

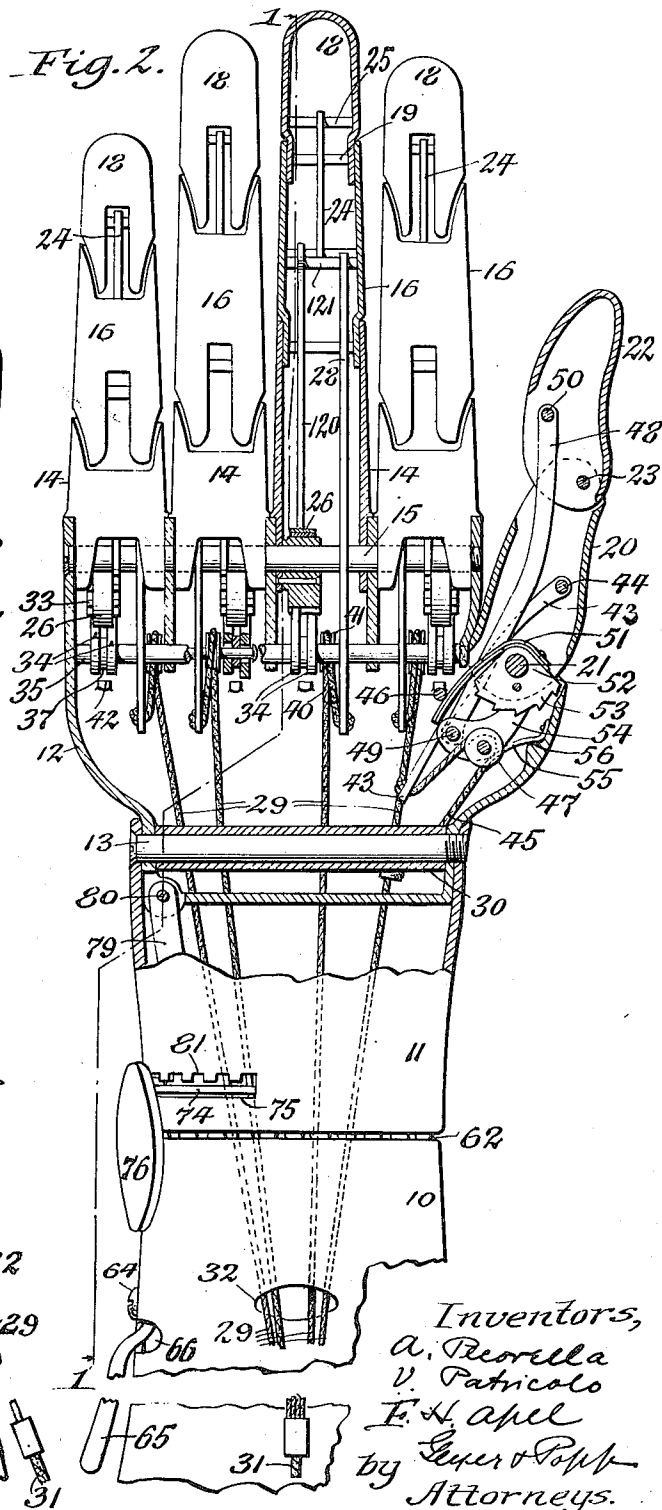
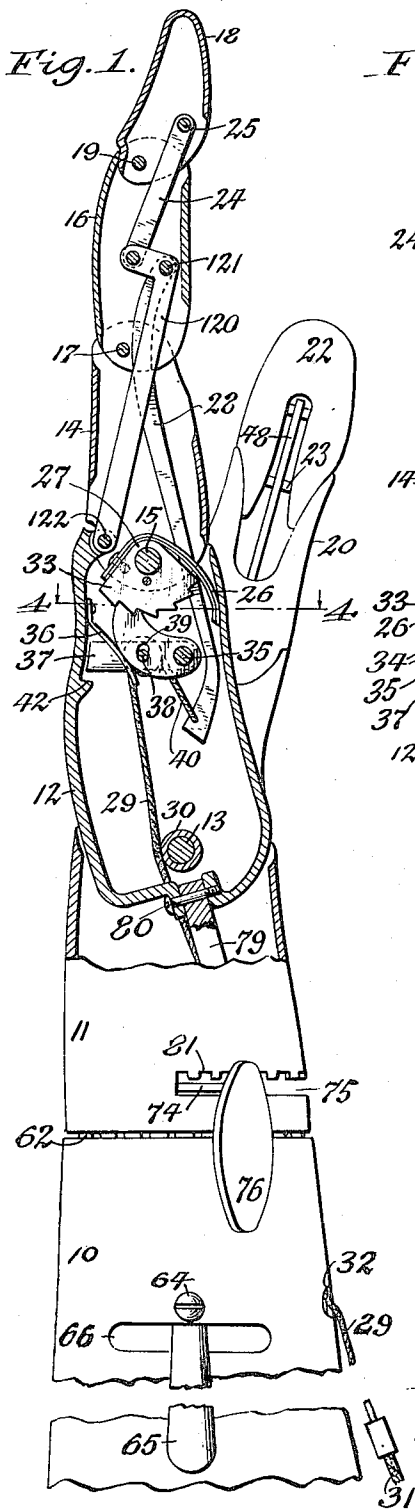
A. PECORELLA, V. PATRICOLO AND F. H. APEL.
ARTIFICIAL LIMB.

APPLICATION FILED OCT. 23, 1919.

1,380,835.

Patented June 7, 1921.

2 SHEETS—SHEET 1.



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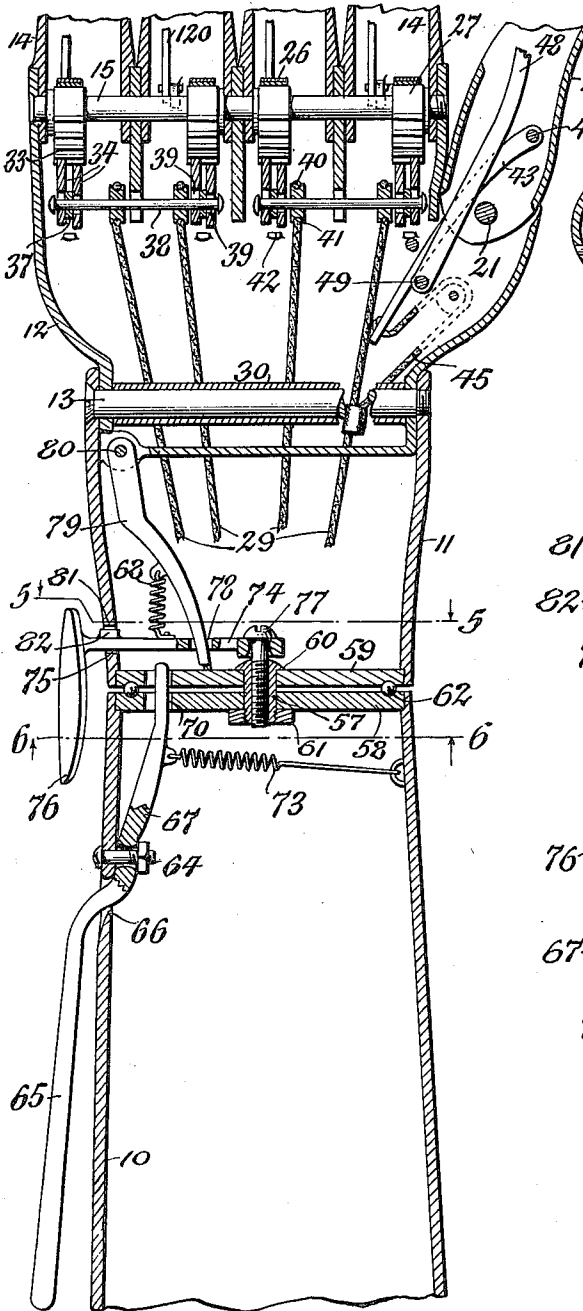


Fig. 3.

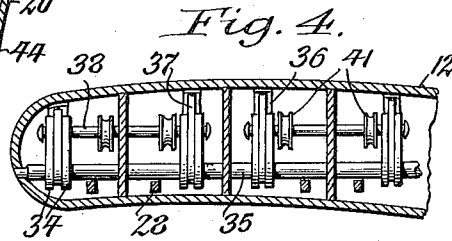


Fig. 4.

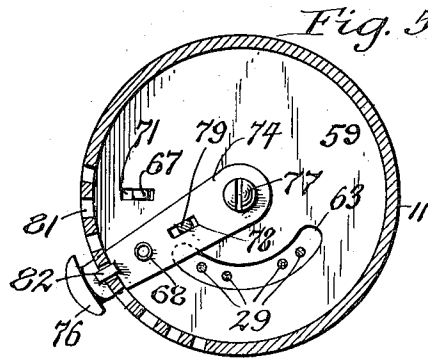


Fig. 5.

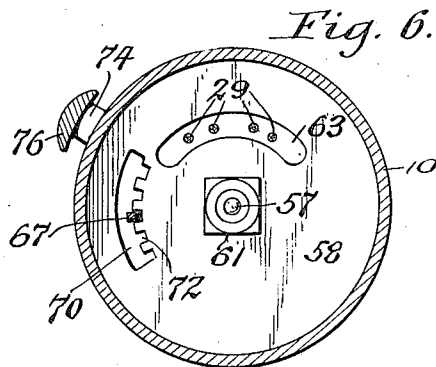


Fig. 6.

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UNITED STATES PATENT OFFICE.

ALBERTO PECORELLA AND VINCENT PATRICOLO, OF BUFFALO, AND FREDERICK H. APEL, OF ATHOL SPRINGS, NEW YORK.

ARTIFICIAL LIMB.

1,380,835.

Specification of Letters Patent.

Patented June 7, 1921.

Application filed October 23, 1919. Serial No. 332,698.

To all whom it may concern:

Be it known that we, ALBERTO PECORELLA and VINCENT PATRICOLO, citizens of the United States, and residents of Buffalo, in the county of Erie and State of New York, and FREDERICK H. APEL, a citizen of the United States, residing at Athol Springs, in the county of Erie and State of New York, have invented new and useful Improvements in Artificial Limbs, of which the following is a specification.

This invention relates to an artificial hand and has for its objects the provision of improved means for operating the fingers so that they can adapt themselves to articles of irregular shape and securely hold the same, to provide improved means for turning the wrist and the parts mounted therein about a longitudinal axis, to improve the means whereby the palm is turned laterally, and to improve the operating mechanism of the several parts in various details of construction.

In the accompanying drawings: Figure 1 is a vertical longitudinal section of an artificial limb embodying our improvements, the section being taken perpendicular to the plane of the palm of the hand and on line 1—1, Fig. 2. Fig. 2 is an elevation, partly in section, of the artificial limb viewed from the palm-side of the hand. Fig. 3 is a sectional view similar to Fig. 2, showing more particularly the mechanism for turning the wrist relatively to the palm and turning the palm laterally relatively to the wrist. Fig. 4 is a fragmentary horizontal section taken on line 4—4, Fig. 1. Figs. 5 and 6 are horizontal sections taken on lines 5—5 and 6—6, Fig. 3, respectively.

Similar characters of reference indicate corresponding parts in the several views.

As shown in the drawings, our improvements are embodied in an artificial limb having a forearm-section 10 which may be attached to the stump of the real arm in any suitable manner, a wrist 11 which is pivotally connected at its rear end with the front end of the forearm so as to be capable of turning relatively thereto about a longitudinal axis, a palm 12 which is pivotally connected at its rear end with the front end of the wrist by a transverse pin 13 so as to be capable of turning laterally relatively to the palm, a plurality of digits, the fingers of which consist each of a first section 14

pivotally connected with the palm by a pin 15, a second section 16 pivotally connected with the first section by a pin 17, and a third section 18 pivotally connected with the second section by a pin 19, and a thumb comprising a first or inner section 20 pivoted on the palm by a pin 21 and a second or outer section 22 pivoted on the first section by a pin 23. All of these several members are preferably constructed of hollow or tubular form in any suitable and approved manner so that the mechanism for operating the same may be located in the interior thereof.

Inasmuch as the means for actuating the several fingers for folding or closing and unfolding or opening the same are alike the following description applying to one of them will apply to all of the several fingers.

The first finger section may be turned about the pin 15 either into its open or closed position. 120 represents a first lever of elbow form which is fulcrumed by a pin 121 on the second finger section outwardly beyond the pivotal connection 17 and which has its inner arm pivotally connected by a pin 122 with the outer front edge of the palm, while its inner arm is connected by a link 24 with a pin 25 arranged on the third finger section outwardly beyond the pin 19. This connection between the several finger sections and the palm causes the second and third finger sections to fold and unfold in unison with the first section for grasping and releasing an article or for other purposes.

When free or released, each finger is folded or moved into its closed position by yielding means which in the preferred form comprise a spring 26 composed of a plurality of leaves which are curved and bear at their inner ends against the inner front edge of the palm while their outer ends are secured to a hub 27 which is loosely mounted on the pin 15 but secured to the adjacent part of the first finger section so as to turn therewith. The opening movement of the fingers is effected by a shifting bar 28 arranged lengthwise in the first finger section and the adjacent parts of the palm and second finger section and pivotally connected at its front end with the pin 121 while its lower end is connected with a pull cord or line 29 which latter upon being drawn backwardly or downwardly causes the shifting bar to be raised or moved forwardly and

the finger sections to be unfolded, while upon relaxing the pull on the cord 29 the finger sections will be folded by the spring 26. The pull cords of the several fingers 5 pass around a roller or sleeve 30 on the pin 13 which prevents undue wear on these cords and at their rear ends the several finger opening cords pass through an opening 32 on the inner side of the forearm and are 10 connected to a main or common operating line 31 whereby the finger opening cords may be operated in unison by pulling on this main line.

Means are provided for locking the fingers 15 in their open position, these means being preferably so organized that the fingers may be unlocked by the initial pull on the lines 28 for opening the fingers. As shown in Figs. 1-4, these means are constructed as 20 follows:

33 represents a segmental detent ratchet formed on the hub 27 of each first finger section and having each of its teeth preferably provided with an abrupt inner side 25 and an inclined outer side. Each of these ratchets is adapted to be engaged by a detent which preferably comprises two dogs or pawls 34 arranged side by side and pivoted on a rod 35 which is mounted transversely 30 on the palm, each pawl having preferably two teeth which are arranged out of line with the corresponding teeth of the companion pawl and thereby reducing the length between the steps at which the segment may 35 be caught and locked without making the teeth on the ratchet or the detent pawls unduly fine and thereby increasing the strength and durability of the locking device. Each of the detent pawls is yieldingly held in 40 engagement with the respective detent ratchet by a spring 36 bearing against the pawl and secured to the adjacent outer front part of the palm. The pair of detent pawls associated with each ratchet are disengaged from 45 the same by a releasing arm 37 pivoted on the rod 35 and having a coupling pin 38 which passes through corresponding slots 39 in the pair of detent pawls 34. In the preferred construction each coupling pin 38 50 passes through two pairs of detent pawls associated with two of the detent ratchets, as best shown in Figs. 3 and 4. The pull cord for each finger is provided in its front part with a loop 40 which passes from the shifting 55 bar 28 forwardly and outwardly around a guide pulley or roller 41 on the coupling pin 38 of the adjacent pair of detent pawls, whereby upon pulling backwardly on the cord 29 the first effect of this pull will be to 60 disengage the detent pawls from the ratchet and release the latter, so that during the subsequent or continued pull on this cord the shifting bar of each finger will be moved forwardly and the finger sections associated 65 therewith will be unfolded. This disen-

gement of the detent pawls from the ratchet during the initial pull on the releasing cords 29 is insured by allowing the pawls to recede under the pull of these cords until they are disengaged from the ratchet and 70 then the further retracting movement of the same is arrested by engagement of the releasing arm 37 with a stop 42 on the palm wall, after which the further pull on the opening lines 29 causes the fingers to unfold. 75 By employing a pin-and-slot connection between the releasing arm and the respective pair of detent pawls the latter are free to adapt themselves individually to their ratchet but these pawls are compelled to re- 80 cele together from the ratchet when the releasing arm is operated for this purpose.

While the detent pawls are thus disengaged from the ratchets of the several fingers, the pull on the line 29 is relaxed suffi- 85 ciently to permit the springs 26 to fold until they grasp the article desired, and then the pull on these lines is entirely removed so as to permit the pawls to engage the ratchets and lock the finger sections in whatever po- 90 sition they may occupy, thereby preventing the fingers from unfolding at this time and causing them to maintain a firm hold on the article. Inasmuch as the closing move- 95 ment of the finger sections is effected by the individual springs 26 each finger closes or folds as much as is possible against the article. It is thus possible for the several fingers to close a greater or lesser extent 100 independently of each other, which permits the fingers to individually adapt themselves to irregularly-shaped articles and hold the same firmly with the same facility as regularly shaped articles. When it is desired to 105 release the articles it is only necessary to pull on the several lines 29 when all the fingers will be swung into their open or unfolded position.

The mechanism for closing or folding and opening or unfolding the sections of the 110 thumb is constructed as follows:

43 represents a longitudinal shifting bar pivotally connected at its front end by a pin 44 with the inner thumb section while 115 its rear end is connected by a pull line 45 with the adjacent finger section pull line 29 so as to operate in unison therewith. The thumb pull line is constructed in the form of a forwardly extending loop which passes 120 around a support 47 having preferably the form of a guide roller. 48 represents a link pivotally connected at its rear end by a pin 49 with the palm while its front end is pivotally connected by a pin 50 with the inner 125 part of the outer thumb section. Upon drawing backwardly on the thumb pull line 45 the shifting bar 43 is moved forwardly, causing the inner section of the thumb to swing outwardly while at the same time the 130 outer section of the thumb is swung in-

wardly by the link 48. When the inner thumb section 20 is swung inwardly the outer section 22 is swung outwardly relatively to the fingers. In this way the natural movement of the hand is simulated in that the tip of the thumb swings slightly away from the palm of the hand while the fingers are folding and thus cause the fingers and thumb to close around or adapt themselves to the object to be grasped in a manner closely resembling the action of a human hand.

The folding action of the thumb sections is effected when the latter are free by means of a spring 51 preferably of leaf form, which is secured at its outer end to a hub 52 which is mounted on the rear end of the inner thumb section, so as to turn therewith while its inner end bears against an abutment pin 46 on the adjacent part of the palm.

For the purpose of locking the thumb sections against unfolding while an article is grasped by the hand, a locking device is provided which preferably consists of a segmental ratchet 53 formed on the hub 52, a detent pawl 54 pivoted on the pin 49 and carrying the roller 47, a spring 55 mounted on the palm and bearing against the pawl 54 for moving the same into engagement with the ratchet 53, and a stop 56 arranged on the palm and adapted to be engaged by the pawl 54 for limiting its movement away from the ratchet.

Upon pulling on the lines 29 and 45 for adapting the hand to an article to be grasped, the first effect of the line 45 is to withdraw the pawl 54 from the ratchet 53 and thus permit the inner section to be swung inwardly by the spring 55 and the outer thumb section to be swung outwardly by the link 48 upon partly relaxing the pull on these lines. When the thumb and finger sections have reached the desired position, the pull on the lines 29 and 45 is fully relaxed, thereby permitting the detent pawls of the fingers and thumb to engage their respective ratchets and hold the fingers and thumb sections in their folded position.

The pivotal connection between the wrist and forearm for turning these members about a longitudinal axis relatively to each other preferably comprises a longitudinal pivot bolt 57 passing through corresponding openings formed centrally in two plates 58, 59 which are mounted on the opposing ends of the forearm and wrist, the head 60 and nut 61 of said bolt bearing against the opposite sides of said plates, as shown in Fig. 3. Near the margins of these plates their opposing surfaces are provided with annular ball races which receive a row of balls 62 whereby the rotary movement of the wrist is relieved of undue friction, noise and wear.

The plates 58, 59 are provided with corresponding openings 63, preferably of segmental form through which the pull lines 29 pass and which permit the forearm and wrist to turn relatively to each other without interference from said lines.

Means are provided for turning the wrist relatively to the forearm and locking the same in various positions relatively to each other without requiring the use of a natural hand for this purpose. The preferred form of these means as shown in the drawings comprises a longitudinal adjusting lever 65 pivoted by a swivel joint on a bolt 64 to the forearm so as to swing crosswise relatively thereto and having a rear arm 65 projecting through an opening 66 in the forearm to the exterior thereof while its front arm 67 projects through a circumferential slot 70 in the forearm plate 58 and into a radial slot 71 in the wrist plate 59. The inner edge of the slot 70 is provided with a plurality of notches 72 which are arranged in a circumferential row and the front arm 67 of the wrist adjusting lever is held in engagement with one or another of these notches by a spring 73 which connects the front arm 67 with the adjacent part of the forearm. When it is desired to turn the wrist relatively to the forearm, the rear arm 65 of the wrist shifting lever is first moved inwardly and then pressed sideways, thereby first unlocking this lever from the notched edge of the slot 70 and then turning the wrist relatively to the forearm. After the wrist has been turned the required extent the pressure against the rear arm 65 is released, whereby the spring 73 draws its front arm 67 into engagement with the adjacent notch 72 and locks the wrist against turning out of this position.

Means are provided for rocking the palm laterally relatively to the wrist and holding the same in various positions relatively to each other, which means are constructed as follows:

74 represents an adjusting lever projecting laterally through a circumferential slot 75 in the rear part of the wrist and provided outside of the latter with a head or handle 76 while its inner end is pivoted by a swivel joint to the front end of a screw 77 which is secured axially to the bolt 57 which couples the plates 58, 59. This adjusting lever is provided with a slot or opening 78 which receives the lower or rear end of a shifting arm 79, the latter being pivoted at its upper or front end on the wrist by a pin or screw 80 so as to permit the shifting arm to swing radially relatively to the axis of the wrist but compelling the same to turn bodily with the wrist about the pivotal connection between the palm and the wrist. The upper side of the slot 78 is constructed to form a segmental row of notches 81 and

the upper side of the adjusting arm is provided with a tooth 82 which is yieldingly held in engagement with one or another of these notches by a spring 68 which connects the adjusting lever 74 with the shifting arm 79.

When it is desired to tilt the palm more or less the adjusting lever 74 is first pressed backwardly or downwardly to disengage the same from the respective notch 81 and then turned circumferentially relatively to the wrist in one direction or the other, which movement is transmitted to the palm by the shifting arm 79. When the palm has reached the desired position the adjusting lever 74 is released and permitted to interlock with the adjacent notch 81 by the spring 68, thereby holding the palm in its adjusted position. By pivoting the shifting arm 79 on the palm, the same is free to follow the adjusting lever 74 as the same swings around the axis of the pivotal connection between the wrist and forearm without producing any cramping action of the parts.

The operation of the adjusting levers 65-67 and 74 may be effected by engaging the same with any object such as the body of a person, or the surface of a table, chair or the like, thus enabling this adjustment to be effected without the use of any hand. A change of position of the fingers and thumb is thus possible in order to simulate a natural hand without attracting the attention of other persons, and thereby avoiding the annoyance and embarrassment usually attending the adjustment of artificial hands.

We claim as our invention:

1. An artificial limb comprising a palm, a finger pivoted on said palm, and means operating constantly to turn said finger into a closed position relatively to said palm comprising a hub mounted on the finger, and a leaf spring secured at one end to said hub and engaging its opposite end with said palm.

2. An artificial limb comprising a palm, a finger pivoted on said palm and having a plurality of pivotally connected sections, and means for unfolding said finger sections comprising a shifting bar connected at its front end with said finger sections, and a pull line connected with the rear end of said bar.

3. An artificial limb comprising a palm, a finger pivoted on said palm and having a plurality of pivotally connected sections, and means for unfolding said finger sections comprising a shifting bar connected at its front end with said finger sections, a pull line connected with the rear end of said bar and having a forwardly extending loop, and a support around which said loop passes.

4. An artificial limb comprising a palm, a

finger pivotally connected with said palm and having a plurality of pivotally connected sections, a shifting bar connected with the finger sections, a pull line connected with said bar and having a forwardly extending loop, a ratchet connected with the rearmost finger section, a detent pawl engaging said ratchet, and a guide roller which is movable bodily with said pawl and around which said loop passes.

5. An artificial limb comprising a palm, a finger pivotally connected with said palm and having a plurality of pivotally connected sections, a shifting bar connected with the finger sections, a pull line connected with said bar and having a forwardly extending loop, a ratchet connected with the rearmost finger section, a detent pawl engaging said ratchet, a guide roller which is movable bodily with said pawl and around which said loop passes, and a stop for limiting the movement of said detent pawl away from said ratchet.

6. An artificial limb comprising a palm, a finger pivotally connected with said palm and having a plurality of pivotally connected sections, a shifting bar connected with the finger sections, a pull line connected with said bar and having a forwardly extending loop, a ratchet connected with the rearmost finger section, a detent pawl engaging said ratchet and provided with a slot, a releasing arm provided with a pin engaging with said slot, a roller arranged on said pin and receiving said loop, and a stop which limits the movement of said arm and pawl away from said ratchet.

7. An artificial limb comprising a palm, a finger pivotally connected with said palm and having a plurality of pivotally connected sections, a shifting bar connected with the finger sections, a pull line connected with said bar and having a forwardly extending loop, a ratchet connected with the rearmost finger section, a pair of detent pawls having differently arranged teeth engaging the ratchet and provided with slots, a releasing arm provided with a coupling pin arranged in said slots, a guide roller arranged on said pin and receiving said loop, and a stop for limiting the movement of said arm away from said ratchet.

8. An artificial limb comprising a palm, a thumb having an inner section pivoted to said palm and an outer section pivoted on said inner section, a shifting bar connected at its front end with said inner section, and a link connecting said palm with said outer section.

9. An artificial limb comprising a palm, a thumb having an inner section pivoted to said palm and an outer section pivoted on said inner section, a shifting bar connected at its front end with said inner section, a

link connecting said palm with said outer section, and a pull line connected with said shifting bar.

10. An artificial limb comprising a palm, 5 a thumb having an inner section pivoted to said palm and an outer section pivoted on said inner section, a shifting bar connected at its front end with said inner section, a link connecting said palm with said outer 10 section, a pull line connected with said shifting bar and having a forwardly extending loop, and a support around which said loop passes.

11. An artificial limb comprising a palm, 15 a thumb having an inner section pivoted to said palm and an outer section pivoted on said inner section, a shifting bar connected at its front end with said inner section, a link connecting said palm with said outer 20 section, a pull line connected with said shifting bar and having a forwardly extending loop, a roller around which said loop passes, a spring operating to fold said inner section, a ratchet connected with the inner 25 section, a detent pawl engaging said ratchet and carrying said roller, a spring for moving said pawl toward said ratchet, and a stop for limiting the movement of said pawl away from said ratchet.

12. An artificial limb comprising a wrist, 30 a palm pivoted on said wrist so as to swing laterally relatively thereto, and means for adjusting said palm comprising an adjusting lever pivoted on the wrist, and a shifting 35 arm mounted on the palm and engaging with said lever.

13. An artificial limb comprising a wrist, 40 a palm pivoted on said wrist so as to swing laterally relatively thereto, and means for adjusting said palm comprising an adjusting lever pivoted on the wrist and provided with an opening, and a shifting arm engaging one end with said opening and pivoted 45 at its opposite end to said palm so as to be free to swing radially relatively to said lever but compelled to turn with the palm about the axis of the latter.

14. An artificial limb comprising a wrist, a palm pivoted on said wrist so as to swing

laterally relatively thereto, and means for 50 adjusting said palm comprising an adjusting lever pivoted on the wrist and operatively connected with said palm, said wrist being provided with a row of notches with which said lever is adapted to engage. 55

15. An artificial limb comprising a wrist provided in its side with a slot having one of its circumferential edges constructed to form a row of notches, a palm pivoted on said wrist to swing laterally relatively thereto, 60 an adjusting lever pivoted by a swivel connection to said wrist and projecting through said slot, a shifting arm pivotally connected at one end with said lever and pivoted at its opposite end on said palm so as to be capable 65 of swinging radially relatively to said lever but compelled to turn with said palm about the axis of the latter, and a spring connecting said arm and lever and operating to hold the latter yieldingly in engagement with one 70 of said notches.

16. An artificial limb comprising a forearm, a wrist pivoted on said forearm to turn about the longitudinal axis of the same, and means for adjusting said wrist relatively to 75 said forearm comprising a lever pivoted on said forearm and having one end projecting on the exterior of the same while its other end is operatively connected with said wrist.

17. An artificial limb comprising a forearm, a wrist pivoted on said forearm to turn about the longitudinal axis of the same, and means for adjusting said wrist relatively to 80 said forearm comprising a lever pivoted by a swivel joint on said forearm and having a rear arm extending to the exterior of the forearm, a plate arranged on the forearm and provided with a row of notches, a plate 85 arranged on the wrist and provided with a radial slot which is engaged by the front arm of said lever, and a spring connecting said lever and forearm and operating to hold said front arm yieldingly in engagement 90 with said notches.

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