Oct. 30, 1951 J. D. CHAPMAN ET AL 2,572,914

ARTIFICIAL ARM WITH ELBOW LOCK AND SELECTIVE CONTROL OF FOREARM FLEXION OR HOOK OPERATION

Filed April 17, 1950 3 Sheets-Sheet 1

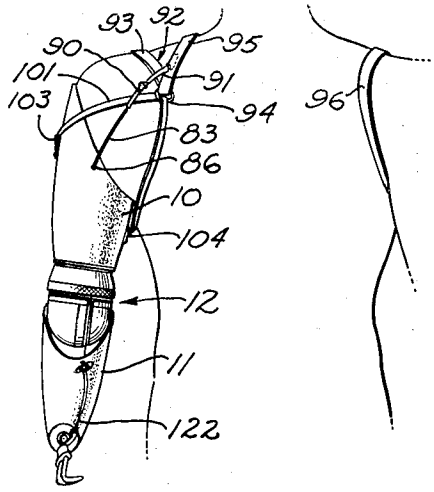
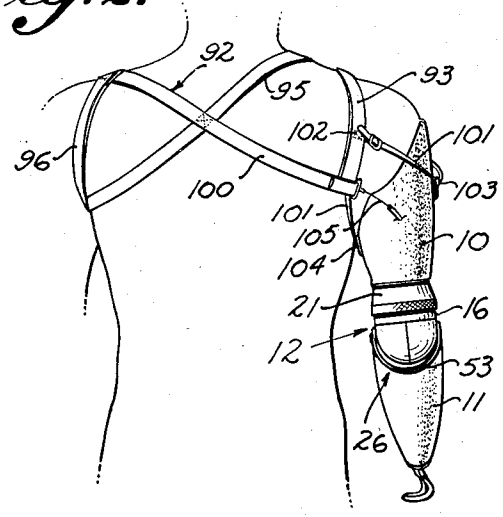


Fig. 1.

Fig. 2.



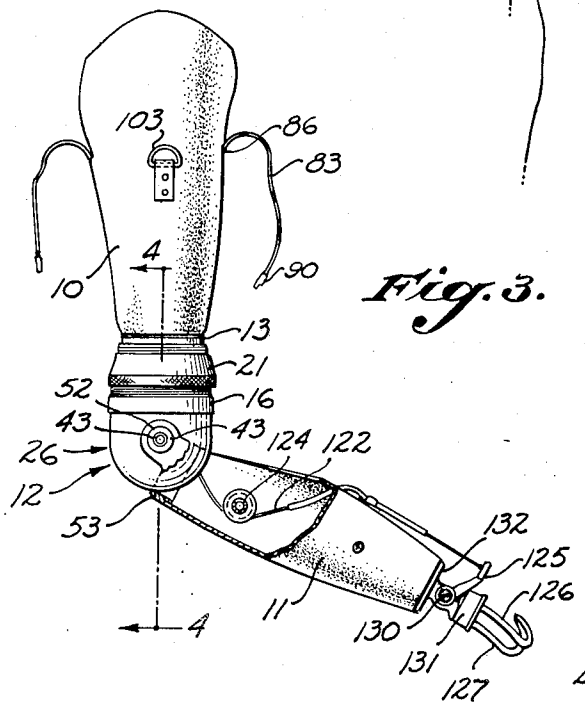


Fig. 3.

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Fig. 4.

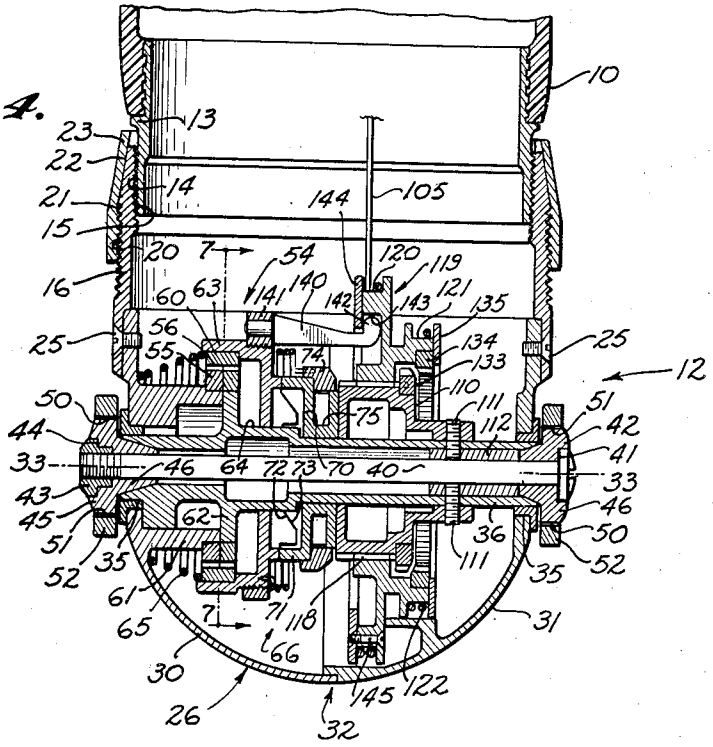
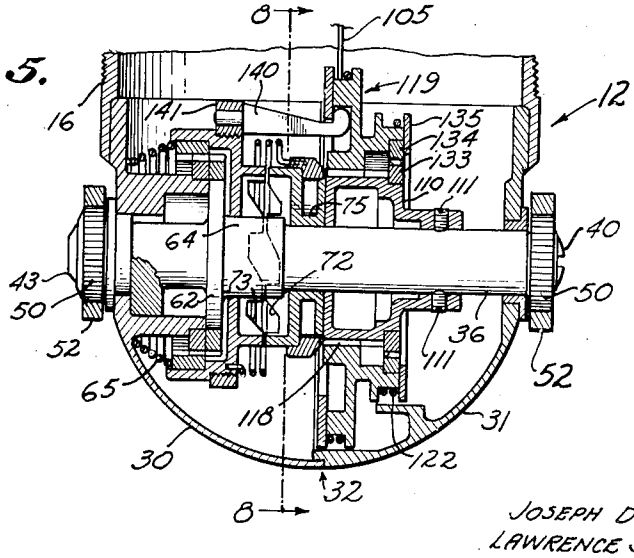


Fig. 5.



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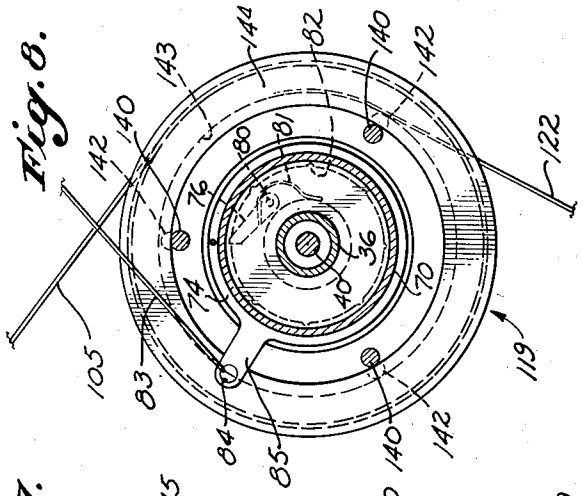


Fig. 8.

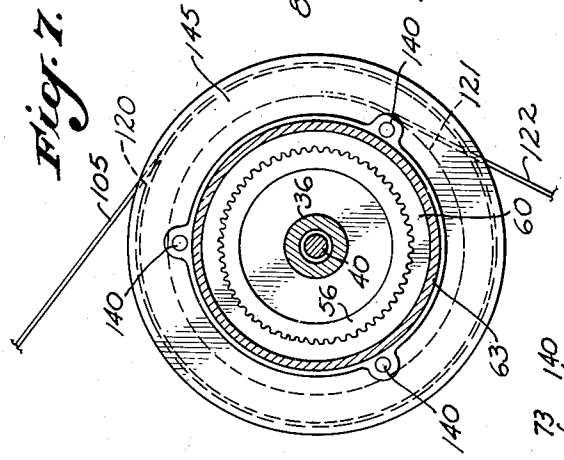


Fig. 7.

Fig. 6.

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UNITED STATES PATENT OFFICE

2,572,914

ARTIFICIAL ARM WITH ELBOW LOCK AND SELECTIVE CONTROL OF FOREARM FLEXION OR HOOK OPERATION

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Application April 17, 1950, Serial No. 156,358

12 Claims. (Cl. 3—12)

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The present invention relates to artificial limbs, and its primary object is to provide means whereby a control force exerted by the amputee can be selectively utilized to perform either of two separate and distinct functions, such as has heretofore required the use of two separate, independent control systems, each of which is actuated by a different muscular effort. The number of body motions that can be utilized to operate a prosthesis is relatively small, and it is this factor, more than anything else, which limits the number of functions that can be duplicated by the prosthesis.

The problem is particularly acute in the case of artificial arms for above-elbow amputations, owing to the number of different functions which must be duplicated if a functional arm of reasonably natural action is to be had, and to the amount of power required by each of the several functions. For example, it is essential that means be provided for raising and lowering the forearm, and also for operating the hook; both of which functions require considerable power, such as can only be exerted by the powerful shoulder, back and chest muscles. Since it is customary to provide an elbow lock in arms of this type, it is also necessary to reserve one of the control motions to actuate the lock, while another control motion may be required to effect pronation-supination movement of the wrist, and still another for flexion and extension of the wrist. Thus, while the principles of the invention are not in any way limited to such use, its advantageous features are utilized to best advantage in the above-elbow arm, and it is another object of the invention, therefore, to provide an artificial arm wherein either one of any two functions of the arm may be actuated at will, independently of the other, by a single control member.

More specifically, another object of the invention is to provide an above-elbow arm wherein the control member can be selectively connected to the forearm to raise and lower the same, or to the hook to operate the same.

A further object is to provide an artificial arm of the class described having an elbow lock, wherein the operative connection of the control member to the forearm is obtained automatically when the elbow lock is unlocked, and connection to the hook is obtained automatically when the elbow is locked; the selective connection being thus effected by actuation of the elbow lock itself.

Another object of the invention is to provide

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an above-elbow arm wherein means is provided for flexing the forearm responsive to application of force by a control member, and embodying means whereby the angular position of the elbow hinge axis can be adjusted about the upper arm centerline, so that the plane of movement of the lower arm can be shifted to secure exact placement of the hook to the mouth or other desired lateral position when the arm is fully flexed.

Another object is to provide an above-elbow arm wherein the elbow housing is shiftable longitudinally with respect to the upper arm, thereby enabling the upper arm to be lengthened or shortened to fit the amputee's requirements.

Still another object of the invention is to provide an above-elbow arm embodying an elbow lock and a selective transfer mechanism of the type described, which is compact, smooth-working and positive in action, and of rugged, trouble-free construction.

These and other objects of the present invention will become apparent to those skilled in the art upon consideration of the following detailed description of the preferred embodiment thereof, reference being had to the accompanying drawings, wherein:

Figure 1 is a front view of an artificial arm embodying the principles of the invention, the arm being shown on the amputee so as to illustrate more clearly the arrangement of the strap in the shoulder harness, and the connection of the control cable therewith;

Figure 2 is a rear view of the same;

Figure 3 is an enlarged, partially cutaway side elevational view of the arm;

Figure 4 is an enlarged cross-sectional view through the elbow housing, taken at 4—4 in Figure 3, showing the elbow in the locked condition, with the control member operatively connected to the hook to operate the same;

Figure 5 is a view similar to Figure 4, showing the elbow in the unlocked condition, with the control member operatively connected to the forearm to raise and lower the same;

Figure 6 is an exploded perspective view of the mechanism contained within the elbow housing;

Figure 7 is a sectional view through the elbow lock, taken at 7—7 in Figure 4; and

Figure 8 is another sectional view through the elbow mechanism, taken at 8—8 in Figure 5.

In the drawings, the artificial arm of my invention is seen to comprise an upper arm portion 10, sometimes referred to as a "stump socket," and a lower arm portion 11 which is

connected thereto for relative swinging movement by an elbow joint 12. The arm portions 10 and 11 may be of any suitable construction, but are preferably formed of laminated, plastic impregnated cotton stockinet, which is pulled over or tightly wrapped around plaster forms, and then cured in an oven. Embedded in and projecting downwardly from the bottom end of the upper arm portion 10 is a metal collar 13, the projecting portion of which is threaded externally at 14 to receive the internal threads 15 of an elbow housing sleeve 16. Sleeve 16 is threaded externally at 20 to receive a clamping ring 21, and the top end of the sleeve is provided with a smooth taper 22 on its outer surface which is engaged by an inwardly tapering annular flange 23 on the ring 21. The sleeve 16 is slit downwardly from its top end at a plurality of angularly spaced points, leaving resilient fingers 24, and when the ring 21 is turned down onto the sleeve 16, the tapering flange 23 acts to squeeze the fingers 24 inwardly, tightly clamping the sleeve to the collar 13.

Inserted up into the bottom end of the sleeve 16 and secured thereto by screws 25 is an elbow housing 26. The housing 26 is preferably formed of two laterally spaced halves 30 and 31, the edges of which abut in a shiplap joint 32, as best shown in Figures 4 and 5. The bottom end of the housing is domed, or spherically rounded, and the pivot axis 33 of swinging movement between the upper and lower arm portions extends transversely through the housing 26 at the center of curvature of the bottom end thereof.

Journaled in bushings 35 which are pressed into holes in the sides of the housing section 30, 31 concentric with the pivot axis 33 is a tubular shaft 36, and extending through the center of this tubular shaft is a tie bolt 40, the head of which is recessed into a socket 41 in the outer face of a serrated plug 42. At the other end of the tie bolt is a nut 43 which is recessed into a socket 44 in a serrated plug 45. Each of the plugs 42, 45 has a tapered nose 46 which seats within a conical seat in the end of the tubular shaft 36. When the nut 43 is drawn up tight on the bolt 40, the tapered nose portions 46 of the two plugs are drawn into the ends of the tubular shaft 36, thereby providing a tight connection between them, without any clearance or looseness.

The outer rim of each of the plugs 42, 45 is provided with serrations 50 which mesh with companionate internal serrations in holes 51 that are provided in ears 52. The ears 52 are formed integral with and project upwardly from a metal saddle 53 which is embedded in or otherwise suitably attached to the top edge of the forearm portion 11. The serrations 50 provide a non-rotatable connection between the plugs 42, 45 and the saddle 53, and from this it will be seen that the tubular shaft 36 is rigidly secured to the forearm portion 11 and is constrained to rotate therewith.

Contained within the housing 26 is an elbow lock 54, the purpose of which is to lock the forearm in any desired position so that the arm may be held in the said position without further effort on the part of the amputee. The lock is comprised of a stationary member 55 which is rigidly fixed to the housing 26, and thus to the upper arm 10; a rotatable member 56 which is fixed to the tubular shaft 36, and thus is rigidly attached to the lower arm 11; and an axially slidable member 60 which is movable between a locked position, in engagement with both of the members 55, 56, as shown in Figure 4, and an unlocked position, in mesh with only the stationary member 55, as in Figure 5. Both the stationary member 55 and the rotatable member 56 are preferably in the form of spur toothed ring gears of the same pitch diameter and same number of teeth, while the slidable member 60 is conveniently formed of an internal ring gear to mesh with the gears 55, 56. The stationary locking gear 55 is pressed onto an annular seat at the inner end of a cylindrical boss 61 which projects laterally inward toward the center of the housing from the left hand section 30. The rotatable locking gear 56 is pressed onto the outer periphery of a radial flange 62 formed integral with the tubular shaft 36, and the slidable locking gear 60 is pressed into a seat on the inside of a drum-shaped housing 63.

The housing 63 is slidably mounted on a slightly enlarged peripheral portion 64 of the tubular shaft 36, but is constrained against rotation, of course, by the engagement of the teeth on the internal ring gear 60 with the teeth of the stationary locking gear 55. A conical spring 65 presses against the housing 63 and sliding gear member 60, urging them to the right, as viewed in Figures 4 and 5, into the locked position of Figure 4.

To release the elbow lock 54, means is provided for shifting the housing 63 and member 60 to the left, against the pressure of spring 65. The preferred lock-actuating mechanism is a cam device, designated in its entirety by the reference numeral 66, and consisting of a rotatable member 70 which is journaled on the tubular shaft 36. Projecting axially from the lefthand side of the member 70 is an annular flange 71 having a plurality of equi-distant, angularly spaced, saw-toothed cam faces 72 provided thereon. Each of the cam faces has an inclined slope at one side, and a relatively straight drop at the other, with a flat crest at the top. These cam faces 72 abut against and cooperate with a companionate ring of cam faces 73 which project outwardly from the adjacent face of the housing 63, and when the member 70 is rotated in the direction wherein the inclined slope of each cam face leaves the straight drop, the inclined slope of the cam faces 72 ride up on the inclined slopes of the cam faces 73, pushing the housing 63 to the left, until the flat crests of the cams 72 stand on top of the crests of cam 73. This is the unlocked condition shown in Figure 5. Continued rotation of member 70 carries the crests of cam 72 beyond the crests of cam 73, and the relatively straight drop in the cam surfaces then allows the spring 65 to snap the housing 63 back to the locked condition.

The cam member 70 is advanced in the proper direction by equal angular increments each time the elbow lock is to be locked or unlocked, and to this end, a ring 74 is journaled on the member 70, said ring being positioned over a circumferential groove 75 in member 70. A finger 76 is disposed down in the groove 75 and is pivotally supported on a pin 80, the free end of the finger 76 being urged outwardly by a small leaf spring 81, so that it is engageable in one of a plurality of transverse grooves 82 on the inside surface of the ring 74. When the finger 76 is thus engaged in one of the grooves 82, as shown in Figure 8, the ring 74 is enabled to drive the cam member 70 in the clockwise direction. Counterclockwise rotation of the ring 74, however, merely causes the finger 76 to ratchet over the grooves 82, and the finger 76 is therefore nothing

more than a uni-directional driving connection between the ring 74 and cam member 70.

The ring 74 is pulled around in the clockwise direction by means of a pull cord 83 which is attached at 84 to a lever arm 85 projecting radially outward from the ring 74. The pull cord 83 is preferably a stainless steel Bowden cable wire which extends upwardly into the upper arm 10 through the usual spring-wound conduit. The Bowden cable wire 83 exits from the upper arm portion 10 through a small hole 86 in the front side thereof, and is attached by a fitting 90 to a strap 91 that is attached to the shoulder harness 92.

The harness 92 is more or less conventional and comprises a shoulder strap 93 extending across the top of the shoulder to which the prosthesis is attached, the said strap passing through a D-ring 94 on the front side of the shoulder, from which the strap passes rearwardly over the shoulder and diagonally down across the back, as strap 95, to the armpit at the opposite side of the body. At this point, the end of strap 95 is attached to a shoulder loop 98. The back end of shoulder strap 93 is attached to the end of another strap 100, and the latter passes diagonally upward across the back to a point of attachment with shoulder loop 96, at the top of the shoulder. Strap 100 is also attached to strap 95 with a cross in back.

The artificial arm is suspended from the harness 92 by means of a strap 101 which is attached at 102 to the back side of shoulder strap 93. Strap 101 passes loosely around the outside of the upper arm portion 10, through D-ring 103, and then up across the shoulder to D-ring 94, and thence down through another D-ring 104 on the inside of the upper arm portion 10. From D-ring 104, the strap 101 extends upwardly to the junction of straps 100 and 93, where it is joined to the others. This arrangement provides support for the artificial arm, while at the same time affording ample freedom of movement by virtue of the free sliding movement of the strap 101 through the D-rings 103, 94, and 104. Before leaving the harness 92, it might be well to point out one more important features, namely, the attachment of a control cable 105 to the junction of straps 100 and 93 at the back of the shoulder to which the prosthesis is fitted. Control cable 105 is likewise a Bowden cable wire, and passes downwardly through the upper arm portion 10 to the elbow housing 26, where its function will presently be described.

Returning now to the elbow housing 26, we provide a hub 110 which is fixedly mounted on the tubular shaft 36 by means of set screws 111. The set screws 111 pass through holes in the tubular shaft 36 and in a tubular plug 112 contained within the shaft at that end thereof, the said set screws being screwed up tightly against the tie bolt 40. Tongues 113 projecting from the end of the tubular plug 112 seat in grooves 114 in the tapered nose 46 of plug 42, thereby providing a key connection between the plug 112 and plug 42. In this way, the hub 110 is solidly connected to the forearm 11, permitting the latter to be raised by application of torque to the tubular shaft 36.

Journaled on the peripheral portion 118 of hub 110 is a dual pulley 119, the said pulley having two cord channels 120 and 121. Channel 120 is larger in diameter than channel 121 and cable 105 is laid therein, the extremity of cable 105 being attached in any suitable manner to the pulley 119. Thus, a pull exerted on control cable 105 causes the pulley 119 to rotate in a counterclockwise direction, as viewed in Figures 7 and 8.

The smaller channel 121 of pulley 119 has another tension transmitting control cord 122 attached thereto, the cord 122 leaving the channel 121 and passing out of the housing 26 through a slot 123. Outside of the housing 26, the cable 122 passes under a roller 124 in the lower arm portion 11 and then exits through the front side of the arm. At its outer extremity, the cord 122 is attached to the operating lever 125 of a pivoted hook 126, the latter cooperating with a stationary hook 127 to form the well known utility hook of the open-and-close type. The pivoted hook 126 swings about the pin 130 as a center, and rubber bands 131 provide tension for holding the hook in normally closed position. This type of hook is known as a "voluntary opening" hook because of the fact that the effort exerted by the amputee merely opens the hook, and closing is done by the rubber bands 131. The invention is not limited in any way to this particular type of hook, however, as it will work equally well with a "voluntary closing" type of hook. It will also be understood that the word "hook" as used in the claims is merely a generic expression which also includes any functional hand of the type having fingers that close, inasmuch as the two are full equivalents of one another.

The hook 126, 127 is mounted on the distal end of the forearm 11 and is attached thereto by means of a wrist plate 132 which is preferably embedded firmly in the plastic material at the time of forming and curing. The hook may be screwed into the wrist plate 132 or secured thereto in any other well known conventional manner.

In order that the pulley 119 may be made to raise and lower the forearm 11, means must be provided for rigidly interlocking the pulley with the hub member 110, and to this end two cooperating locking members 133 and 134 are provided which interlock when the pulley is at the left-hand extremity of its axial sliding movement. The locking member 133 is the stationary element, and is preferably in the form of a spur-toothed ring gear which is pressed into a recessed annular seat at the righthand end of the peripheral portion 118 of hub member 110. The ring gear 133 may also be pinned or otherwise secured against rotation on the member 110, if necessary.

The locking member 134 is likewise preferably in the form of a ring gear, but in this instance, the gear is an internal gear, with the teeth extending inwardly toward the center. The two ring gears 133, 134 are of the same pitch diameter and the same number of teeth, and therefore mesh freely when the pulley 119 is shifted axially to the left. When they are thus intermeshed, the pulley 119 is, of course, held against rotation relative to the tubular shaft 36, and therefore a pull exerted on the control cable 105 rotates the pulley and the forearm together, thereby raising the forearm. A flat ring 135 is secured to the righthand end of the pulley member 119, confining the ring gear 134 to its seat and forming a radial flange defining the right-hand side of the cord channel 121.

The pulley 119 is shifted axially with the elbow lock housing 63 between locked and unlocked positions, by means of three fingers 140 which are attached equi-distantly to a ring 141 and extend axially from the righthand face thereof. The outer ends of the fingers 140 are bent radially outward at 142 and are slidably received within an inwardly facing circular groove 143 in the pulley member 119. For ease of construction and assembly, the lefthand flanges of

the groove 143 and cord channel 120 may be formed by a flat, circular ring 144, which is secured by screws 145 to the lefthand end of the pulley member 119, as shown in Figure 4. The ring 141 is threaded internally, and is screwed onto an externally threaded portion of the elbow lock housing 63. By virtue of this arrangement, the pulley 119 is tied to the axially slidable housing 63, and is therefore constrained to move therewith. Since the outwardly bent ends 142 of the fingers 140 are merely slidable within the groove 143, there is no interference with rotation of the pulley 119, and the latter is therefore free to turn on the hub 110 when the locking members 133, 134 are not interlocked.

When the amputee wishes to raise the forearm 11, he has only to release the elbow lock 54. This is accomplished by a downward shrug of the shoulder to which the prosthesis is attached, the effect of such a shrug being to exert a pull on the control cable 83. A pull on cable 83 causes the ring 74 to rotate in a clockwise direction, as viewed in Figure 8, thereby engaging the finger 76 and driving the cam member 70 in the same direction. As the cam member revolves, the inclined faces 73 ride up the inclined faces 72, thereby shifting the elbow lock housing 63 to the left and sliding the ring gear 60 out of engagement with the locking gear 56. At the same time, the fingers 140 shift the pulley 119 to the left the same distance, thereby meshing the internal ring gear 134 with the external ring gear 133. When the elbow is unlocked, the parts are in the position shown in Figure 5, and a pull on cable 105 rotates the pulley 119, thereby raising the forearm 11.

To lock the elbow and operate the hook, the amputee has only to shrug the shoulder downwardly again, applying another pull on cable 83 which drives the cam member 70 through another angular increment and in the same direction as to unlock the elbow. In this instance, however, the further rotation of cam member 70 causes the cam faces 73 to be forced into full seating engagement with the cam faces 72 by axial pressure from conical spring 65, thereby shifting the housing back to the right, and restoring the parts to the position shown in Figure 4. In so doing, the pulley 119 is shifted to the right by fingers 140, disengaging the ring gear 134 from ring gear 133 and releasing the pulley member for free rotation on the hub 110. A pull on the cable 105 now causes the pulley 119 to rotate with respect to the forearm 11, which winds up cable 122 on the cord channel 121 and thereby pulls the hook 126 open against the resistance of the rubber band 131. The control member 105 may be pulled either by a forward shrug of the opposite shoulder, or by swinging the stump forwardly, which has the effect of lengthening the distance between the end of the Bowden cable conduit and the point of attachment of the cable to the harness.

The connection of the elbow housing 26 to the upper arm 10 by means of the threaded collar 13, split sleeve 16, and clamping ring 21 has three distinct advantages. First, it permits angular adjustment of the elbow hinge axis about the longitudinal centerline of the upper arm, whereby the plane of movement of the lower arm can be shifted to secure exact placement of the hook to the mouth or other desired lateral position when the arm is fully flexed. This is accomplished by merely loosening the ring 21 and turning the elbow housing 26 on the threaded collar 13 until

the hinge axis is positioned to secure the desired path of movement of the hook. The unilateral amputee may make this adjustment when fully clothed, and without removing the prosthesis.

The second advantage is that the elbow housing 26 can be screwed up or down the threads of collar 13 of the upper arm to lengthen or shorten the prosthesis to fit the amputee's requirements; and the third advantage is that the upper arm 10 can be quickly and easily detached from the elbow unit without the use of tools.

While we have shown and described in considerable detail what we believe to be the preferred form of the invention, it is to be understood that such details are not restrictive, and that various changes may be made in the shape and arrangement of the several parts without departing from the broad scope of the invention, as defined in the appended claims

We claim:

1. In an artificial arm having upper and lower arm portions connected together by an elbow joint for relative swinging movement about a pivot axis, an elbow lock comprising cooperating means attached to said upper and lower arm portions, respectively, adjacent said pivot axis for locking said arm portions against relative movement, and a hook of the open-and-close type mounted on the distal end of said lower arm portion, the combination of a pulley wheel journaled for rotation about the pivot axis of said elbow joint, a control member connected to said pulley wheel to rotate the same, a force-transmitting member connecting said pulley wheel to said hook to operate the same when said elbow is locked and said pulley wheel is rotated with respect to said lower arm, and cooperating means attached to said pulley and to said lower arm portions, respectively, adjacent said pivot axis for locking said pulley wheel against rotation with respect to said lower arm portion when said elbow is unlocked, whereby a force applied by said control member causes said lower arm portion to be raised.

2. In an artificial arm, upper and lower arm portions connected together for relative swinging movement by an elbow joint, said elbow joint including a housing mounted on said upper arm portion, a shaft fixed to said lower arm portion and journaled in said elbow housing, a pulley wheel journaled for rotation about said shaft and movable axially with respect thereto between two positions, a tension-transmitting control cord connected to said pulley wheel to rotate the same, a hook of the open-and-close type mounted on the distal end of said lower arm portion and operatively connected to said pulley wheel, cooperating means on said shaft and on said pulley for locking the latter to said shaft when the pulley is in one of its two positions, and cooperating means on said shaft and on said elbow housing for locking said shaft against rotation with respect to said housing when the pulley is in the other of its two positions, said pulley wheel being operable, when in said one position, to raise said lower arm portion responsive to a pull exerted by said control cord, and when in said other position, to operate said hook responsive to a pull exerted by said control cord.

3. In an artificial arm, upper and lower arm portions connected together for relative swinging movement by an elbow joint, said elbow joint including a housing mounted on said upper arm portion, a shaft fixed to said lower arm portion and journaled in said elbow housing, a pulley

wheel journaled for rotation about said shaft and movable axially with respect thereto between two positions, a tension-transmitting control cord connected to said pulley wheel to rotate the same, a hook of the open-and-close type mounted on the distal end of said lower arm portion and operatively connected to said pulley wheel, cooperating means on said shaft and on said pulley for locking the latter to said shaft when the pulley is in one of its two positions, cooperating means on said shaft and on said elbow housing for locking said shaft against rotation with respect to said housing when the pulley is in the other of its two positions, said pulley wheel being operable, when in said one position, to raise said lower arm portion responsive to a pull exerted by said control cord, and when in said other position, to operate said hook responsive to a pull exerted by said control cord, another pull cord controlled by movement of the amputee, and cooperating rotary cam means operatively connected to said last-named pull cord to be rotated thereby through a predetermined angular increment each time the cord is pulled, said cam means being associated with said pulley wheel and operable to shift the latter alternately from one of its positions to the other each time the cam is rotated through one of said angular increments, whereby said control cord can be connected optionally to either said lower arm portion to raise the same, or to said hook to operate the same.

4. In an artificial arm, upper and lower arm portions connected together for relative swinging movement by an elbow joint, said elbow joint including a housing mounted on said upper arm portion, a shaft fixed to said lower arm portion and journaled in said elbow housing, a pulley wheel journaled for rotation about said shaft and movable axailly with respect thereto between two positions, a tension-transmitting control cord connected to said pulley wheel to rotate the same, a hook of the open-and-close type mounted on the distal end of said lower arm portion and operatively connected to said pulley wheel, an elbow lock comprising a pair of companionate members arranged side-by-side, concentric with said shaft, one of said members being fixed to said housing and the other being fixed to said shaft, a third member movable axially between a locked position in engagement with both of said pairs of members and an unlocked position in engagement with only one of them, said third member being connected to said pulley, whereby the latter is shifted axially therewith, cooperating means on said shaft and on said pulley for locking the latter to the shaft when said pulley and said third member are in the position to unlock said elbow, said pulley wheel being operable to raise said lower arm portion when in one axial position or to operate said hook, when in the other axial position, and cooperating cam means associated with said third member and operable to shift the same from one to the other of its two positions.

5. In an artificial arm having upper and lower arm portions connected together for relative swinging movement by an elbow joint, and a hook of the open-and-close type mounted on the distal end of said lower arm portion, the combination of a rotatable and axially slidable pulley wheel disposed coaxial with the pivot axis of said elbow joint, a control member connected to said pulley wheel to rotate the same, a tension-transmitting pull cord connecting said pulley wheel

to said hook to operate the same when said pulley wheel is rotated relative to said lower arm portion, an elbow lock comprising a pair of cooperating members arranged side by side on said pivot axis, one of said members being attached to said lower arm portion to rotate therewith, the other member being non-rotatably attached to said upper arm portion, said other member being slidable axially along said pivot axis between a locked position in engagement with said one member, and an unlocked position disengaged therefrom, a cam journaled on said pivot axis and engageable with said slidable other member to shift the same between said locked and unlocked positions, and to shift said pulley wheel axially therewith, and cooperating means on said pulley and on said lower arm portion for locking said pulley wheel to said lower arm portion when said slidable member is in said unlocked position, or for releasing said pulley wheel to rotate when said slidable member is in said locked position, whereby said elbow can be locked and said hook operated by said control member, or said elbow can be unlocked and said lower arm raised by said control member.

6. In an artificial arm having upper and lower arm portions connected together for relative swinging movement about a pivot axis, and a hook of the open-and-close type mounted on the distal end of said lower arm portion, the combination of a rotatable and axially slidable pulley wheel disposed coaxial with said pivot axis, a control member connected to said pulley wheel to rotate the same, a tension-transmitting pull cord connecting said pulley wheel to said hook to operate the same when said pulley wheel is rotated relative to said lower arm portion, an elbow lock comprising a pair of cooperating members arranged side by side on said pivot axis, one of said member being attached to said lower arm portion to rotate therewith, and the other member being non-rotatably attached to said upper arm portion, said other member being slidable axially along said pivot axis between a locked position in engagement with said one member, and an unlocked position disengaged therefrom, said slidable other member being connected to said pulley, whereby the latter is shifted axially therewith, a rotatable cam journaled on said pivot axis and engageable with said slidable other member to shift the same alternately from one to the other of its locked and unlocked positions as the cam is rotated through equal angular increments in one direction, a rotatable member coaxial with said cam and engageable therewith to advance the cam in said one direction by said angular increments when said member is successively oscillated, a pull cord connected to said rotatable member to oscillate the same, and cooperating means on said pulley wheel and on said lower arm portion for locking said pulley wheel to said lower arm portion when said slidable member is in said unlocked position, or for releasing said pulley wheel to rotate when said slidable member is in said locked position, whereby said elbow can be locked and said hook operated by said control member, or said elbow can be unlocked and said lower arm raised by said control member.

7. In an artificial arm having upper and lower arm portions connected together for relative swinging movement about a pivot axis, and a hook of the open-and-close type mounted on the distal end of said lower arm portion, the combination of a rotatable and axially slidable pulley

wheel disposed coaxial with said pivot axis, a control member connected to said pulley wheel to rotate the same, a tension-transmitting pull cord connecting said pulley wheel to said hook to operate the same when said pulley wheel is rotated relative to said lower arm portion, an elbow lock comprising a pair of companionate members arranged side-by-side, concentric with said pivot axis, one of said members being fixed to said upper arm portion and the other being fixed to and rotatable with said lower arm portion, a third member movable axially between a locked position in engagement with both of said pairs of members and an unlocked position in engagement with only one of them, a spring urging said third member toward said locked position, means connecting said third member to said pulley, whereby the latter is shifted axially therewith, a rotatable cam coaxial with said pivot axis, said cam having an annular ring of equidistantly spaced, axially projecting cam faces which are engageable with said third member to shift the same to said unlocked position against the pressure of said spring when the cam is in certain angular positions, and to release said third member so that the spring can return the same to said locked position when the cam is in certain other angular positions, said locked and unlocked positions occurring alternately as the cam is rotated through equal angular increments in one direction, a rotatable member coaxial with said cam and engageable therewith to advance the cam in said one direction by said angular increments when said member is successively oscillated, a pull cord connected to said rotatable member to oscillate the same, and cooperating means on said pulley wheel and on said lower arm portion for locking said pulley wheel to said lower arm portion when said third member is in said unlocked position, whereby said elbow can be locked and said hook operated by said control member, or said elbow can be unlocked and said lower arm raised by said control member.

8. The device of claim 7, wherein the means for advancing said cam through one angular increment at a time comprises a rotatable ring concentric with said cam, a spring-pressed finger on said ring engageable with said cam to drive the latter in one direction, a pull cord connected to said ring to rotate the latter in said one direction, and a spring for returning said ring to its initial position when the pull on said cord is relaxed.

9. In an artificial arm of the type comprising upper and lower arm portions which are connected together by an elbow housing and pivot shaft for relative swinging movement, and having a voluntary control hook of the open-and-close type, mounted on the distal end of said lower arm portion, the combination of a tension-transmitting control cord, an elbow lock comprising a pair of cooperating members fixed to said upper and lower arm portions, respectively, adjacent said pivot shaft for locking said arm portions against relative movement, a rotatable actuator journaled on said pivot shaft and shiftable axially thereon between two positions, said actuator being operable to lock said elbow lock and connect said control cord to said hook when in one of said two positions, whereby the hook is operated when a force is applied by said control cord, and to unlock said elbow lock and connect said control cord to said lower arm portion when in the other of said two positions, whereby said lower arm portion is raised when a force is applied by said control cord, a cam journaled on said pivot shaft and engageable with said actuator to shift the same between said two positions, and means providing an adjustable connection between said elbow housing and said upper arm portion, whereby said housing can be turned about the longitudinal axis of said upper arm portion to secure accurate placement of said hook to the mouth or other lateral position when the arm is fully flexed, said last-named means including a threaded collar fixed to the bottom end of said upper arm portion and projecting downwardly therefrom, an upwardly extending sleeve on said housing having threads on its inner and outer surfaces, and having slots cut into the end thereof, said sleeve being screwed onto said collar, a threaded clamping ring screwed onto the outside of said sleeve, and cooperating means on said collar and on said sleeve for constricting the slotted end of the latter, whereby said elbow housing is claimped tightly to said collar.

10. An artificial arm comprising upper and lower arm portions connected together for relative swinging movement about a pivot axis, a hook of the voluntary control type mounted on the distal end of said lower arm portion, an actuator journaled for rotation about said pivot axis and shiftable axially thereon between two operating positions, a pull cord connected to said actuator to rotate the same, means connecting said actuator to said hook to operate the same when said actuator is rotated with respect to said lower arm portion, a pair of cooperating lock members fixed to said upper and lower arm portions, respectively, adjacent said pivot axis, for locking said arm portions against relative movement when said actuator is in one of said positions, said actuator being then free to rotate with respect to said lower arm portion and thereby operate said hook responsive to a pull on said cord, and means on said actuator engageable with companionate means on said lower arm portion when said actuator is in the other of said operating positions, for locking said actuator against rotation relative to the lower arm portion, said lower arm portion being then unlocked and free to swing relative to said upper arm portion responsive to a pull on said cord.

11. An artificial arm comprising upper and lower arm portions connected together for relative swinging movement about a pivot axis, a hook of the voluntary control type mounted on the distal end of said lower arm portion, an actuator journaled for rotation about said pivot axis and shiftable axially thereon between two operating positions, a pull cord connected to said actuator to rotate the same, means connecting said actuator to said hook to operate the same when said actuator is rotated with respect to said lower arm portion, a pair of cooperating elbow locking members fixed to said upper and lower arm portions, respectively, adjacent said pivot axis, means shiftable by the axial movement of said actuator for interlocking said elbow locking members, so as to prevent relative movement between said upper and lower arm portions when said actuator is in one of said positions, said actuator being then free to rotate with respect to said lower arm portion and thereby operate said hook responsive to a pull on said cord, and means on said actuator engageable with companionate means on said lower arm portion when said actuator is in the other of said operating positions, for locking said actuator against rotation relative to the lower arm portion, said lower arm por-

tion being then unlocked and free to swing relative to said upper arm portion responsive to a pull on said cord.

12. An artificial arm comprising upper and lower arm portions connected together for relative swinging movement about a pivot axis, a hook of the voluntary control type mounted on the distal end of said lower arm portion, an actuator journaled for rotation about said pivot axis and shiftable axially thereon between two operating positions, a pull cord connected to said actuator to rotate the same, means connecting said actuator to said hook to operate the same when said actuator is rotated with respect to said lower arm portion, a pair of cooperating elbow locking members fixed to said upper and lower arm portions, respectively, adjacent said pivot axis, means shiftable by the axial movement of said actuator for interlocking said elbow locking members so as to prevent relative movement between said upper and lower arm portions when said actuator is in one of said positions, said actuator being then free to rotate with respect to said lower arm portion and thereby operate said hook responsive to a pull on said cord, means on said actuator engageable with companionate means on said lower arm portion when said actuator is in the other of said operating positions, for locking said actuator against rotation relative to the lower arm portion, said lower arm portion being then unlocked and free to swing relative to said upper arm portion responsive to a pull on said cord, an alternator mechanism associated with said actuator and operable to shift the latter alternately from one of its operating positions to the other each time that the said mechanism is operated, and a control cord connected to said alternator mechanism to operate the same by successive pulls.

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