M. E. CRONEMILLER.

ARTIFICIAL ARM AND HAND.

APPLICATION FILED FEB. 9, 1916.

1,225,415.

Patented May 8, 1917.

3 SHEETS—SHEET 1.

FIG. 1.

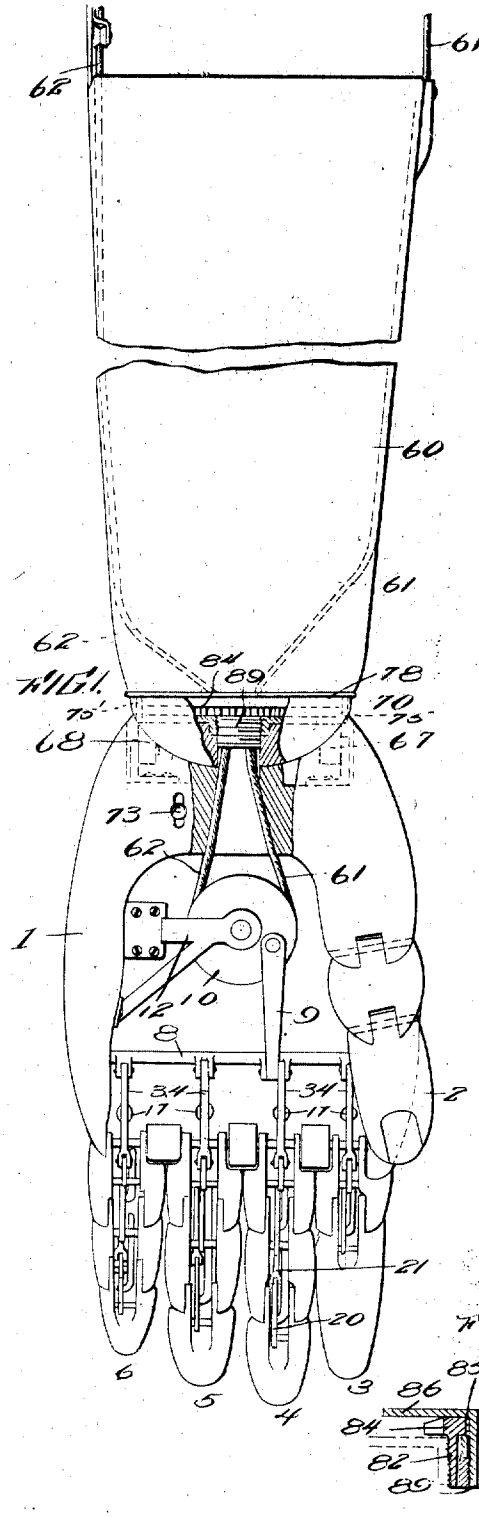


FIG. 2.

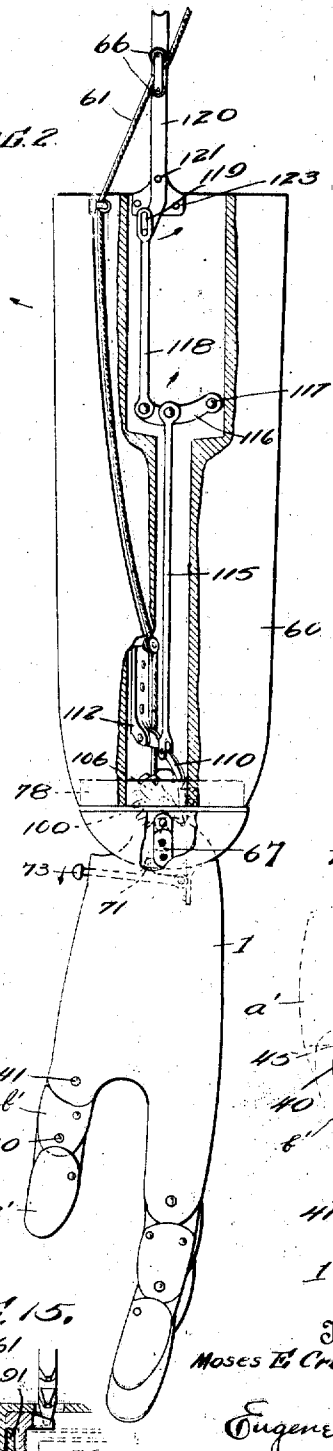


FIG. 3.

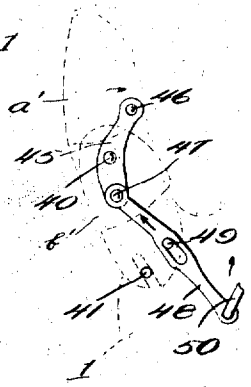
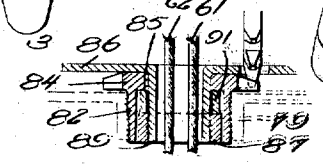


FIG. 15.



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3 SHEETS—SHEET 2.

FIG. 4.

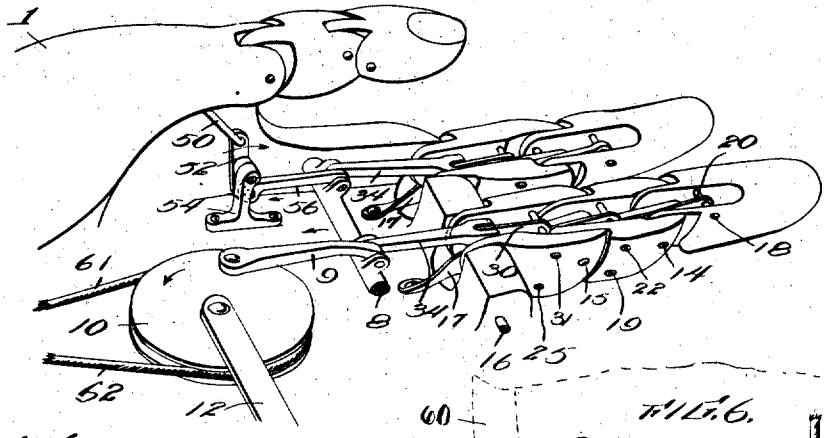


FIG. 5.

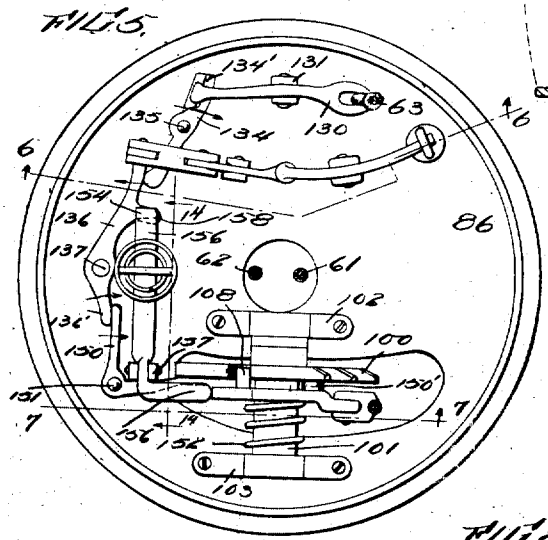


FIG. 6.

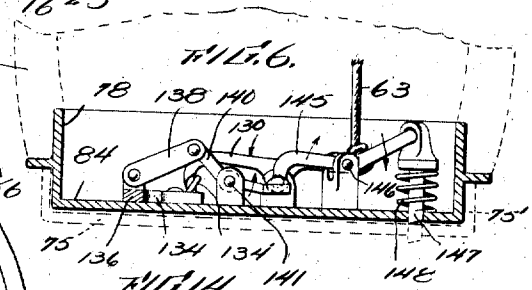


FIG. 14.

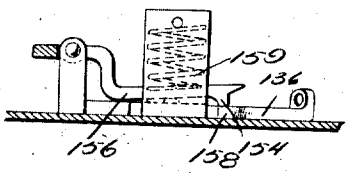


FIG. 8.

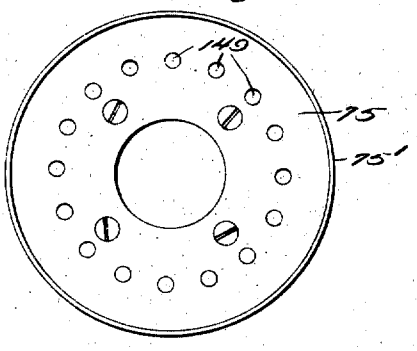
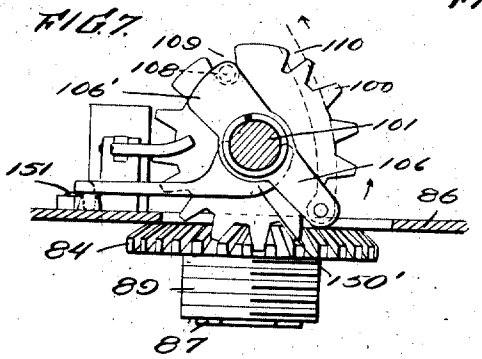


FIG. 7.



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Patented May 8, 1917.

3 SHEETS—SHEET 3.

FIG. 12.

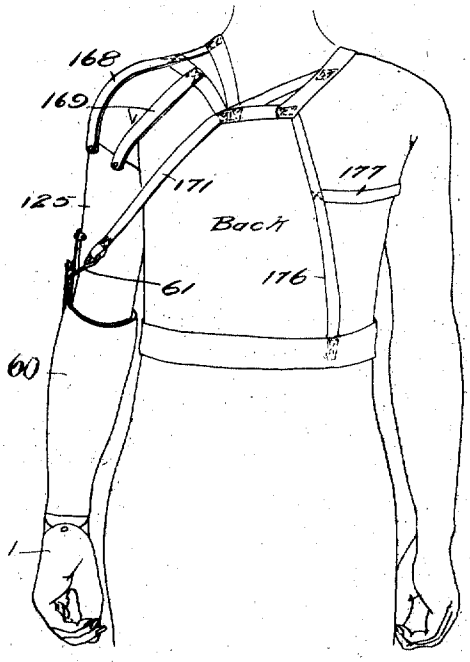


FIG. 13.

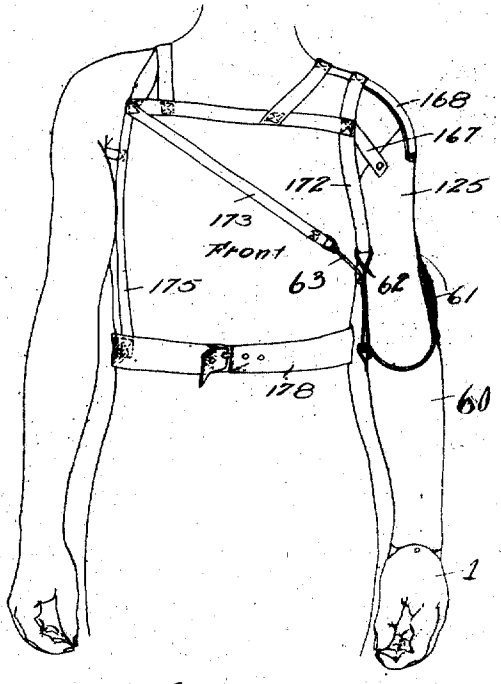


FIG. 9.

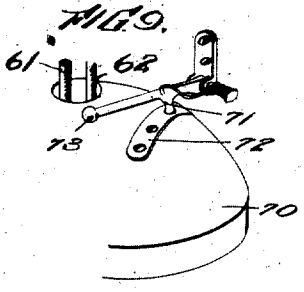
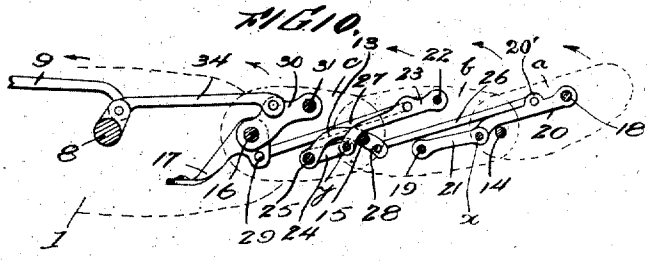


FIG. 10.



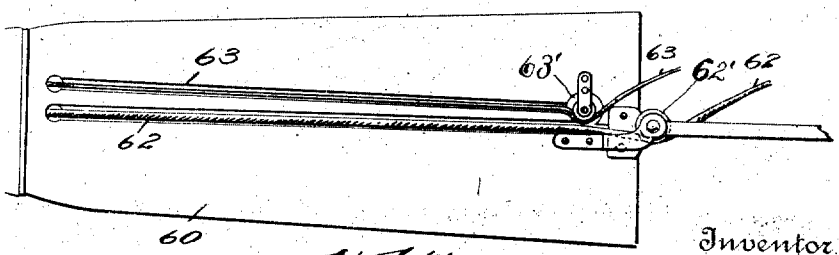


FIG. 11.

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UNITED STATES PATENT OFFICE.

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ARTIFICIAL ARM AND HAND.

1,225,415. Specification of Letters Patent. Patented May 8, 1917.

Application filed February 9, 1916. Serial No. 77,271.

To all whom it may concern:

Be it known that I, MOSES E. CRONEMILLER, a citizen of the United States, residing at Patton, in the county of Cambria and State of Pennsylvania, have invented certain new and useful Improvements in Artificial Arms and Hands, of which the following is a specification.

My invention relates to improvements in artificial arms and hands, together with an arrangement of supporting harness therefor.

The main objects of this invention are to produce an artificial arm and hand adapted to be fitted to the forearm or to the stump of the wearer and relates to improvements for operating and controlling the wrist of the hand upon the artificial forearm; to improvements in the finger operating mechanism whereby the joints of the fingers may conform more nearly in operation to the movements of the natural hand and to the construction of the harness by which the movements of the parts are effected.

Other objects will appear from the following detailed description of my invention in connection with the accompanying drawings, in which—

Figure 1 is a side elevation of an arm and hand embodying my invention, a portion of the wrist being broken away to show the operating cords; Fig. 2 is a side elevation of the same with the parts turned at right angles to that of Fig. 1, and with a portion of the forearm broken away to show the operating lever mechanism; Fig. 3 is an enlarged detail of the thumb and contained lever mechanism; Fig. 4 is an enlarged perspective view of a portion of the hand showing the finger-operating mechanism; Fig. 5 is an enlarged plan view of the inner side of the plate in the outer end of the forearm with the attached wrist-controlling mechanism; Fig. 6 is a sectional view on the line 6—6 of Fig. 5; Fig. 7 is a sectional view on the line 7—7 of Fig. 5; Fig. 8 is a plan view of the end plate in the wrist; Fig. 9 is an enlarged perspective view of the locking device for locking the wrist in different positions as it is shifted forward or backward; Fig. 10 is a longitudinal section through one of the fingers to show the lever mechanism for bending the joints; Fig. 11 is a side elevation of the forearm showing the guiding pulleys for the operating cords at the elbow joint; Figs. 12 and 13 are back and front views of the supporting and operating harness; and Figs. 14 and 15 are detail views of certain operating parts.

The artificial hand comprises a main portion 1, to which the thumb 2, and fingers 3, 4, 5, 6 are pivotally connected. The actuating levers of the thumb and fingers are connected by links to a rock-shaft 8 extending transversely across the body part of the hand, this shaft being connected by a link 9 to a pulley 10 pivoted in a bracket 12 and to which the operating cords are connected. As appears from Figs. 1, 4 and 10, the finger joints are pivoted to each other at 14 and 15, while the inner joints are pivotally mounted upon the transverse rod 16, carried by brackets 17. The outer finger joint *a*, is operatively connected to the intermediate joint *b*, by toggle links 20, 21 pivotally connected at *x* and pivotally mounted at opposite ends on pins 18 and 19; and the intermediate finger joint *b* is operatively connected to the innermost joint *c*, by toggle links 23, 24, pivotally connected at *y* and pivoted at opposite ends on pins 22, 25. The outer links 20 and 23, of the toggles are connected by connecting-rods 26, 27 respectively with ears 28, 29 on the stationary brackets 13 and 17. The rod 16 passes through the bracket 17 and the pins 15 and 25 pass through the bracket 13. A link bar member 30 connected at 31 to the innermost joint *c*, and swinging upon the pivot rod 16, is connected by connecting-rod or link 34, with the rock-shaft 8.

It will be seen, therefore, that if the link 9 is moved in the direction of the arrow in Figs. 4 and 10, a pull in the same direction will be exerted by the rock-shaft and connecting-rod 34, upon the innermost joints *c* of each of the fingers, causing them to swing on the pivot-rod 16 upward toward the palm of the hand, *i. e.*, upward in the direction of the arrows in Fig. 10. As the connecting-rod 27 is pivoted in the ear 29, eccentric to the pivot 16 upon which the finger joint *c* swings, the toggle 23, 24, will be forced downward and bent upon its middle connecting pivot *g* and thus cause the middle finger joint *b* to fold over toward the inner joint *c*. Inasmuch as the connecting-rod 26 is secured to the ear 28, eccentric to the pivot pin 15 upon which the joint *b* swings, it will exert a pull upon

the upper link 20 and cause the toggle 20, 21 to bend or fold upon its middle connecting pivot and thereby cause the end joint a, to swing toward the middle joint upon the pivot pin 14. The resultant effect of these combined movements is a bending of the finger joints and a movement toward the palm in a manner similar to the movements of the natural hand. I have usually found it sufficient for practical purposes to form the fore-finger with only two joints or sections, as indicated in Figs. 1 and 4.

By referring to Figs. 1, 3 and 4, it will be observed that the outer joint a' of the thumb is pivoted at 40 to the inner joint b', and the latter is pivoted at 49 to the main part 1 of the hand, the movements being guided by the pin 41. A lever-bar 45 held by the pivot 40 and a pin 46 is pivotally connected at 47 to a link 48 which slidably fulcrums upon a pin 49. The inner end of the link 48 is connected by a link 50 to a rock arm 52 centrally pivoted to the standard or bracket 54, the lower end of the arm 52 being connected by link 56 to the rock shaft 8. When, therefore, the shaft 8 is rocked by a pull on the link 9 in the direction of the arrow in Fig. 4, to cause the joints of the fingers to fold over toward the palm of the hand in the manner previously described, the link 56 pushing upon the lower end of the rock lever 52 will cause the upper end and the link 50 to move in the opposite direction, as indicated, and this will cause the lever link 48 to slide on the fulcrum pin 49, pushing upon the lever 45, which rocks upon the pivot 40, and bends the outer joint a' inwardly toward the palm. The thumb thus bends inwardly simultaneously with the fingers to cooperate with them in grasping an object, or to close tightly against the palm of the hand, or to close against the palm of the hand.

The closing or opening movements of the fingers and thumb are effetced by the rotary movement of the pulley disk 10 in one direction or the other, by a pull upon either the cord 61 or the cord 62. These cords, which are preferably rawhide, pass centrally through the wrist portion and then through grooves or channels upon opposite sides of the fore arm 60, and are fastened to straps of the harness passing about the neck and shoulders in the manner illustrated in Figs. 12 and 13.

The hand is pivoted to brackets 67, 68, secured to opposite sides of the wrist member 70 and may be adjusted in different angular relations thereto by means of the spring-pressed dog or catch 71, which engages one or another of the holes in a plate 72, see Fig. 9, and may be unlatched by lifting the finger piece 73.

The wrist-member 70 is provided with a base plate 75, having a flange 75′ which surrounds a flange 78 projecting from the plate 84, on the end of the fore-arm portion and having a central aperture surrounded by an annular flange 79 threaded to a hollow stem 82, projecting from the miter-gear 84. The miter-gear 84 is secured to the end plate 86, on the forearm by means of a nut 87, threaded upon a hollow stem 89, projecting from said plate 86, the nut bearing upon a loose ring 91, which engages an internal flange 85 on the miter-gear. This construction forms a secure connection between the wrist-member and the forearm while permitting the miter-gear and wrist to rotate freely about the hollow stem 89.

For the purpose of causing the hand and wrist to partially rotate, simulating the movement of the natural hand, as the forearm is moved upwardly upon the elbow hinges, I provide a spur-gear 100, with actuating mechanism in a recess in the outer end of the forearm, the spur-gear being journaled upon a shaft 101 carried by brackets 102, 103 secured to the plate 86, the spur-gear projecting through an aperture in the plate and engaging the miter-gear 84. A lever-arm 106, centrally pivoted on the shaft 101, carries at one end a pin 108, which normally projects into a notch 109 in the spur-gear, the other end being connected by a lever 110, to a bracket 112. A link 115, operating in a channel in the side of the forearm pivotally connects an intermediate point of the lever 110 with an intermediate point of the lever 116, which is pivoted at 117 and connected by a link 118, with the elbow lever 120, provision being made for lost motion by a slot 119. The elbow lever 120, is pivoted at 121 to a bracket 123, and secured in any suitable manner to the upper arm member 125. It will be apparent that when the forearm is swung upwardly toward the upper-arm, the link 118 will first be shifted rearwardly to the opposite or rear side of the pivot 121 and then moved toward the elbow, swinging the lever 116 in the direction of the arrow in Fig. 2, thereby exerting a pull upon the link 115 and operating through the lever 110 to rotate the spur-gear 84 in mesh therewith, thus effecting a partial rotation of the hand and wrist. The parts may be so proportioned that the hand will be turned about 90° while the forearm moves upwardly through the same angle.

It is sometimes desirable to disconnect the mechanism which actuates the miter-gear to turn the hand and wrist and to lock the wrist in any desired angular relation with respect to the arm. As one means for accomplishing this purpose, I provide the system of levers shown in detail in Fig. 5, in connection with the operating cord 63. A pull upon the cord 63 attached to one end of a lever 130, centrally pivoted to a bracket 131, causes the other end of the lever to

move toward the plate 86 and to impinge against a cam surface 134′ at one end of a lever 134, which swings laterally upon a pivot 135, and bears at the opposite end against a lever 136, pivoted at 137. One end of the lever 136 is connected by a link 138 with the raised end of a bent lever 140, pivoted at 141. As the link 136 is pushed laterally in the direction of the arrow in Fig. 5, it pulls upon the inclined link 138, and this exerts a downward pull upon the upper end of lever 140 and causes the lower end to bear upon the lever 145, swinging it upon its pivot 146 and projecting the locking pin 147, through the arm plate 84, into one of the holes 149, in the wrist plate 75, to thereby lock the wrist in the desired angular position.

The mechanism which actuates the spur-gear 100 and the miter-gear 84 must be disengaged simultaneously with the locking of the wrist plate in order to permit any desired movement of the forearm. To effect this disengagement, the arm 136′ of the lever 136, bears against one end of the bell-crank lever 150, pivoted at 151, and formed at the opposite end into a yoke 150′ which embraces the shaft 101, between the spur-gear 100 and the clutch lever 106. When the bell-crank lever 150 is swung upon its pivot in the direction of the arrow in Fig. 5, the yoke end 150′ slides the lever or clutch member 106 along the shaft 101 away from the spur-gear 100, against the action of the spring 152, until the pin 108, moves out of the notch 109 in the spur-gear. As the lever 136 swings laterally to effect the movement just described, the lug 154 of the lever 156, pivoted at 157, which is forced downwardly by the spring 159, slides over the top of the lug 158 on the lever 136 and snaps behind it, thereby preventing the return of the system of interconnected levers and thus locking the parts in position with the pin 147 projecting in one of the holes 149 and the pin 108 disengaged from the spur-gear 100, so that the clutch lever 106 is free to move about the shaft 101. The hand and wrist are thus locked in the desired angular position while the forearm may be moved up and down without affecting them; the movements of the levers 116, 110 and links 115 and 118, merely causing the lever 106 to rock on the shaft 101 without affecting the spur-gear.

When it is desired to unlock the wrist and connect the spur-gear with the actuating levers in the forearm, the latter is raised until the clutch lever 106 is rotated sufficiently to cause the end 106′ to strike the end 156′ of the lever 156, thereby lifting the lug 154, and permitting the springs 152 on the shaft 101 and 148 on the pin 147, to return the parts to normal position, sliding the clutch lever 106 toward the spur-gear until the pin 108 engages the notch 109 and withdrawing the pin 147 from the wrist plate. The wrist and hand will then move angularly in unison with the vertical movements of the forearm.

The harness which supports the artificial arm and to which the actuating cords are attached, passes around the neck and over the shoulders of the wearer in the manner shown in rear and front views in Figs. 12 and 13. The upper arm member 125 is supported by straps 170, 171 and 172 passing over the shoulder. The cords 61 and 62 which control the finger-actuating disk or pulley 10, are connected by end loops to straps 171 and 172 secured to the neck yoke at the rear and front respectively upon the side of the maimed member; while the cord 63 which controls the locking of the wrist and the disconnecting of the wrist-actuating mechanism, is connected to strap 173, secured to the harness at the front of the shoulder of the opposite or whole arm. The harness is maintained in position to exert the desired pulls upon the operating cords by vertical straps 175 and 176, connected by the under-arm strap 177, upon the opposite side from the maimed member, these straps being firmly held by a waist-band or belt 178.

The operation of the several parts to effect the movements of the forearm, wrist and fingers will be understood from the foregoing detailed description. When the wearer has lost only the hand, the vertical movements of the fore-arm will of course be effected naturally, the artificial arm being then made hollow to receive the arm.

When, however, only a stump of the upper arm remains, this is inserted in the upper artificial arm part 125. Assuming the latter condition, a forward movement of the stump places a strain on the strap 171 secured to the harness at the rear of the shoulder adjacent the maimed member, and the pull thereby exerted upon the cord 61, causes the forearm 60 to move upwardly in a vertical plane, the leverage upon the forearm being exerted from a point several inches above the elbow hinge by placing the guide rollers 66, between which the cord 61 passes, on the lever 120, a distance from the pivot 121, as indicated in Fig. 2; at the same time the pull upon the cord 61 also rotates the disk or pulley 10, in the direction of the arrow in Fig. 4, which causes the fingers and thumb to move into the closed position. The degree of movement of the fingers depends upon the amount of vertical movement imparted to the forearm by the forward impulse of the stump and consequently the person can first cause the forearm to move partially upward until the fingers have bent around into a partially closed position, then move bodily until the hand sur-

rounds the object to be grasped and finally move the forearm sufficiently to tightly grasp the object.

The forearm may be moved at once to the desired height or position by the tension upon the strap 171 and cord 61 through the forward movement of the stump in the manner above described, the fingers being simultaneously bent or folded into closed position by the pull of the cord 61 acting on the pulley disk 10. The fingers may then be opened to any desired extent, while maintaining the raised position of the forearm in the following manner. By raising the shoulder adjacent the artificial arm a pull or tension will be exerted upon the strap 172 and the attached cord 62, while the tension upon the strap 61 is correspondingly slackened, with the result that the pulley disk 10 is turned in the opposite direction from the arrow in Fig. 4, thereby causing the fingers to open. If desired, the fingers can be again closed to grip an object, by lowering the previously raised shoulder and thus loosening the tension upon cord 62 and pulling upon the cord 61. Thus it will be seen that the fingers and thumb may be opened and closed at will by raising and lowering the shoulder adjacent the artificial arm.

As I have previously explained, the operating lever 106 may be disengaged from the spur-gear 100, so that the movements of the fore-arm will not cause any angular movements of the wrist and hand, by raising the shoulder upon the opposite side from the artificial arm thereby causing a tension or pull upon the cord 63, which also causes the pin 147 to lock the wrist in the desired position. It will be observed that the cords 62 and 63 pass over guide rollers 62′ and 63′ respectively carried by brackets adjacent the elbow hinge, so that no tension is placed upon these cords by the movements of the fore-arm. On the other hand the guides 66 for the cord 61 are carried by the lever 120 at a distance from the elbow hinge pivot 121, so that a forward movement of the upper arm 125 under the control of the person's stump, places a strain and leverage due to said distance from the elbow pivot, which causes the upward movement of the fore-arm.

The advantages derived from the use of my improvements will be apparent to those familiar with the construction and operation of artificial limbs and also by engineers familiar with the principles of mechanical devices. The system of toggle connections and links connecting the joints of the fingers, shown in detail in Fig. 10, not only affords great strength to the fingers, but produces a more powerful and efficient action than prior devices with which I am familiar. I have explained that since the link 26, pivoted in the braeket 28, swings upon a different center from the pivot 15, upon which the finger joint *b* turns, a movement of the joint *b*, in the direction of the arrow in Fig. 10, will cause the link 26 to pull the ear 20′ of the toggle link 20 inward and cause the toggle 20, 21 to buckle or bend at its pivot connection *x*. This movement causes the outer finger joint *a* to bend toward the joint *b*, turning upon its pivot 14. The strain upon the pivot 14 connecting the joints *a* and *b*, is relieved both by the toggle links which are pivoted at 18 and 19 to the respective joints, and also by the operating or tension link 26, which is connected to the ear 20′ and to the bracket 28 attached to the first or inner joint *c*. Moreover, it will be observed that my system of link connections remains entirely within the contour of the finger joints during all movements of the fingers which contributes to the appearance of the hand. It will be understood, of course, that all of the various parts of the hand and arm are provided with a smooth outer covering of suitable material and texture so that they will be neat, attractive and inconspicuous. Another feature which contributes to the compactness of the mechanism contained within the structure of the hand resides in the manner of arranging the system of levers which actuate the fingers and the simplicity of the actuating mechanism, all being controlled by a single flat pulley disk 10 which is mounted within the palm portion of the hand. There are no gears or other devices to project beyond the normal contour of a hand.

In order to provide efficient mechanism for controlling the swivel or twisting movements of the wrist upon the fore-arm within a small compass, so that the wrist can be made of the normal size, I have devised the system of interconnected levers shown in plan view in Fig. 5 and I have so arranged them that they are distributed over a comparatively small superficial area. The entire system of levers is controlled by a single cord 63 which operates by a single pulley to simultaneously disengage the wrist turning mechanism and lock the wrist to the fore-arm in the desired angular relation. The actuation of the swivel movements of the wrist to automatically turn the hand so that the palm will be toward the face when the fore-arm is raised, simulating the movements of the natural arm and hand, is effected by a single line of levers and links which are connected to the elbow hinge member 120. By providing the link 118 with an extended slot 123, I provide a certain amount of lost motion which permits the fore-arm to swing slightly backward and forward without actuating the levers controlling the wrist swivel. It will be understood that that is for the purpose of per-

mitting a natural swinging movement of the arm when in lowest position without causing any movement of the hand. It will appear, therefore, that I have greatly simplified the mechanism for actuating and controlling the movements of artificial hands and arms and at the same time, I have made the operating mechanism more efficient. I have described in detail the construction illustrated in the accompanying drawings for the purpose of fully disclosing an embodiment of my invention, but I am aware that various changes and modifications may be made therein within the scope of my claims and without departing from the spirit of my invention.

I claim:

1. An artificial hand having a plurality of fingers each composed of a plurality of pivotally connected joints or members, a toggle lever having its links pivoted at their outer ends to adjacent finger members, and an actuating link-rod connected to the outer toggle link and to a part separate from said adjacent members.

2. An artificial hand having a plurality of fingers each composed of a plurality of pivotally connected joints or members, a toggle lever having its links pivoted at their outer ends to adjacent finger members, and means directly connected with said toggle lever for causing it to fold or bend when the finger is swung toward the palm of the hand.

3. An artificial hand having a plurality of fingers each composed of a plurality of pivotally connected joints or members, toggle levers connecting the adjacent members, a rod extending transversely across the hand upon which the innermost finger members are pivoted, a link bar member secured to said innermost finger joint and pivoted on said rod, a rock-shaft, and links connecting said rock-shaft with the said link bar member.

4. An artificial hand having a plurality of fingers, each composed of a plurality of pivotally connected joints or members, a rock-shaft extending transversely of the hand, links connecting said shaft with the respective fingers, a rotary disk mounted to rotate in the plane of the hand, and a connecting rod or link pivoted to said disk and to said rock-shaft respectively.

5. An artificial hand having a plurality of fingers, each composed of a plurality of pivotally connected joints or members, toggle-levers connecting adjacent members, means for causing said toggles to bend or fold when the fingers are moved toward the palm of the hand, a rock-shaft extending transversely of the hand, links connecting said shaft with the respective fingers, a rotary disk mounted to rotate in the plane of the hand, and a connecting rod or link pivoted to said disk and to said rock-shaft respectively.

6. An artificial hand having a plurality of fingers, each composed of a plurality of pivotally connected joints or members, toggle-levers connecting adjacent members, a connecting rod or link connecting the inner toggle of each joint with a bracket on the body of the hand, and a connecting rod or link connecting the outer toggle with a fixed part on the innermost joint or member.

7. The combination in an artificial arm of a fore-arm member, a rotary gear-wheel carried upon a shaft mounted in the outer end of said fore-arm member, a clutch device loosely mounted upon said shaft and normally spring-pressed into operative engagement with said gear-wheel, a wrist-member swiveled upon the outer end of said fore-arm, a gear wheel carried by said wrist-member and meshing with said first mentioned gear-wheel to cause a swivel wrist movement, locking means adapted to prevent said swivel movement, a system of co-acting levers adapted to simultaneously shift said clutch device out of engagement with said first mentioned gear-wheel and to actuate said locking device, a latch to automatically hold said system of levers in moved position and having a trip-arm in the path of said clutch device when in disengaged position, and means under control of the wearer for actuating said lever system and for causing said clutch device to engage said trip-arm.

8. The combination in an artificial arm of a fore-arm member, a rotary gear-wheel carried upon a shaft mounted in the outer end of said fore-arm member, a clutch device loosely mounted upon said shaft and normally spring-pressed into operative engagement with said gear-wheel, a wrist-member swiveled upon the outer end of said fore-arm, a gear wheel carried by said wrist-member and meshing with said first mentioned gear-wheel to cause a swivel wrist movement, an elbow lever pivoted to the upper or inner end of said fore-arm, a pair of levers pivoted to the side of said fore-arm and connected by a link, one of said levers being connected to said clutch device, and a link connecting the other lever to said elbow lever and having a lost motion connection to permit a slight swinging of the fore-arm without affecting said levers.

9. The combination in an artificial arm of a fore-arm member, a rotary gear wheel carried upon a shaft mounted in the outer end of said member, an actuating member loosely mounted upon said shaft and normally spring-pressed into operative engagement with said gear wheel, a gear-wheel rotarily mounted in mesh with said first mentioned gear, a wrist-member se-

cured upon the hub of said last mentioned gear-wheel, an elbow lever pivoted to the upper or inner end of said fore-arm and forming an elbow hinge-member, lever mechanism connecting said actuating member and said elbow hinge-member to thereby actuate said gears when the fore-arm is swung upon said hinge-member, and means under control of the wearer for moving said actuating member along said shaft to disengage it from said first mentioned gear-wheel.

In testimony whereof I affix my signature in presence of two witnesses.

MOSES E. CRONEMILLER.

Witnesses:

CHARLES C. CRONEMILLER,

WILBER F. SHOFF.