Feb. 6, 1951 G. M. MOTIS 2,540,374

ARTIFICIAL ARM

Filed Nov. 3, 1947 2 Sheets-Sheet 1

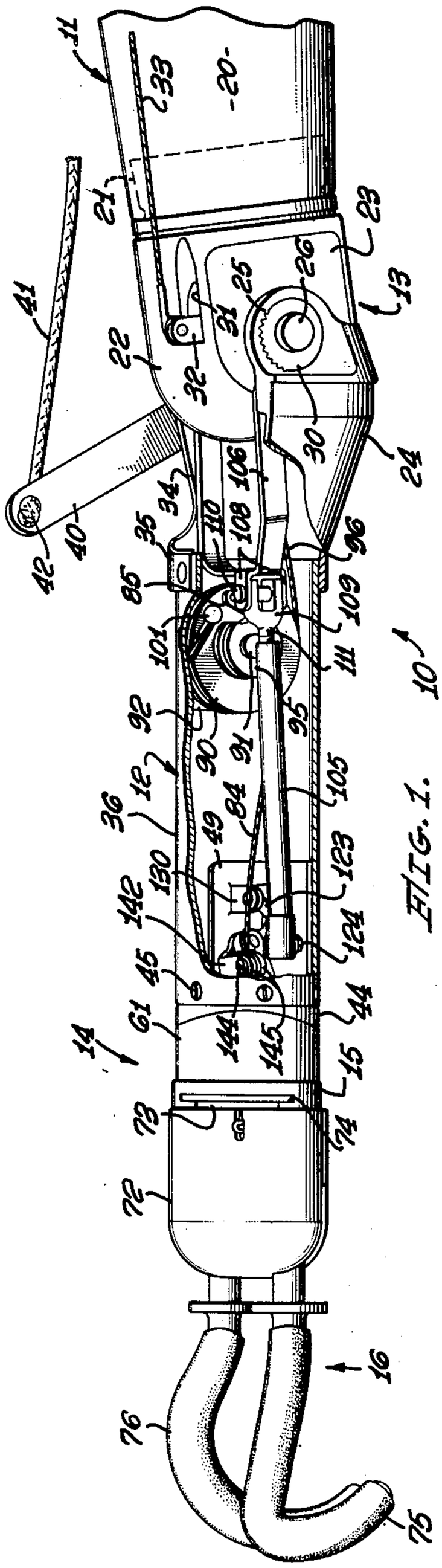

FIG. 1.

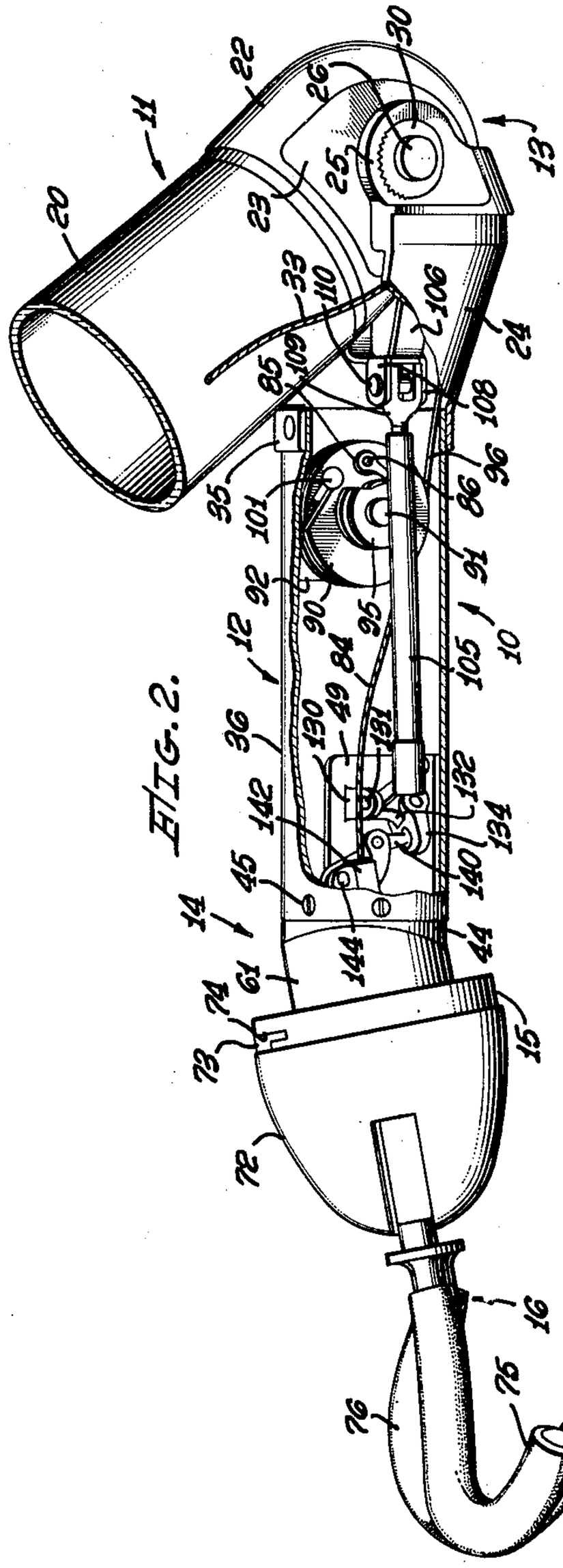

FIG. 2.

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ARTIFICIAL ARM

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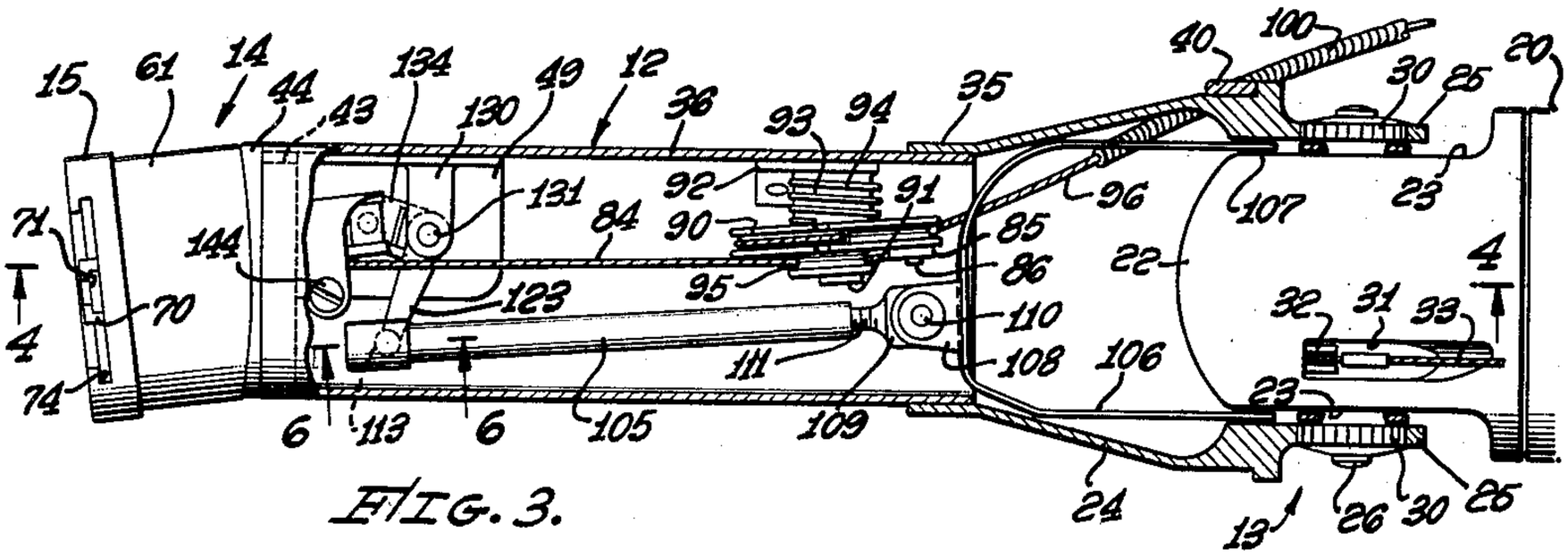

FIG. 3.

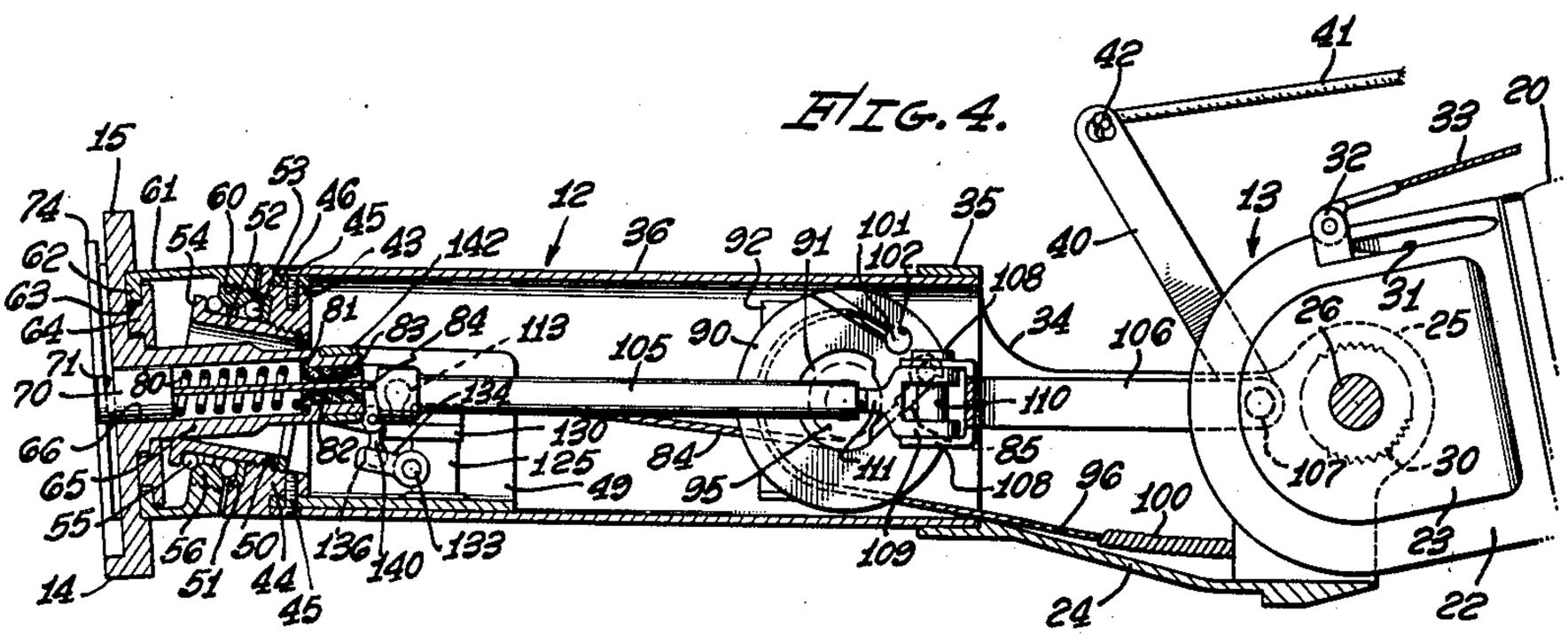

FIG. 4.

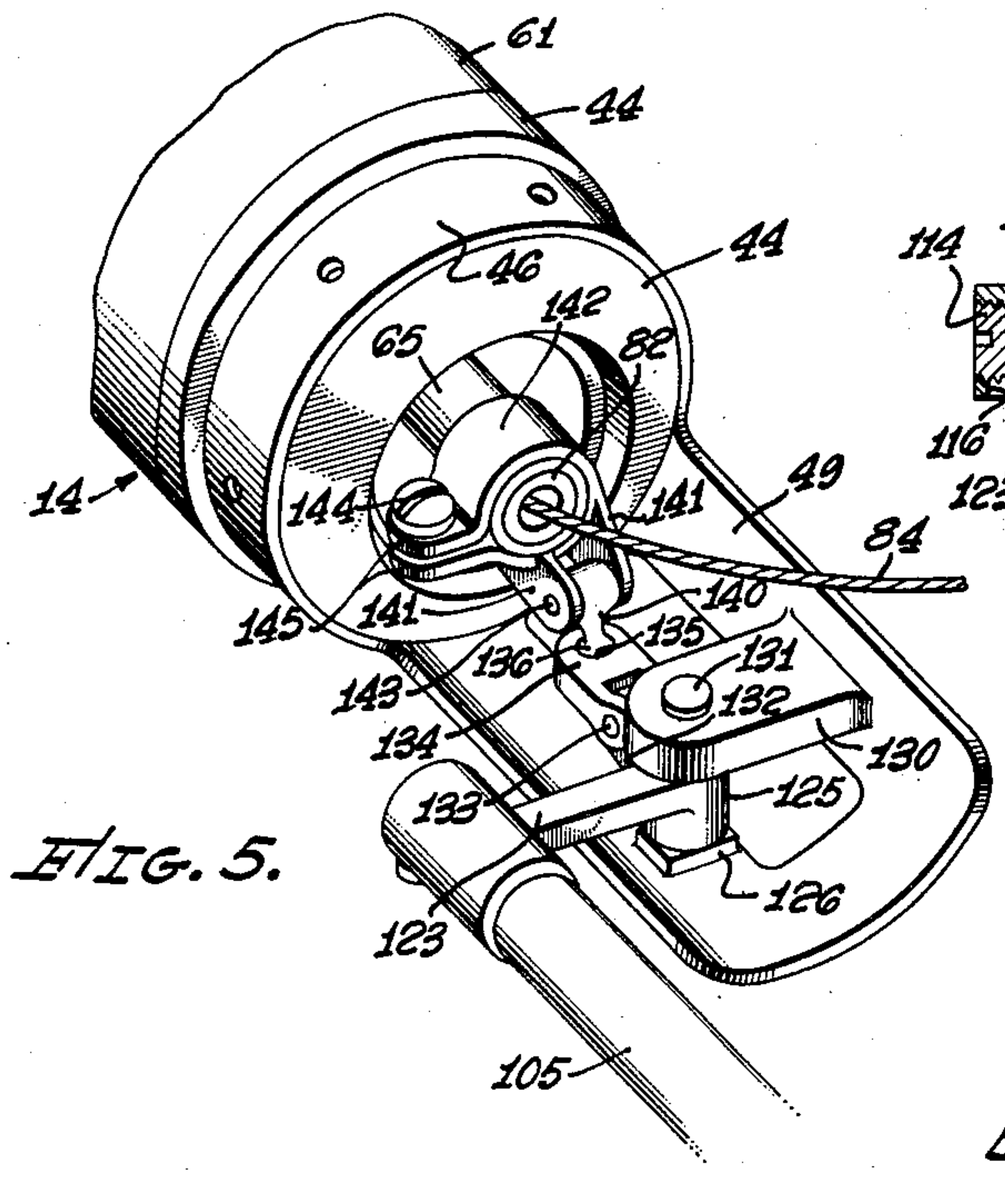

FIG. 5.

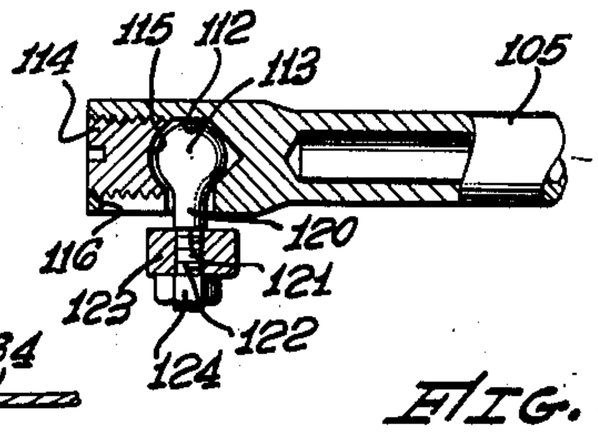

FIG. 6.

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Patented Feb. 6, 1951

2,540,374

UNITED STATES PATENT OFFICE

2,540,374

ARTIFICIAL ARM

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Application November 3, 1947, Serial No. 783,689

10 Claims. (Cl. 3—12)

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The present invention relates to artificial arms, and the primary object of the invention is to provide an arm having a rotatable wrist unit which is coupled to the upper arm component so that when the forearm is raised, the driven member of the wrist unit is automatically turned, and which is constructed and arranged so that such rotation of the driven member causes the hook or hand mounted thereon to move in a manner combining the motions of supination, flexion, and abduction.

The principal purpose for which the invention was developed is to provide improved facility in eating, since the act of raising a fork or spoon from the table to the mouth requires a combination of supination, flexion, and abduction to hold the utensil level and turn the same into the mouth. In all prior arms having rotatable wrist units which are turned by forearm flexion, the only motion provided has been that of supination, which is inadequate for the manipulation of eating utensils, since it necessitates raising the elbow to an awkward level in order to provide the angular adjustment of the hook normally accomplished in the natural hand by abduction of the wrist, and also requires swinging the elbow forwardly in order to provide the angular motion normally accomplished by flexion of the wrist. In certain prior arms, attempts have been made to improve facility in eating by providing for passive or manual flexion adjustment of the wrist, so that the utensil is turned in toward the mouth without having to swing the elbow forwardly. However, practical considerations dictated the location of the flexion axis ahead of the supination axis, and the resulting coupled rotation causes the hook or hand to swing the utensil outwardly in an arcuate path about the supination axis, spilling the food contained therein, unless the elbow is raised simultaneously to hold the utensil in a level position. The reason for this will become immediately apparent when it is considered that a plane passing through the top edge of a spoon held in the hook has a fixed angular relation to the supination axis which, for all practical purposes, may be treated as the forearm axis. Thus, if the forearm axis is horizontal when the spoon is held level at table height, it will also need to be horizontal when the spoon is raised to the mouth, which means that the elbow must be raised to the level of the mouth. This is an awkward position, and is objectionable to the amputee because it calls attention to his handicap.

In the present invention, the axis of rotation of the wrist unit driven member is disposed at

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an angle to the forearm axis so that a spoon held in the hook is maintained level, both at table height when the forearm is substantially horizontal, and when raised to the mouth, with the forearm at a natural angle. In addition to providing improved facility in eating, the present invention enables the amputee to perform other acts such as smoking, shaving, and the like, wherein the hook is raised to face level, with greater ease and a more natural arm motion.

The foregoing and other objects and advantages of the 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, in which:

Figure 1 is a partially cut away perspective view of an artificial arm embodying the principles of the invention, showing the arm in the extended position;

Figure 2 is a similar view of the same, showing the forearm member flexed with respect to the upper arm component;

Figure 3 is a partially cut away top plan view of the arm;

Figure 4 is a vertical section, taken along the line 4—4 in Figure 3;

Figure 5 is an enlarged perspective view of the linkage for turning the wrist unit driven member about its axis of rotation; and

Figure 6 is an enlarged sectional view of a detail of the driving mechanism, taken along the line 6—6 in Figure 3.

In the drawings, the reference numeral 10 designates the artificial arm in its entirety, said arm comprising an upper arm component 11, to which a forearm member 12 is connected by an elbow hinge 13. Mounted on the outer end of the forearm member 12 is a wrist unit 14 having an attach plate 15 which is provided with means for detachably receiving a hook unit 16. In the embodiment illustrated, the upper arm component 11 consists of a stump socket 20 which is preferably made up of laminated plastic-impregnated fabric, formed to receive the stump in a snug-fitting engagement; the lower end of the socket 20 being molded over and bonded to an annular flange 21 projecting rearwardly from a housing 22 forming a part of the elbow hinge unit 13. The elbow unit 13 is the same as that disclosed in the copending application of Meyer Fishbein et al., Serial No. 747,690, filed May 13, 1947, now Patent Number 2,537,338, to which reference may be had for details of construction and operation.

The housing 22 is generally cylindrical in

shape, with a spherically curved outer end portion, and flats 23 at opposite sides thereof. A saddle 24 is mounted on the upper end of the forearm member 12 and has two laterally spaced ears 25 which are disposed to lie against the flats 23. Extending through the housing 22 and journalled in suitable bearings therein, is a hinge pin 26, the ends of which project from the flats 23 and are rigidly connected to the ears 25 by serrated plugs 30. Inside the housing 22 is a locking device (not shown) for locking the forearm member in any one of a large number of closely spaced angular positions relative to the upper arm component 11, and projecting through a slot 31 in the housing is a pivoted elbow lock lever 32 which is operatively connected to the locking device to actuate the same. A control wire 33 is connected to the outer end of the lever 32, and is attached at its upper end to one of the straps of the shoulder harness, so that the locking device can be locked and unlocked by alternate shrugs of the shoulder.

The saddle 24 consists of a conically tapered shell which embraces the bottom half of the housing 22 and is cut out at 34 to provide clearance for the housing when the forearm member is flexed, as shown in Figure 2. Below the cut out opening 34 is a cylindrical collar 35 which is inserted over and riveted to the top end of a tube 36 forming the load-carrying structure of the forearm member 12. A forearm lift lever 40 is attached to the outer side of the saddle 24 adjacent the rear end thereof, and projects upwardly and forwardly therefrom. A pull cord 41 is passed through a hole in the outer end of the lift lever 40 and is knotted on the other side at 42 to keep it from pulling through the hole. The cord 41 extends upwardly along the outside of the arm through suitable guide loops, and is attached at its upper end to the shoulder harness, whereby the forearm member can be raised by a shrug of the shoulder.

The outer end of the forearm tube 36 extends over an annular shoulder 43 projecting rearwardly from the back of an end bearing cap member 44, which forms the stationary member of the wrist unit 14, and is secured thereto by a plurality of countersink screws 45. Interposed between the inner surface of the tube 36 and the shoulder 43 is a collar 46 having a cylindrically curved plate 49 projecting axially from a portion of its back edge up into the tube 36. The plate 49 lies against the inner surface of the tube 36 and forms a bell crank hinge bracket which supports certain parts of the driving mechanism, to be described presently.

Extending through the center of the bearing cap 44 at an angle to the axis, or centerline, of the forearm member 12 is an upwardly and inwardly inclined, threaded bore 50. The angle formed by the inclination of the axis of the bore 50 to the forearm centerline may be any angle in the neighborhood of from 10° to 20°, which I have found by experiment to be about the practical limit for most effective operation, although these limits are not to be taken as restrictive, in any sense, since they might be exceeded in either direction without departing from the scope of the invention. I have found, however, that if an angle of less than 10° is used, the amount of flexion and abduction obtained is inadequate for most purposes, while an angle of greater than 20° introduces certain structural difficulties in the design of the wrist unit and driving mechanism therefor. In the preferred

form of the invention, the axis of the bore 50 is also inclined inwardly toward the body to an angle of approximately 45° to a plane passing through the forearm centerline and the axis of the elbow hinge pin 26. Or, expressed in another way, a plane passing through the axis of the bore 50 and the forearm centerline is inclined 45° to the axis of the elbow hinge pin 26. One other important relationship that should be observed is that the inclined axis of the bore 50 is flexed about the flexion-extension axis of the wrist unit, and is abducted about the abduction-adduction axis thereof.

The outer face of the cap 44 is cut off perpendicular to the bore 50, and is counterbored to receive a washer 51 which cooperates with a cylindrical sleeve 52 to form the inner race for a rear row of ball bearings 53. The sleeve 52 is threaded on its rear end and is screwed into the threaded bore 50; the front end of the sleeve projecting forwardly beyond the outer face of the cap 44. A radially outwardly turned flange 54 on the front end of the sleeve 52 cooperates with the cylindrical outer surface thereof to form an inner race for a front row of ball bearings 55. The outer race for both rows of ball bearings 53 and 55 is formed by an annular ring 56 having conical faces on both sides thereof, against which the balls 53 and 55 bear. The ring 56 is threaded on its outer surface and is screwed into a threaded bore 60 formed in the back end of a wrist unit driven member 61.

The bore 60 is concentric with the bore 50 in the cap 44, and therefore bears the same angular relation to the forearm centerline as the latter bore. The rear face of the driven member 61 is cut off perpendicular to the bore 60, and is disposed closely adjacent to the front face of the cap 44. The outer surface of driven member 61 is cylindrical, and the axis thereof is inclined to the axis of the bore 60 at the same angle as that defined between the axis of bore 50 and the forearm centerline. Preferably, although not necessarily, the angular relationship between the axes of the cylindrical outer surface of the driven member 61 and the bore 60 is such that when the forearm is fully extended, the axis of the cylindrical outer surface is substantially parallel to the forearm centerline, and when the forearm is flexed, the driven member 61 is turned by the driving means, which will be described later, so that its axis is inclined to the forearm centerline at an angle somewhat greater than the angle of the bores 50, 60 thereto. The purpose of this arrangement is to increase the amount of flexion and abduction obtained with a given amount of supination, over that which would be obtained solely by virtue of the inclination of the axis of rotation.

At the front end of the wrist unit driven member 61 is an inwardly turned flange 62 which is received within an annular groove 63 formed in the back surface of the attach plate 15. The attach plate is secured to the member 61 by means of a clamping ring 64 having oppositely extending shoulders which engage the inside surface of the flange 62 and the inner margin of the groove 63, respectively; said clamping ring being secured to the attach plate by means of suitable screws (not shown). Formed integrally with the attach plate 15 and projecting rearwardly from the back side thereof through the center of the bearing race sleeve 52 is a tubular extension 65 having a central bore 66 formed therein. A cylindrical coupling member 70 is slidably disposed

within the bore 66, and formed in the outer end thereof is a socket 71 which is adapted to receive a companionate coupling member on the hook unit 16, to provide an operating connection therewith.

The hook unit 16 is adapted to be detachably mounted on the outer face of the attach plate 15, and is provided with a housing 72 having a flanged, vertically extending coupling plate 73 on its back face which is adapted to be inserted down into companionate ways 74 formed in the end of the attach plate 15. A hook control coupling member (not shown) projecting from the back of the plate 73 seats in the socket 71 of the coupling member 70 as the housing 72 approaches full seating engagement with the attach plate 15, and the said coupling members are thereafter connected together and move as one. The coupling member on the unit 16 is operatively connected to a pivoted hook 75, and causes the latter to be closed against a stationary hook 76 when the interconnected coupling members are moved axially toward the right in the bore 66. The mechanism for actuating the pivoted hook 75 forms no part of the present invention, and therefore need not be described in further detail.

The coupling member 70 is urged to the left by a compression spring 80 which is disposed within the bore 66 and bears against a radial flange 81 at the end of a tubular fiber bushing 82. The bushing 82 is pressed into a reduced bore 83 in the end of the tube 65, and the flange 81 abuts against the shoulder formed at the junction of bores 83 and 66.

The coupling member 70 is adapted to be pulled to the right against the pressure of spring 80 to close the movable hook 75 against the stationary hook 76, by means of a control wire 84 which extends through the center of the bushing 82 and spring 80, and into the back end of the member 70, to which it is attached in any suitable manner. The control wire 84 extends up into the forearm tube 36 and has a fitting 85 soldered to its upper end. The fitting 85 is drilled to receive a pin 86 projecting laterally from one side of a cable pulley 90 which is journalled on a shaft 91 extending horizontally from a supporting bracket 92. The bracket 92 is curved to conform to the inside surface of the tube 36 and is attached thereto by screws or other suitable fastening means. A hub 93 projects from the other side of the cable pulley 90 to the bracket 92, and encircling this hub is a torsion spring 94, one end of which is attached to the bracket 92, and the other being attached to the hub 93. Projecting from the inside surface of the pulley 90 and concentric therewith is a smaller pulley 95, around which the wire 84 is trained when the pulley 93, 95 is rotated in a counterclockwise direction. Such counterclockwise rotation of the pulleys causes the wire 84 to be pulled to the right, causing the movable hook 75 to close against the stationary hook 76.

The cable pulley 90 is made to turn in a counterclockwise direction by means of a Bowden cable control wire 96, having a spring wound housing 100 which is threaded through a tapped hole in the outer side wall of the saddle 24 below the hinge pin 26. The upper end of the wire 96 is attached to one of the straps of the shoulder harness in the usual manner, so that when the harnessed shoulder is shrugged forwardly, the wire is pulled through the housing 100. The lower end of the wire 96 enters the groove of the pulley 90 at the bottom thereof and is trained around the pulley in a clockwise direction. A ball fitting 101 is soldered to the end of the wire 96 and is seated in a socket 102 in the pulley 90 to secure the wire thereto. When the control wire 96 is pulled, the pulley 90 is rotated in a counterclockwise direction, causing the wire 84 to be wound up onto the smaller pulley 95. The tensile force in the wire 96 is multiplied in the wire 84 by an amount equal to the ratio of the radius of the large pulley 90 to that of the small pulley 95, with a corresponding reduction in travel of wire 84.

The wrist unit driven member 61 is turned on its axis of rotation by driving means which will now be described. In the embodiment illustrated, the driving means is preferably in the form of a push-pull drive tube 105 which is connected at one end by a system of linkage to the tube 65 on the attach plate 15, and is connected at the other end by a drive yoke 106 to the elbow housing 22 on the upper arm component 11. The yoke 106 is generally U-shaped in plan form, and its ends are connected by pins 107 to the housing 22 at a point spaced outwardly from the hinge pin 26. Projecting forwardly from the bight portion of the yoke 106 to one side of the centerline thereof are two vertically spaced ears 108, and disposed between these ears is a bifurcated end member 109 which is pivotally connected to the ears 108 for horizontal swinging movement by means of a pin 110. Extending forwardly from the member 109 is a threaded stem 111 which is screwed into the end of the tube 105.

The opposite end of the drive tube 105 is solid, as shown in Figure 6, and is drilled axially at 112 to form a socket for a ball member 113. The outer end portion of the hole 112 is screw-threaded to receive a screw plug 114, the inner end of which is formed with a spherical seat 115 which bears against the ball 113. A keyhole slot 116 in the bottom wall of the tube provides an opening through which the ball 113 can be inserted into the socket 112, and through which the shank 120 of the ball member projects. The shank 120 of the ball member is formed with a downwardly facing shoulder 121, and projecting from this shoulder is a threaded stud 122 which extends through a hole in the outer end of a bell crank arm 123. A nut 124 is screwed onto the projecting bottom end of the stud 122, and draws the shoulder 121 tightly against the top of the bell crank arm 123, clamping the ball member rigidly to the arm.

The bell crank arm 123 projects laterally from a hub 125 and moves in a plane substantially parallel to the plane of the forearm centerline and elbow hinge axis. The hub 125 is disposed between a raised boss 126 on the bottom of the plate 49, and a lug 130 projecting laterally inward from the side thereof. A pin 131 extends downwardly through aligned holes in the lug 130, hub 125, and boss 126, providing a pivot support for the bell crank. The other arm of the bell crank is shown at 132 and projects forwardly from the hub 125, being considerably shorter in length than arm 123. Pivotally connected by a horizontal pin 133 to the bell crank arm 132 is a link 134 which functions as a jointed extension to the arm. A socket 135 is formed in the top of the link 134 adjacent the outer end thereof, and confined within this socket is a ball 136 which is formed on the bottom end of an upwardly extending link 140. The upper end of the link 140 is disposed between two laterally

spaced arms 141 projecting rearwardly from a split clamp 142 mounted on the rear end of the tube 65. The link 140 is connected to the arms 141 by a transverse pin 143 which permits swinging movement of the link 140 in a plane parallel to the axis of the tube 65 and offset slightly to one side thereof. The clamp 142 is secured on the tube 65 by means of a screw 144 which extends through aligned holes in two outwardly turned, vertically spaced ears 145, said screw being threaded into the bottom ear so that when the screw is turned down, the ears are drawn together.

The purpose of the several links in the system just described is to provide means for accommodating the different paths taken by pin 133 on the bell crank, and pin 143 on the clamp member 142. Pin 143 travels in a circular path described in a plane perpendicular to the inclined axis of rotation of the wrist unit driven member 61. Pin 133, on the other hand, travels in a circular path described in a substantially horizontal plane, perpendicular to the bell crank pivot pin 131. The pivoted links 134 and 140, and the ball and socket connection 135, 136 accommodate this divergence of paths, and enable the drive tube 105 to rotate the wrist unit driven member 61 about the latter's inclined axis. A driving mechanism constructed as described above is capable of rotating the wrist unit driven member through an angular distance of as much as 90° responsive to an angular movement between the forearm member and upper arm component of approximately 130°.

The manner in which the arm works is believed to be self-evident from the foregoing description. When the forearm member 12 is fully extended, the wrist unit driven member 61 is turned so that the attach plate 15 is substantially perpendicular to the forearm centerline, with the hook unit 16 positioned in its normal relationship to the forearm, as shown in Figure 1. As the forearm is raised in flexion, the driving mechanism acts to turn the driven member 61 about its inclined axis of rotation, so that when the forearm is fully flexed, as in Figure 2, the wrist member 61 and hook unit 16 are turned in a manner combining the motions of supination, flexion, and abduction. This combination of motions enables the amputee to hold a spoon level while raising the same from table level to the mouth, and also turns the spoon inwardly toward the mouth in a natural manner. As the forearm is lowered or extended, the driving mechanism acts to return the hook unit to its initial, or normal position.

While I have shown and described in considerable detail what I believe to be the preferred form of my invention, it is to be understood that such details are merely illustrative, and that various changes may be made in the shape and arrangement of the several parts without departing from the scope of the invention as defined in the appended claims.

I claim:

1. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member mounted for rotation about an axis disposed at an angle of between 10° and 20° to the forearm centerline, an attach plate fixed to said wrist unit driven member and adapted to receive a

hook or hand on the outer face thereof, the plane of said outer face being disposed at the same angle to said axis of rotation as said axis forms with said forearm centerline, said attach plate being positioned so that the plane of said outer face is substantially perpendicular to said forearm centerline when said forearm is fully extended, and means connected to said upper arm component for rotating said wrist unit driven member responsive to flexion of said forearm member with respect to said upper arm component.

2. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member mounted for rotation about an axis disposed at an acute angle to the centerline of said forearm member, said axis being flexed about the flexion-extension axis of said wrist unit, and being abducted about the abduction-adduction axis thereof, an attach plate fixed to said wrist unit driven member and adapted to receive a hook on the outer face thereof, the plane of said outer face being disposed at the same angle to said axis of rotation as said axis forms with said forearm centerline, said attach plate being positioned so that the plane of said outer face is substantially perpendicular to said forearm centerline when said forearm is fully extended, a tube extending rearwardly from the back of said attach plate perpendicular to said outer face, said tube extending through said wrist unit and intersecting said axis of rotation, a hook control coupling device disposed within said tube and having a rearwardly extending force-transmitting member attached thereto, said coupling device being adapted to engage an actuating member on said hook, and means connected to said upper arm component for rotating said wrist unit driven member responsive to flexion of said forearm member with respect to said upper arm component.

3. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member mounted for rotation about an axis disposed at an angle of between 10° and 20° to the forearm centerline and lying in a plane inclined at an angle of approximately 45° to the axis of said elbow hinge, an attach plate fixed to said wrist unit driven member and adapted to receive a hook on the outer face thereof, the plane of said outer face being disposed at the same angle to said axis of rotation as said axis forms with said forearm centerline, said attach plate being positioned so that the plane of said outer face is substantially perpendicular to said forearm centerline when said forearm is fully extended, a tube extending rearwardly from the back of said attach plate perpendicular to said outer face, said tube extending through said wrist unit and intersecting said axis of rotation, a hook control coupling device disposed within said tube and having a rearwardly extending force-transmitting member attached thereto, said coupling device being adapted to engage an actuating member on said hook, and means connected to said upper arm component for rotating said wrist unit driven

member responsive to flexion of said forearm member with respect to said upper arm component.

4. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member mounted for rotation about an axis disposed at an angle of between 10° and 20° to the forearm centerline and lying in a plane inclined at an angle of approximately 45° to the axis of said elbow hinge, an attach plate fixed to said wrist unit driven member and adapted to receive a hook on the outer face thereof, the plane of said outer face being disposed at the same angle to said axis of rotation as said axis forms with said forearm centerline, said attach plate being positioned so that the plane of said outer face is substantially perpendicular to said forearm centerline when said forearm is fully extended, a tube extending rearwardly from the back of said attach plate perpendicular to said outer face, said tube extending through said wrist unit and intersecting said axis of rotation, a hook control coupling device disposed within said tube and having a rearwardly extending force-transmitting member attached thereto, said coupling device being adapted to engage an actuating member on said hook, a driving member mounted for longitudinal movement with respect to said forearm member, said driving member being pivotally connected at one end to said upper arm component at a point spaced from said elbow hinge, and articulated link means connecting the other end of said driving member to said tube, whereby said wrist unit driven member is turned from 60° to 90° responsive to an angular movement between the forearm member and said upper arm component of approximately 130°.

5. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge swingably connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member having attachment means at the outer end thereof to receive a hand or hook, said driven member being mounted on said forearm member for turning movement about an axis inclined at an acute angle relative to the forearm centerline, and means connected to said upper arm component for turning said driven member responsive to flexion of said forearm member with respect to said upper arm component, said hook or hand being mounted on said driven member at an angle to said inclined axis of rotation such that when said forearm member is fully extended, the axis of said hook or hand is substantially parallel to said forearm centerline, the rotation of said driven member about said inclined axis responsive to forearm flexion causing said hook or hand to turn and swing in a movement combining the motions of supination, flexion, and abduction.

6. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge swingably connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member having attachment means at the outer end thereof to receive a hand or hook, said driven member being mounted on said forearm

member for turning movement about an axis inclined at an acute angle relative to the forearm centerline, said axis being abducted about the abduction-adduction axis of said wrist unit and being flexed about the flexion-extension axis thereof, and means connected to said upper arm component for turning said driven member responsive to flexion of said forearm member with respect to said upper arm component, said hook or hand being mounted on said driven member at an angle to said inclined axis of rotation such that when said forearm member is fully extended said hook or hand is in a substantially neutral position about both said flexion-extension and abduction-adduction axes, the rotation of said driven member about said inclined axis responsive to forearm flexion causing said hook or hand to turn and swing in a movement combining the motions of supination, flexion, and abduction.

7. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge swingably connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member having attachment means at the outer end thereof to receive a hand or hook, said driven member being mounted on said forearm member for turning movement about an axis inclined at an acute angle relative to the forearm centerline, said axis lying in a plane inclined at an acute angle to the axis of said elbow hinge, and means connected to said upper arm component for turning said driven member responsive to flexion of said forearm member with respect to said upper arm component, said hook or hand being mounted on said driven member at an angle to said inclined axis of rotation such that when said forearm member is fully extended, said hook or hand is extended about the flexion-extension axis, and is centered between the abducted and adducted positions, the rotation of said driven member about said inclined axis responsive to forearm flexion causing said hook or hand to turn and swing in a movement combining the motions of supination, flexion, and abduction.

8. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge swingably connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member having attachment means at the outer end thereof to receive a hand or hook, said driven member being mounted on said forearm member for turning movement about an axis disposed at an angle of between 10° and 20° to the forearm centerline, said axis being flexed about the flexion-extension axis of said wrist unit and being abducted about the abduction-adduction axis thereof, and means connected to said upper arm component for turning said driven member responsive to flexion of said forearm member with respect to said upper arm component, said hook or hand being mounted on said driven member at an angle to said inclined axis of rotation such that when said forearm member is fully extended, said hook or hand is extended about the flexion-extension axis, and is centered between the abducted and adducted positions, the rotation of said driven member about said inclined axis responsive to forearm flexion causing said hook or hand to turn and swing in a movement combining the motions of supination, flexion, and extension.

9. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge swingably connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member having attachment means at the outer end thereof to receive a hand or hook, said driven member being mounted on said forearm member for turning movement about an axis inclined at an acute angle relative to the forearm centerline, said axis lying in a plane inclined at an angle of approximately 45° to the axis of said elbow hinge and extending in a direction such that said inclined axis is flexed about the flexion-extension axis of said wrist unit and is abducted about the abducton-adduction axis thereof, and means connected to said upper arm component for turning said driven member responsive to flexion of said forearm member with respect to said upper arm component, said hook or hand being mounted on said driven member at an angle to said inclined axis of rotation such that when said forearm member is fully extended, said hook or hand is extended about the flexion-extension axis, and is centered between the abducted and adducted positions, the rotation of said driven member about said inclined axis responsive to forearm flexion causing said hook or hand to turn and swing in a movement combining the motions of supination, flexion, and extension.

10. An artificial arm comprising, in combination, an upper arm component, a forearm member, an elbow hinge swingably connecting said forearm member to said upper arm component, a wrist unit mounted on the outer end of said forearm member, said wrist unit including a driven member having attachment means at the outer end thereof to receive a hand or hook, said driven member being mounted on said forearm member for turning movement about an axis disposed at an angle of between 10° and 20° to the forearm centerline, said axis lying in a plane inclined at an angle of approximately 45° to the

axis of said elbow hinge and extending in a direction such that said axis is flexed about the flexion-extension axis of said wrist unit and is abducted about the abduction-adduction axis thereof, and means connected to said upper arm component for turning said driven member responsive to flexion of said forearm member with respect to said upper arm component, said hook or hand being mounted on said driven member at an angle to said inclined axis of rotation such that when said forearm member is fully extended, said hook or hand is extended about the flexion-extension axis, and is centered between the abducted and adducted positions, the rotation of said driven member about said inclined axis responsive to forearm flexion causing said hook or hand to turn and swing in a movement combining the motions of supination, flexion, and extension.

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