the flange a⁵.

A bolt E has a screw-threaded part e and a tapering end e'. The bolt E screws into the plate A², extends through the tube A⁴, and the tapering end of the bolt fits in the tapering hole a⁴. A screw E' screws into the end of the bolt E and connects firmly together the parts A², E, and A³. The tube A⁴ turns on the bolt E, so as to permit oscillation of the member B on the bolt E.

A bridge F extends transversely across the member B and is secured therein by screws f, screwing into the member B and into the ends of the bridge F.

The limb in its complete state is usually covered with rawhide to give it a smooth finish. This rawhide covering is put on while damp, and it is found in practice that the contraction of the rawhide in drying compresses the walls of the shank member, so as to cause the ends of the bridge to project therethrough and produce slight protuberances on the front and back of the shank. The screws f hold the ends of the bridge firmly in the wood of the shank and prevent its being forced out, as described. An arched metal plate f' lies on top of and strengthens the bridge in its

central part. A cushion F², of rubber or other yielding material, underlies the bridge F and is connected therewith by a bolt F³, which passes through the cushion and through the bridge and through the plate F' and screws into a plug F⁴, secured on a pipe F⁵. The upper part of the pipe F⁵ is screw-threaded and screws into a block F⁶, which is pierced by a transverse hole f' and turns on the tube A⁴. A jam-nut F⁷ fits on the threaded part of the pipe F⁵ and abuts against the lower end of the block F⁶. Holes f² through the pipe F⁵ serve to receive the points of a key or other instrument by which the pipe may be turned to screw into or out of the block F⁶. By turning the pipe F⁵ the length of the connection may be adjusted so as to cause such pressure on the cushion F² as will prevent undue play or rattling of the parts. When the parts are adjusted as described, the jam-nut F⁷ may be screwed up against the block F⁶ to secure the pipe in position.

The upper parts of the plates A² and A³ are segmental and have circumferential grooves a' and a⁸, respectively. A grooved pulley A⁵ turns on a screw a⁹, screwing into the member A. A similar grooved pulley A⁶ turns on a stud-screw A⁷, secured on an arm A⁸, which turns on a screw h¹⁰, screwing into the member A. A pawl A¹⁰ turns on a stud-screw a¹¹, secured on the arm A⁸. When that end of the arm on which the pawl is mounted is depressed, the end of the pawl enters notches a¹⁷, extending around the upper edge of the plate A³, and stops further movement of the plate, as hereinafter explained. A pin a¹² limits the movement of the pawl A¹⁰. A spring A¹¹ is connected with the member A by a screw a¹³ and abuts against the stop a¹⁴ on the member A, and the lower end of the spring bears against the upper edge of the arm A⁸. Elastic-web straps G have their upper ends secured on the member A. Pulley-plates G' are suitably connected with the lower ends of the straps G. Grooved pulleys G² are mounted to turn in the forks of the plates G'. The elastic straps G pull upward and keep the cords G⁴ taut and prevent the cords from running out of the grooves in the pulleys A⁵ A⁶ and the plates A² and A³. Clamping-plates G³ are connected with the plates G' by screws g and securely connect the upper ends of the cords G⁴ with the plates G'. Clamping-plates a¹⁵ are connected with the plates A² and A³, respectively, by screws a¹⁶. The cords G⁴ respectively lie in the grooves a⁷ and a⁸ of the plates A² and A³, and the lower ends of the cords are secured to the plates by the clamping devices a¹⁵. Cords G⁵ pass around the grooved pulleys G², through loops g', and are connected with suspenders G⁶, which pass around the shoulders of the wearer. When applied to a left amputation, as shown, the suspenders connected with the cords on the inner side of the limb pass around the right shoulder

der and suspenders connected with the cords on the outer side of the limb pass around the left shoulder.

The cords G^4 and G^5 are exactly alike and are composed of a small round flexible chain g^2 , molded in rubber, the rubber being covered with thin soft leather, cemented thereon. This construction produces a cord which is strong, flexible, and noiseless in operation.

By reason of the construction and connection of the parts as described the shrugging of the right shoulder will pull on the cord G^4 , passing around the inside plate A^3 , and will cause the shank member to turn forwardly. Shrugging of the left shoulder will pull on the cord passing around the outside plate A^3 , so as to cause the shank member to turn rearwardly. In case the wearer should wish to move the shank member forwardly, or if from any cause, such as striking an obstacle, the shank member should tend to move rearwardly contrary to the will of the operator he would then shrug the right shoulder, thereby pulling upward on the cord G^4 , connected to operate the plate A^3 . If, however, from any cause the shank member should fail to respond to the pull on the cord to turn the shank member forwardly as desired, a further shrugging of the shoulder, and consequently a stronger pull on the cord A^4 , pulling against the pulley A^6 , would raise that end of the arm A^8 on which the pulley is mounted to cause the point of the pawl A^{10} to enter the notches a^{17} , thereby locking the plate A^3 , so as to prevent backward turning of the shank member. Immediately upon discontinuing the pull on the cord G^4 the spring A^{11} , having been previously compressed by the upward movement of the arm A^8 , would react to force the arm downward into its initial position, thereby releasing the pawl and permitting normal action of the limb.

The strength of the spring A^{11} is such that it will normally hold the arm A^8 down, so as to prevent lifting of the arm when there is such a pull on the cord G^4 as is necessary to operate the shank member under ordinary conditions; but when there is an excessive pull on the cord the spring will yield and permit the arm to raise and bring the point of the pawl into engagement in the notches in the plate A^3 , as already described.

From the foregoing it may be seen that the construction and arrangement of the parts is such that the movement of shrugging of the shoulder on the amputated side when the shank is moving forward and the leg is almost straight tends to reverse the movement of the shank, and thereby check its forward movement to such extent as to prevent it from stopping too suddenly with a thud when the leg reaches the limit of its forward movement. In other words, the shrugging of the left shoulder acts to cause the shank to move rearward. Hence such shrugging at the

proper instant serves to prevent excessive forward movement of the shank.

By controlling the rearward movement of the limb by the suspender passing around the shoulder on the amputated side and controlling the forward movement of the limb by the suspender passing around the shoulder on the other side the wearer is enabled to move his foot forward without a slam and is enabled to step backward naturally.

The suspenders passing around the shoulders and connected with the shank member as described enable the wearer to raise his foot and step over an obstacle in a natural manner without sidewise movement of the limb. This construction also gives the wearer control not only of the direction of movement of the shank member, but also gives him control of the speed of its movement, so that he may move it in either direction and may vary the speed of its movement, making it slow or quick, as occasion may demand.

After some experience in the use of the limb the wearer becomes so accustomed to controlling the action of the limb by the shrugging of the shoulders that the control of the movements of the limb practically becomes a control by reflex action of the brain exercised without any conscious forethought or predetermined action on the part of the wearer. This double control of the movements of the limb by the shoulders, one shoulder causing it to move in one direction and the other causing it to move in the opposite direction, is a new and valuable feature of my invention.

In artificial limbs having a knee-joint it is desirable for the knee-joint to turn sufficiently to kneel and to limit the turning of the shank member, so that it shall not turn rearward farther than is necessary for that purpose. To accomplish this result, I provide at the lower end of the thigh member a ledge a^{19} , running half-way around the lower part of the thigh member, and I provide at the upper end of the shank member B a metal rim b^3 , which strikes against the ledge a^{19} and limits rearward turning of the shank member. The rim b^3 also serves to strengthen the upper part of the member B. A toothed segment-plate D' , of rawhide, is secured to the lower end of the shank member B, and a similar segment-plate D^2 is connected with the foot member D. The teeth of the plates D' and D^2 intermesh and have a rolling and noiseless contact with each other. A wedge D^3 , slidable under the segment-plate D^2 , serves to raise or lower the segment-plate and to adjust the angle of the foot with respect to the shank. Bolts D^4 and D^5 have at their upper end cross-heads d , having chisel edges which bear on slotted plates D^6 , secured in the lower part of the shank member. Cushions D^7 , of rubber or other yielding material, surround the bolts between the wedge D^3 and the heads of the bolts. In walking when the pressure is against the toe it

causes the foot to turn with a rolling action on the lower end of the shank and causes the heel to pull downward on the bolt D⁴, so as to compress the cushion D⁷ and the cushion yields, so as to produce a steady movement of the foot without jerk or jar. When the pressure is on the heel, the bolt D⁵ and its cushion are brought into action in like manner. Whichever way the foot is turned the rawhide gears, the bolts, and the cushions cooperate to produce smooth and uniform action of the foot free from jerk or jar. Normally the bolts and cushions serve to retain the foot in that angle with respect to the shank member to which it is adjusted by means of the wedge D³. It will be observed that when the shank is in a vertical position, as shown, the fulcrum on which the foot turns is at the center of the plate D¹; but when the toe is turned upward the fulcrum travels forward. Hence the leverage of the foot is shortened, and it acts with less power against the bolt D⁴ than it would do if the fulcrum remained stationary and central. In like manner when the heel is raised the fulcrum moves rearward. By reason of this shifting of the fulcrum forward or rearward the leverage of the toe member of the foot or the heel part of the foot, as the case may be, is diminished to such extent as to materially lessen the danger of undue strain and consequent breakage of the parts.

At the lower end of the member A is a slot A¹⁸, adapted to permit oscillation of the block F⁶ in the slot, and a screw A¹² extends through the wall of the member A and has at its inner end a pad A¹³, against which the block F⁶ strikes. By turning the screw A¹² inward or outward the position of the pad may be changed, so as to give the shank member the desired adjustment with respect to the member A. The pad A¹³ being of yielding material deadens sound and prevents shock when the shank member, turning quickly forward, stops against the pad.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. A knee connection for artificial limbs, consisting of serrated plates attachable to the shank member of the limb, complementary serrated plates matching said first-named serrated plates and a connecting device connecting said complementary serrated plates; in combination with a shank member, securing devices securing said serrated plates in pairs on said shank member, and a thigh member in which the device connecting the complementary serrated plates is turnable, as set forth.

2. A knee-adjuster for artificial limbs, consisting of a threaded tubular member, a block into which said tubular member screws, a jam-nut abutting against said block, a plug secured on said tubular member, and a bolt connected with said plug; in combination with a

shank member a stationary bridge in said shank member, a cushion adjacent to said bridge, a connecting device transverse to said shank member and on which said block turns, and a thigh member in which said connecting device turns, as set forth.

3. A knee-adjuster for artificial limbs, composed of a bolt transverse to the shank member, an adjusting device connectible with the bridge and turning around said bolt, and a screw turnable in the thigh member and carrying a cushion; in combination with a thigh member on which said screw is mounted, a shank member having a bridge with which said adjusting device is connected, said shank member being oscillative on said thigh member, as set forth.

4. In an artificial limb, the combination of a thigh member having a ledge extending practically half-way around its lower part, a shank member having a metal-bound upper edge abutting against said ledge on the thigh member, and a connecting device pivotally connecting said shank member with said thigh member, as set forth.

5. In an artificial limb, the combination of a thigh member, pulleys on said thigh member, a shank member oscillative on said thigh member, segment-plates secured on said shank member, cords connected with said segment-plates and passing around said pulleys, and suspenders connected with said cords and respectively passing around the right and left shoulders of the wearer, the suspender on one shoulder operating to cause the shank member to turn forwardly and the suspender on the other shoulder operating to cause the shank member to turn rearwardly, as set forth.

6. A safety device for artificial limbs, embracing a notched segment-plate, an oscillative arm, a pulley and a pawl mounted on said arm, a spring acting against said arm and a cord secured to said segment-plate and passing around said pulley; in combination with a thigh member on which said oscillative arm is mounted, an oscillative shank member on which said segment-plate is secured, and means for pulling said cord, as set forth.

7. In an artificial limb, the combination of a thigh member, a stationary tube transverse to said thigh member, a shank member, serrated plates secured to said shank member, fitting on said serrated plates, two serrated segment-plates one having a screw-threaded hole and the other having a tapering hole, a bolt screwing into the screw-threaded hole in one of said segment-plates, as set forth.

8. In an artificial limb, the combination of a thigh member, a transverse tube fixed in said thigh member, a shank member, serrated plates secured on said shank member, segment-plates fitting on said serrated plates respectively, one of said segment-plates having a screw-threaded hole and the other having a

tapering hole, a bolt screwing into the screw-threaded hole in one of said segment-plates and having a tapering end fitting in the tapering hole in the other segment-plate, and a screw passing through one of said segment-plates and screwing into a hole in the tapering end of said bolt, as set forth.

9. In an artificial limb, the combination of a thigh member, a shank oscillative on said thigh member, and a supplemental thigh member pivotally connected with said first-named thigh member and oscillative in a direction diametrically opposite to the oscillation of the shank member, as set forth,

10. In an artificial limb, the combination of a shank, a toothed segment-plate secured on the lower end of said shank, stationary bearing-blocks transverse to said shank, bolts having knife-edges turning on said bearing-blocks, a foot, a toothed segment-plate connected with said foot and meshing with the segment-plate on the shank, cushions surrounding said

bolts, and a wedge slidable under said last-named toothed segment-plate, as set forth.

11. In an artificial limb, the combination of a thigh member, a shank pivotally connected with said thigh member, grooved segment-plates secured on said shank, elastic straps, secured on said thigh member, pulley-plates secured on said elastic straps, pulleys on said pulley-plates, cords passing around the pulleys on said pulley-plates, suspenders connected with said cords, pulleys on the thigh member, and cords secured to the segment-plate and passing around the pulleys on the thigh member and connected with the pulley-plate, as set forth.

In witness whereof I have hereunto subscribed my name, at Springfield, Illinois, this 28th day of December, 1903.

HENRY WENNEBORG, JR.

Witnesses:

J. H. LORD,

MAY F. RYAN.