May 22, 1951 H. L. MASON 2,553,827

ARTIFICIAL HAND WITH ARTICULATED FINGERS AND PASSIVELY POSITIONED THUMB

Filed Oct. 27, 1948 4 Sheets-Sheet 1

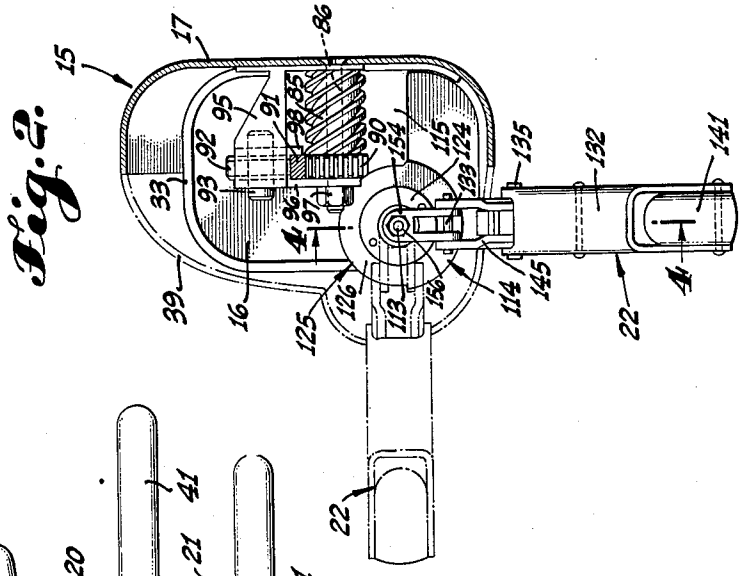


Fig. 2.

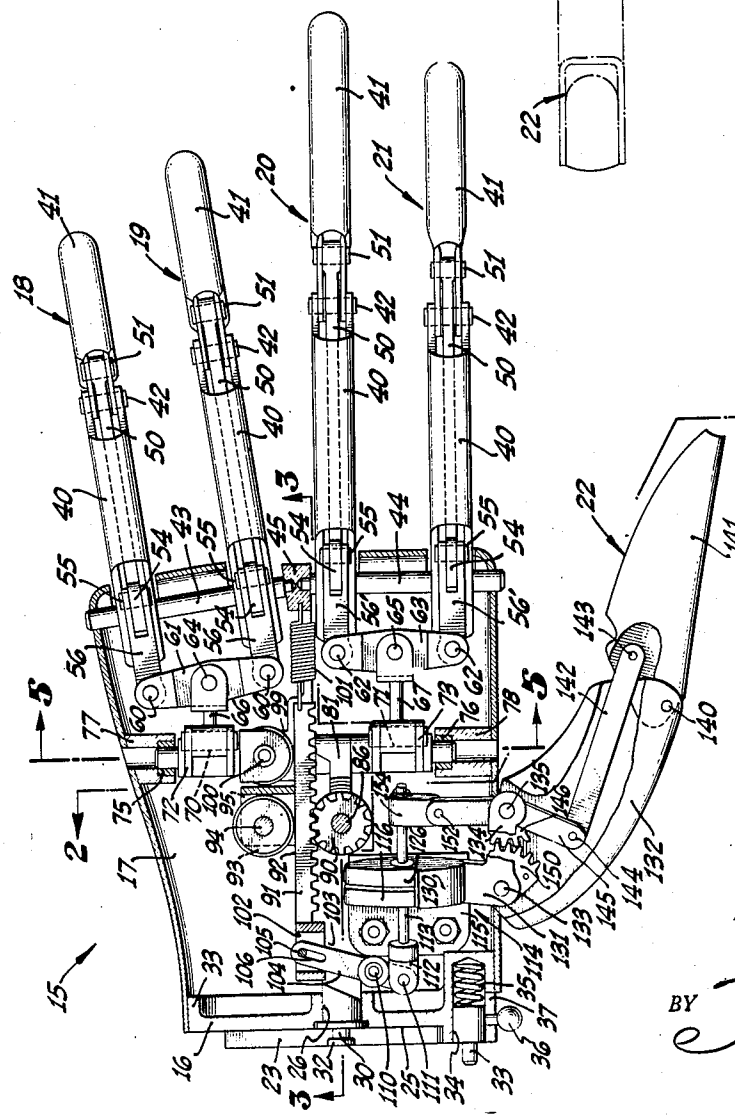


Fig. 1.

HUBERT L. MASON,
INVENTOR.

BY Forrest J. Filley

ATTORNEY.

May 22, 1951 H. L. MASON 2,553,827

ARTIFICIAL HAND WITH ARTICULATED FINGERS AND PASSIVELY POSITIONED THUMB

Filed Oct. 27, 1948 4 Sheets-Sheet 2

Fig. 4.

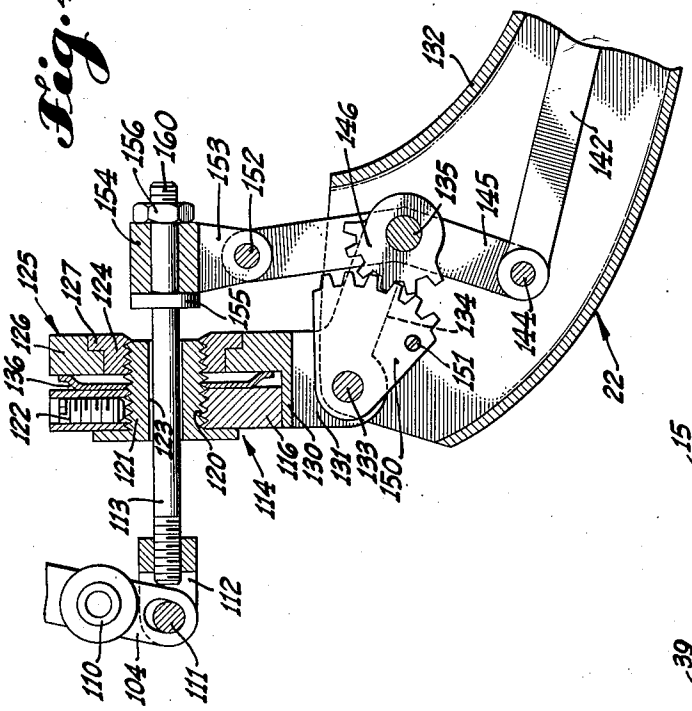


Fig. 5.

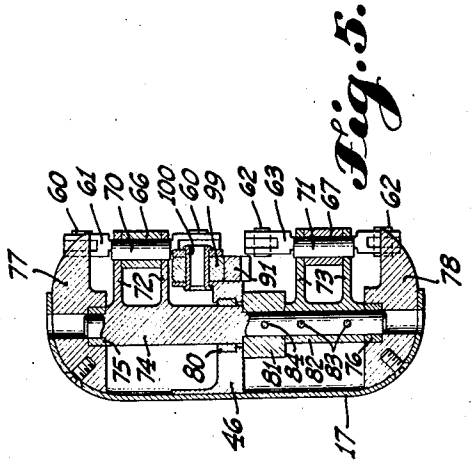
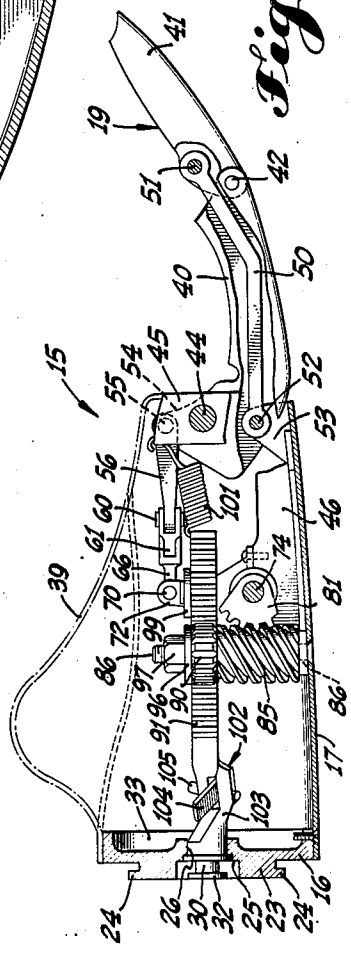


Fig. 3.



HUBERT L. MASON,
INVENTOR.

BY Forrest J. Lilly
ATTORNEY.

May 22, 1951 H. L. MASON 2,553,827

ARTIFICIAL HAND WITH ARTICULATED FINGERS AND PASSIVELY POSITIONED THUMB

Filed Oct. 27, 1948 4 Sheets-Sheet 3

Fig. 7.

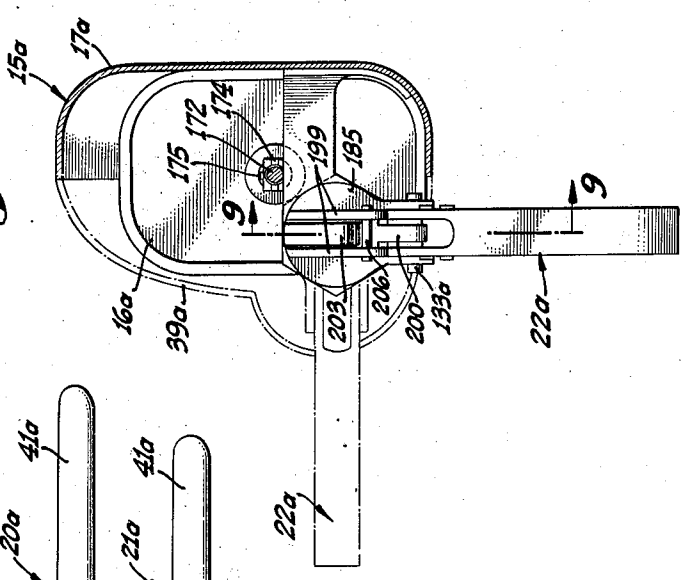
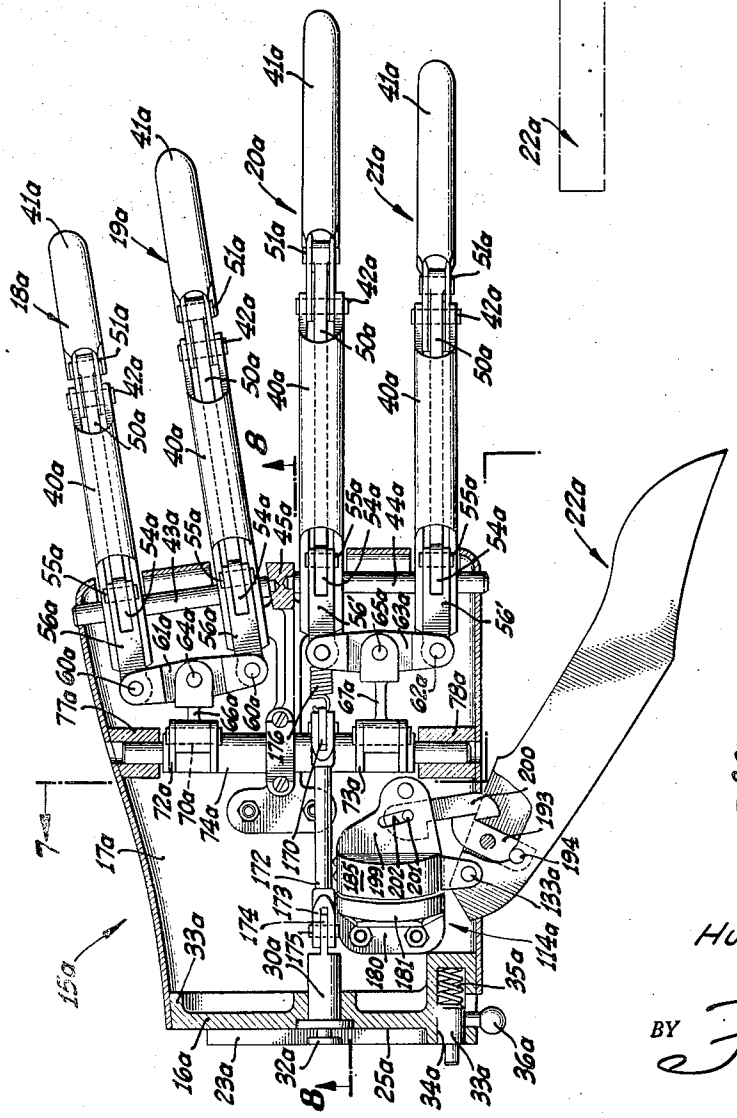


Fig. 6.



HUBERT L. MASON,
INVENTOR.

BY James J. Tilley

ATTORNEY.

May 22, 1951 H. L. MASON 2,553,827

ARTIFICIAL HAND WITH ARTICULATED FINGERS AND PASSIVELY POSITIONED THUMB

Filed Oct. 27, 1948 4 Sheets-Sheet 4

Fig. 9.

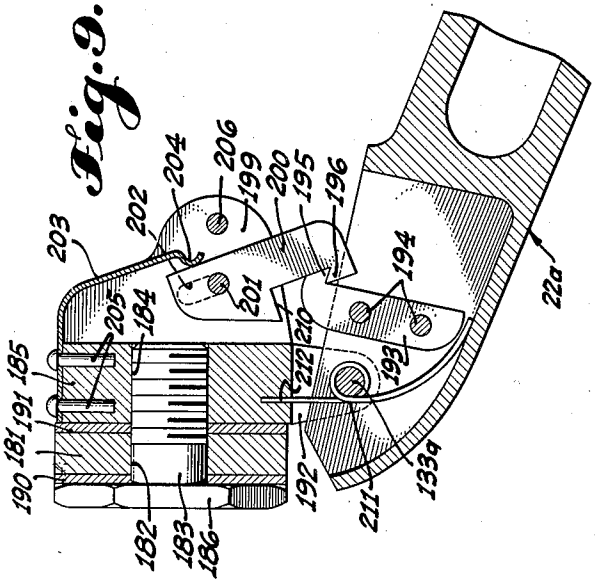


Fig. 10.

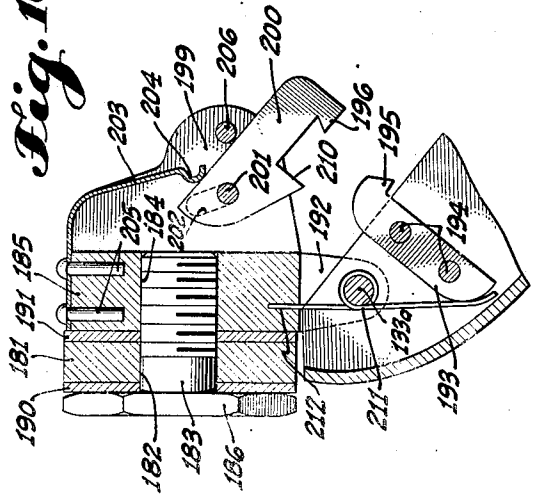
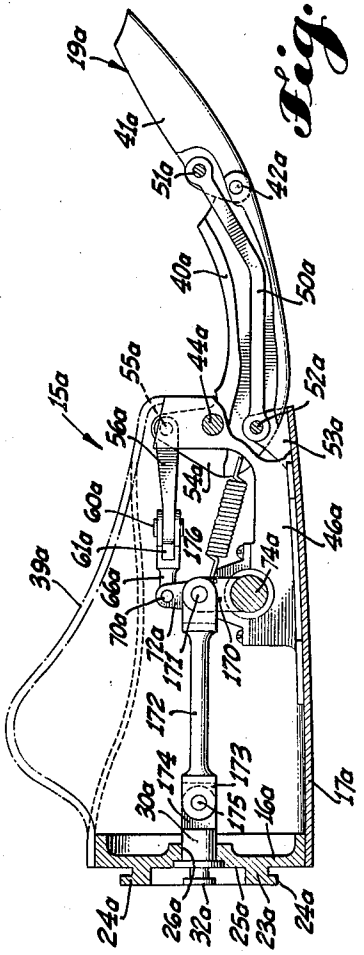


Fig. 8.



HUBERT L. MASON,
INVENTOR.

BY Forrest J. Lilly

ATTORNEY.

Patented May 22, 1951 2,553,827

UNITED STATES PATENT OFFICE

2,553,827

ARTIFICIAL HAND WITH ARTICULATED FINGERS AND PASSIVELY POSITIONED THUMB

Hubert L. Mason, Long Beach, Calif., assignor to Northrop Aircraft, Inc., Hawthorne, Calif., a corporation of California

Application October 27, 1948, Serial No. 56,866

4 Claims. (Cl. 3—12)

1

The present invention relates to artificial hands, and one of its general objects is to provide a new and improved hand capable of grasping and holding articles of all shapes and sizes in a manner realistically duplicating the prehension of the natural hand. A more specific object is to provide an artificial hand having articulated fingers which may be closed with an equalized force about an irregular object, together with an articulated thumb which is mechanically linked to the fingers so as to close therewith.

Another important object of the invention is to provide an artificial hand having a thumb which is pivoted for passive rotation between the adducted and abducted positions, and which is adapted to be yieldingly held in any adjusted position about its pivot axis. In this same connection, one of the features of the invention resides in the provision of a pivoted thumb which is also articulated for flexion and extension, and which is connected to the finger-closing mechanism by a novel system of linkage, whereby the thumb can be flexed and extended at any position about its adduction-abduction axis.

A further object of the invention, in one of its aspects, is the provision of a novel latch for securing the thumb in the flexed position, which is releasable by striking the back of the thumb lightly against the body or against any stationary object such as a table, chair, or the like. The advantage of this arrangement is that it enables the amputee to change the position of the thumb without requiring the use of the other hand, which is particularly desirable in the case of bilateral amputations.

The foregoing and other objects and advantages of the present invention will become apparent to those skilled in the art upon consideration of the following detailed description of two illustrative embodiments thereof, reference being had to the accompanying drawings, wherein:

Figure 1 is a partially sectioned top plan view of the preferred form of the invention, the palmar cover plate of which has been removed to show the finger and thumb actuating mechanism;

Figure 2 is a sectional view of the same, taken along the line 2—2 in Figure 1;

Figure 3 is another sectional view through the hand, taken along the line 3—3 in Figure 1;

Figure 4 is an enlarged sectional view of the mechanism at the base of the thumb, taken at 4—4 in Figure 2;

Figure 5 is a sectional view, taken along the line 5—5 in Figure 1;

2

Figure 6 is a partially sectioned top plan view of another embodiment of the invention;

Figure 7 is a transverse sectional view through the same, taken at 7—7 in Figure 6;

Figure 8 is a sectional view taken at 8—8 in Figure 6;

Figure 9 is an enlarged sectional view of the mechanism at the base of the thumb, taken at 9—9 in Figure 7, showing the thumb in the closed, or flexed position; and

Figure 10 is a view similar to Figure 9, but showing the thumb in the extended position.

The embodiment of Figures 1 to 5, inclusive, will be taken up first, and in these drawings, the hand is designated in its entirety by the reference numeral 15. The hand 15 is seen to comprise a base plate 16, to which a body shell 17 is attached, and mounted on the body shell are articulated fingers 18, 19, 20 and 21, together with the thumb 22, and the actuating mechanism therefor; the construction and operation of which will be described in detail presently.

The base plate 16 constitutes the wrist of the hand and is preferably, although not necessarily, provided with a quick disconnect arrangement of the type shown and described in the pending application of Gilbert M. Motis, Serial Number 24,598, filed May 1, 1948, now Patent No. 2,516,792, and entitled Quick Disconnect Coupling for Artificial Hand or Hook, to which reference may be had for full details of construction and operation. Briefly, the base plate 16 is adapted to be coupled to a companionate member on the distal end of a forearm component (not shown), and to this end is provided on its back surface with a rearwardly projecting, vertically extending rib 23 having straight and parallel side edges which are provided with outwardly facing flanges 24.

A shallow, longitudinally extending slot 25 is milled out of the center of the rib 23, said slot being open at one end and preferably closed at the other end. A circular hole 26 is provided in the center of the plate 16, and slidably disposed within this hole is a connector 30 which is attached at its front end to the finger closing mechanism. The connector 30 extends rearwardly beyond the bottom of the slot 25 and has a radial flange 32 on the end thereof, which is adapted to be received within a slot in the end of a coupling member (not shown) projecting forwardly from the face of an attach plate on the forearm member.

The said attach plate is companionate to the base plate 16, and is formed with channels to receive the flanges 24. The base plate 16 is coupled to the forearm member by sliding the

flanged rib 23 endwise into a corresponding recess in the attach plate, and then locking the parts together, for which purpose a spring-pressed locking pin 33 is provided on the base plate adjacent the top end thereof. The pin 33 is slidably disposed within a cylindrical bore 34, and is urged outwardly by a spring 35 to seat in a hole in the attach plate. The locking pin 28 is adapted to be disengaged from the attach plate by means of a manually operable handle 36 which projects through a slot 37 in the end of the base plate 16.

As the base plate approaches its fully seated position, the connector 30 is engaged by the aforesaid coupling member on the attach plate, which is attached to a Bowden cable control wire extending upwardly along the arm. The control wire is attached to a shoulder harness in the usual manner, and this arrangement causes a pull to be exerted on the control wire when the harnessed shoulder is shrugged forwardly. From the foregoing it will be seen that the muscular force for operating the fingers and the thumb is transmitted to the actuating mechanism of the hand by the connector 30, and the latter can therefore be defined as the "control member" of the hand, by which name it is identified in the claims.

Projecting forwardly from the base plate 16 around the outer edge thereof is a flange 38 to which the body shell 17 and a palm cover shell 39 are attached by means of flat head machine screws. The body shell 17 constitutes the back half of the hand, and is preferably formed of heavy gage sheet aluminum or other light metal. The fingers 18, 19, 20 and 21 may be of any desired construction and, as shown herein, each comprises two generally tubular sheet metal sections 40 and 41 which are pivotally joined together by a pin 42. The base ends of the inner section 40 of fingers 18 and 19 are pivotally mounted on a shaft 43, while fingers 20 and 21 are pivotally mounted on another shaft 44; the axes of said shafts being disposed at an angle to one another so that the fingers 18 and 19 tend to spread apart from fingers 20 and 21 when extended, and to come together when closed. The outer ends of the shafts 43 and 44 are received within holes in the opposite side walls of the body shell 17, and the inner ends thereof are supported by a central block 45 which is formed on a bracket member 46 mounted on the body plate 17.

Extending longitudinally through the inner sections 40 of the fingers are links 50, the outer ends of which are attached by pins 51 to the outer finger sections 41 above the pivot pins 42 (Figure 3), and the inner ends of which are attached by pins 52 to bracket 53 mounted on the body shell 17. Pins 52, it will be noted, are located below the pivot shafts 43, 44, which is opposite to the disposition of pins 42, 51. Link 50 therefore crosses a line connecting the centers of pins 42 and shafts 43 or 44; and by virtue of this arrangement, the outer finger section 41 is pulled inwardly, or in a counterclockwise direction, about its pivot 42 when the inner section 40 is swung upwardly about its supporting pivot shafts 43, 44.

Ears 54 project upwardly from the inner finger section 40 above the pivot shafts 43, 44, and connected to these ears by pins 55 are rearwardly extending links 56, 56'. The rear ends of the links 56 for fingers 18 and 19 are connected by pins 60 to the opposite ends of a transversely disposed equalizer bar 61, while the links 56' for

fingers 20 and 21 are connected by pins 62 to another equalizer bar 63. The equalizer bars 61 and 63 are connected at their midpoints by pins 64 and 65 to links 66 and 67, said links extending rearwardly from the equalizer bars and being connected by pins 70 and 71 to lever arms 72 and 73.

Lever arm 72 is formed integrally with and projects upwardly from a transverse shaft 74 adjacent one end thereof. The ends of the shaft 74 are journalled for rotation in bushings 75 and 76 which are mounted in bearing support blocks 77 and 78, said blocks being secured to the opposite side walls of the body shell 17 by flathead machine screws. The shaft is supported at its midpoint in another bushing 80 which is mounted in the bracket member 46.

The portion of shaft 74 lying on the side of bracket 46 opposite the lever arm 72 is reduced slightly in diameter, and mounted side by side on this reduced portion is a gear sector 81 and sleeve 82. The lever arm 73 is formed integrally with the sleeve 82 and projects upwardly therefrom substantially parallel to lever arm 72. Sleeve 82 and gear sector 81 are fixedly secured to the shaft 74 by pins 83 and 84, and therefore rotate as one with the shaft.

Meshing with the teeth of gear sector 81 is a worm 85 which is rotatably mounted on an axle 86 projecting upwardly from the base of bracket 46. A pinion 90 is rigidly connected to the worm at the upper end thereof, and meshes with a rack 91 extending lengthwise of the hand. The back surface 92 of rack 91 is smooth and flat, and bearing on this surface directly across from the pinion 90 is a roller 93 turning on an axle 94. The purpose of the roller 93 is to back up the rack 91 and hold the latter in mesh with the pinion 90, while at the same time permitting free longitudinal movement of the rack.

The roller 93 and its axle 94 are supported on a bracket 95, the top portion of which includes a shelf 96 extending laterally across the top of rack 91 and pinion 90. The axle 86 for the worm 85 and pinion 90 extends through a hole in the shelf 96 and has a nut 97 screwed onto the projecting threaded end thereof. The bottom edge of the rack 91 is slidably supported on another ledge 98 projecting laterally from the bracket 95, and the rack 91 is thus confined against movement relative to the pinion 90 in the axial direction thereof. Another roller 99 turning on a tubular axle 100 alongside the roller 93, also runs on the back surface 92 of the rack, and provides directional stability for the rack. The rack 91 is yieldingly urged outwardly, or to the right, as seen in Figure 1, by a spring 101, one end of which is anchored to the block 45, and the other end being attached to the outer end of the rack.

Formed on the rear end of rack 91 is a box 102 which is fixedly connected to an arm 103 projecting obliquely from the connector 30. The rack 91 is thus joined directly to the connector 30 and moves with the latter as though it were an integral part thereof. One end of a pivoted lever 104 projects into the space between the top and bottom sides of the box 102 and is connected thereto by a pin 105, said pin passing through a longitudinally extending slot 106 in the lever. The lever 104 is swingably supported on a pivot pin 110, and its other end is connected by a pin 111 to a clevis 112 screwthreaded on the rear end of a push rod 113.

The push rod 113 extends forwardly through the pivot center of a supporting structure 114 for

the thumb 22, and is connected at its front end to the thumb actuating linkage. The thumb-supporting structure 114 consists of a base 115 which is secured by flathead machine screws to the body shell 17, and formed on the upper end of said base is a circular plate 116 having a tapped hole 120 through its center, as shown in Figure 4. An adjusting screw 121 is threaded through the hole 120, and is secured against turning by a set screw 122. The center of the screw 121 is drilled to provide a hole 123, through which the push rod 113 passes.

Threaded onto the front end of the screw 121 is a radially flanged bearing member 124, upon which is swiveled a turntable 125. The turntable 125 comprises a circular plate 126 having a central aperture in which the bearing member 124 is received, said aperture being recessed around its outer edge to provide a seat for the thrust flange 127 of the bearing member. A cylindrically curved flange 130 projects rearwardly from a portion of the outer edge of the swiveled plate 126, back over the peripheral edge of the stationary plate 116, and formed integrally with this flange are two laterally spaced, outwardly extending bracket arms 131. The bracket arms 131 project into the hollow base section 132 of the thumb 22 and are connected therewith by a pivot pin 133. Extension arms 134 project obliquely forward from the outer ends of the bracket arms 131, and these are drilled to receive a pin 135 which serves as an axle for certain elements of the thumb-actuating linkage, which will be taken up in detail presently.

The swiveled plate 126 is spaced a short distance out from the stationary plate 116, and disposed within the space between them is a dished spring friction member 136 having a central aperture through which the adjusting screw 121 passes. The center portion of the friction member 136 bears against the stationary plate 116, and the outer edge portion thereof bears against the adjacent surface of the swiveled plate 126.

The bearing member 124 is adapted to be tightened down on the screw 121 by means of a spanner wrench (not shown), causing the friction member 136 to be compressed between the plates 116 and 126. The frictional resistance to rotation of plate 126 relative to plate 116 is proportional to the bearing pressure of the member 136 against the plates; hence, the tighter the member 136 is compressed, the greater is the resistance, and the more firmly the thumb is held in its angularly adjusted position about the pivot axis.

Pivotally connected by a pin 140 to the outer end of the base section 132 of the thumb is an outer section 141, which is likewise formed of sheet metal. A link 142 is attached at one end by a pin 143 to the outer thumb section 141 adjacent the pivot 140, and the other end of the link is connected by a pin 144 to one arm of a bell crank 145 which is rotatably supported on the pin 135 between the extension arms 134. In the illustrative embodiment, the bell crank 145 is made up of two laterally spaced side members which are joined together to rotate as one about the pivot 135. Rigidly fixed to the bell crank 145 between the side members is a gear sector 146 which meshes with another gear sector 150. Sector 150 is pivotally supported on the pin 133 between the bracket arms 131, and is connected to the thumb section 132 by a pin 151, so that the thumb is constrained to rotate with the sector 150.

The other arm of the bell crank 145 projects laterally inward toward the center of the hand,

and is connected by a pin 152 to a bracket 153 projecting radially from a sleeve member 154 on the push rod 113. The sleeve member 154 is free to rotate on the push rod, but is confined against axial movement with respect thereto by a radial flange 155 on the push rod which engages one end of the sleeve. The other end of the sleeve is engaged by a nut 156 which is screwed onto thread 160 on the end of the push rod.

The fingers and thumb are pulled closed, or flexed in prehension, when the connector 30 is pulled rearwardly by a shrug of the harnessed shoulder. Such rearward movement of the connector 30 causes the rack 91 to move rearwardly with it, which drives the pinion 90 and worm 85. Rotation of the worm 85 drives the gear sector 81 and shaft 74 in a counterclockwise direction, as viewed in Figure 3, thereby swinging the two lever arms 72 and 73 rearwardly. Links 66 and 67 are carried rearwardly with the lever arms 72, 73, and the tensile force transmitted by each of the links is distributed equally by the equalizer bars 61, 63 to the fingers to close the same.

Rearward movement of the rack 91 also causes the lever 104 to rock in a counterclockwise direction about its pivot 110, which causes push rod 113 to be pushed forwardly through the thumb-supporting structure 114. Forward movement of the push rod 113 rocks the bell crank 145 and gear sector 146 in a clockwise direction, which drives the gear sector 150 in a counterclockwise direction to close the thumb.

The thumb 22 is adapted to be moved to any desired position about the pivot axis of the rotatable plate 126 between the adducted position, shown in phantom lines in Figure 2, and the abducted position, shown in solid lines in Figure 2. This pivot axis thus represents the adduction-abduction axis of the thumb; while the pivot pin 133 represents the flexion-extension axis of the thumb. The thumb is yieldingly held in its angularly adjusted position about the adduction-abduction axis by means of the friction member 136, and the amount of frictional resistance to rotation of the thumb is determined by the extent to which the friction member is compressed.

The other embodiment of the invention, shown in Figures 6 to 10, inclusive, is generally similar in construction to the previously discussed embodiment, and parts that are similar to those already described are given the same reference numerals with the suffix *a*. The finger-closing mechanism differs from that of the previous embodiment in that the shaft 74*a* is provided with an upwardly extending arm 170 which is connected by a pin 171 to the front end of a link 172. The rear end of the link 172 is provided with a clevis 173 which receives a tongue 174 projecting forwardly from the end of the connector 30*a*, and is connected therewith by a pin 175. A spring 176 which is anchored at one end to the bracket 53*a* of finger 20*a*, is attached at its other end to arm 170 and exerts a pull thereon tending to restore the fingers to the normally extended condition shown in the drawings.

When the connector 30*a* is pulled rearwardly by a shoulder shrug, the shaft 74*a* is rocked in a counterclockwise direction, as viewed in Figure 8, drawing the fingers closed with an equalized pull. When the force on the connector 30*a* is relaxed, the shaft 74*a* is rocked back to its initial position by the spring 176, opening the fingers out to the extended position.

The thumb 22*a* is swiveled for rotation about the adduction-abduction axis between the two

positions shown in Figure 7, and is pivoted also for swinging movement about the flexion-extension axis, represented by the pin 133a. The thumb itself, however, is made in one piece, without the joint shown in the preceding embodiment, and is not adapted to be closed by the operation of the connector 30a. Instead, the thumb is passively changed from the extended position shown in Figure 10 to the flexed position shown in Figure 9, and is releasably held in the latter position by latching means which will be described presently.

The thumb 22a is supported on a stationary standard 180 which is fixed to the body shell 17a, and formed on the upper end of the standard is a circular boss 181 having a central hole 182. Extending through the hole 182 is a bolt 183, the threads of which are screwed into a tapped hole 184 of a rotatable member 185. Interposed between the head 186 of the bolt 183 and the adjacent face of the stationary boss 181 is a resilient friction disk 190 of cork or like material, while another friction disk 191 is interposed between the adjacent faces of the rotatable member 185 and stationary boss 181. When the screw 183 is tightened, the disks 190 and 191 are compressed, increasing the frictional resistance to turning of the member 185 with respect to member 181.

Laterally spaced bracket arms 192 project radially outward from one side of the member 185, and pass on opposite sides of the thumb 22a; the ends of pivot pin 133a being received within holes in the said arms. A torsion spring 211 is wrapped around the pin 133a and one end thereof is anchored at 212 in the member 185. The other end of the spring bears against the thumb 22a urging the latter outwardly toward the extended position shown in Figure 10.

The thumb is adapted to be latched in the flexed position shown in Figure 10, and to this end is provided with a catch 193 which is secured by rivets 194 to the thumb. A lip 195 on the outer end of the catch 193 is adapted to be engaged by another lip 196 on a detent 200, and when thus engaged, locks the thumb in the flexed position until the lip 196 is disengaged from lip 195.

Extending through a hole in detent 200 and projecting laterally from opposite sides thereof is a pin 201, the ends of which are slidably disposed within slots 202 in bracket members 199, said bracket members being formed integrally with the member 185 and projecting from one end thereof. A leaf spring 203 is secured to the member 185 by pressed-in rivets 205, and a rolled lip 204 on the spring bears downwardly against the top of the detent 200.

When pin 201 is at the bottom of slot 202, the spring lip 204 engages the detent 200 above the pin, exerting a counterclockwise torque on the detent. When pin 201 is at the top of slot 202, the spring lip 204 engages the detent below the pin and exerts a clockwise torque thereon. A limit stop pin 206 limits the counterclockwise rotation of detent 200 to the position shown in Figure 10.

If the thumb and latch detent are in the positions shown in Figure 10, the thumb is closed to the flexed position and locked in place by merely striking the back of the thumb lightly against the body, or any convenient object such as a table top, chair, or the like. As the thumb swings upwardly, or counterclockwise about pivot 133a, the end of catch 195 engages a shoulder 210 on detent 200, pushing the latter inwardly until pin

201 reaches the top of slot 202. At this point, the spring 203 urges the detent down into engagement with the catch, with the result that the lip 196 remains interlocked with lip 195 when the presure is removed from the back of the thumb. Spring 211 now pulls the thumb out to the position shown in Figure 9, with pin 201 at the bottom of slot 202. The interlocking engagement of the lips 195, 196 prevents the detent 200 from yielding to the spring 203 and swinging about pin 201 to the limit stop 206. However, the next time that pressure is applied to the back of the thumb, the lip 196 is disengaged from lip 195 and detent 200 snaps back against the limit stop. The advantage of this arrangement will be readily apparent to those skilled in the art, since it enables the amputee to change the position of the thumb without using the other hand or hook.

While I have shown and described in considerable detail two illustrative embodiments of my 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.

I claim:

1. In an artificial hand, the combination of a plurality of articulated fingers and an articulated thumb, said thumb being swiveled for rotation about an adduction-abduction axis, a force-transmitting control member, linkage means operatively connected to said control member for closing said fingers with an equalized force, and for closing said thumb, said linkage means for closing said thumb including an axially movable push rod disposed coaxial with the swivel axis of the thumb.

2. In an artificial hand, the combination of a plurality of fingers and an articulated thumb, said thumb being swiveled for rotation about an adduction-abduction axis, a force transmitting control member, linkage means operatively connecting said control member to said thumb for closing the same, said linkage means including an axially movable push rod disposed coaxial with said adduction-abduction axis, and a member journaled on said push rod for rotation about the axis thereof but constrained against axial movement with respect thereto, said member being connected to a portion of said linkage means mounted on said thumb and rotatable therewith, whereby said thumb can be closed by said linkage means in all positions about said adduction-abduction axis.

3. In an artificial hand having a plurality of fingers and a thumb, the combination of a thumb-supporting plate swiveled on said hand for rotation about an adduction-abduction axis, said thumb being pivotally supported on said plate for swinging movement about a flexion-extension axis, a force transmitting control member, linkage means operatively connecting said control member to said thumb for swinging the same about said flexion-extension axis, said linkage means including an axially movable push rod extending through said plate coaxial with said adduction-abduction axis, a gear sector fixed to said thumb concentric with said flexion-extension axis, another gear sector pivotally supported on said plate and meshing with said first-named sector, and a lever arm fixed to said last-named sector and connected to said push rod, whereby axial movement of said push rod causes said last-

named sector to drive said first-named sector, thereby swinging said thumb about said flexion extension axis.

4. In an artificial hand having a plurality of articulated fingers and an articulated thumb, a force-transmitting control member, a longitudinally movable rack connected to said control member, a rotatable pinion meshing with said rack, a worm fixedly connected to said pinion to rotate therewith, a gear sector meshing with said worm, said gear sector being fixedly mounted on a transversely disposed, rotatable shaft, a pair of arms projecting from said shaft, forwardly extending links connected to said arms, each of said links being connected to the midpoint of an equalizer bar, and other links connecting the two ends of each equalizer bar to two of said fingers, whereby an equalized force is transmitted to the two fingers associated with each equalizer bar, and means connected to said control member for closing said thumb simultaneously with said fingers.

HUBERT L. MASON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
760,102	Carnes	May 17, 1904
1,046,966	Carnes	Dec. 10, 1912
1,324,564	Pringle	Dec. 9, 1919
2,464,577	Hobbs	Mar. 15, 1949

FOREIGN PATENTS

Number	Country	Date
345,340	Great Britain	Mar. 20, 1931