May 26, 1953 T. C. HARRY 2,639,437

MECHANICAL HAND

Filed Dec. 1, 1947 4 Sheets-Sheet 1

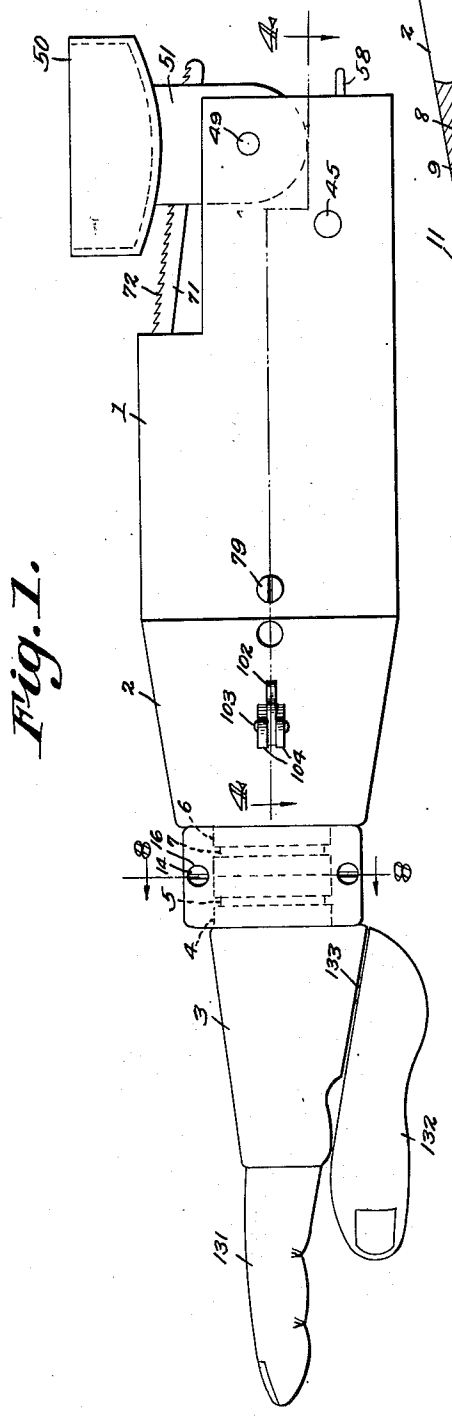


Fig. 1.

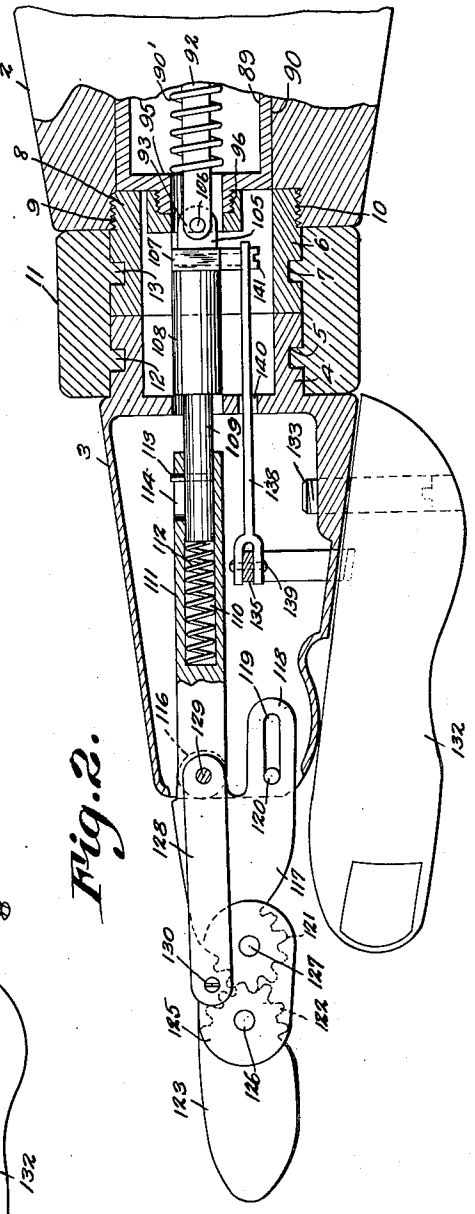


Fig. 2.

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MECHANICAL HAND

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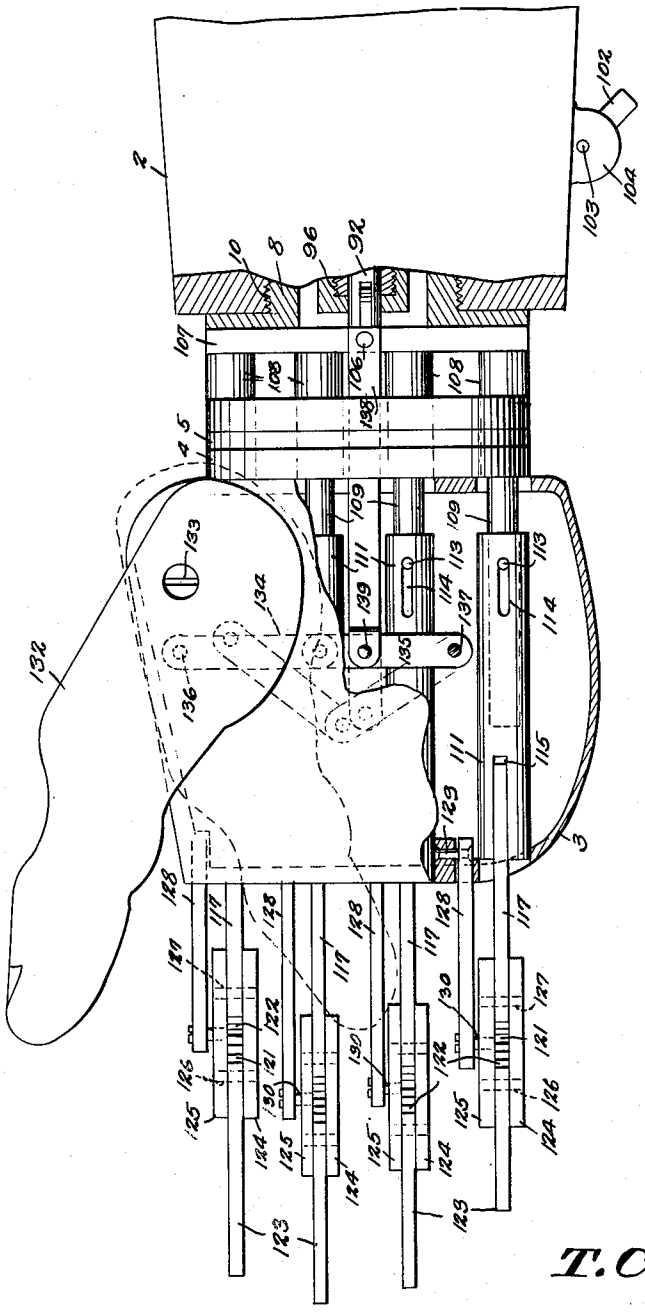


Fig. 3.

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MECHANICAL HAND

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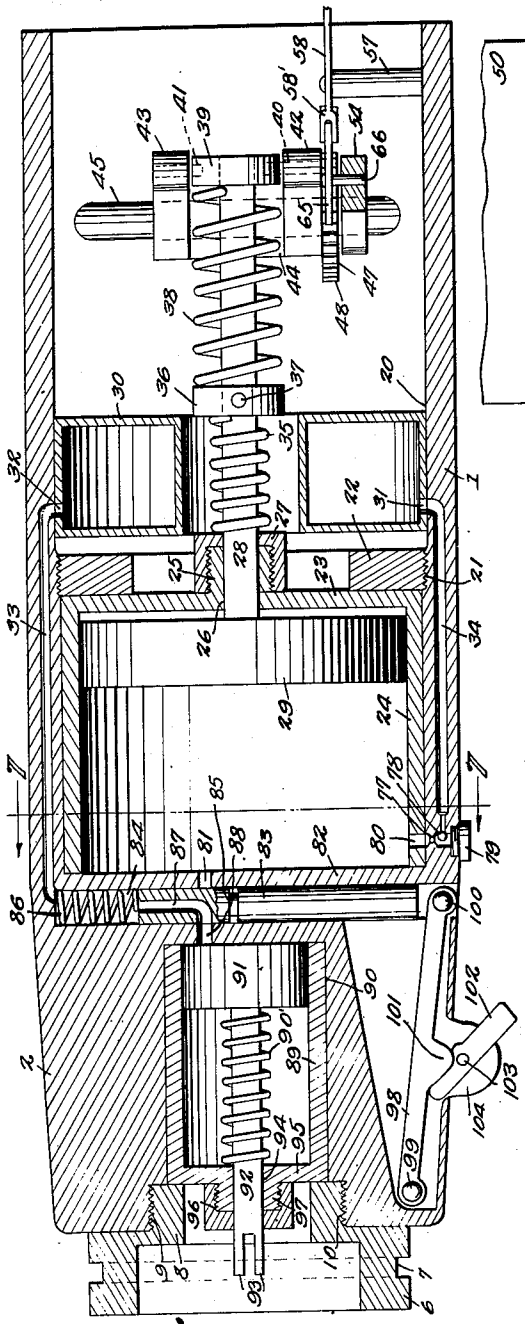


Fig. 4.

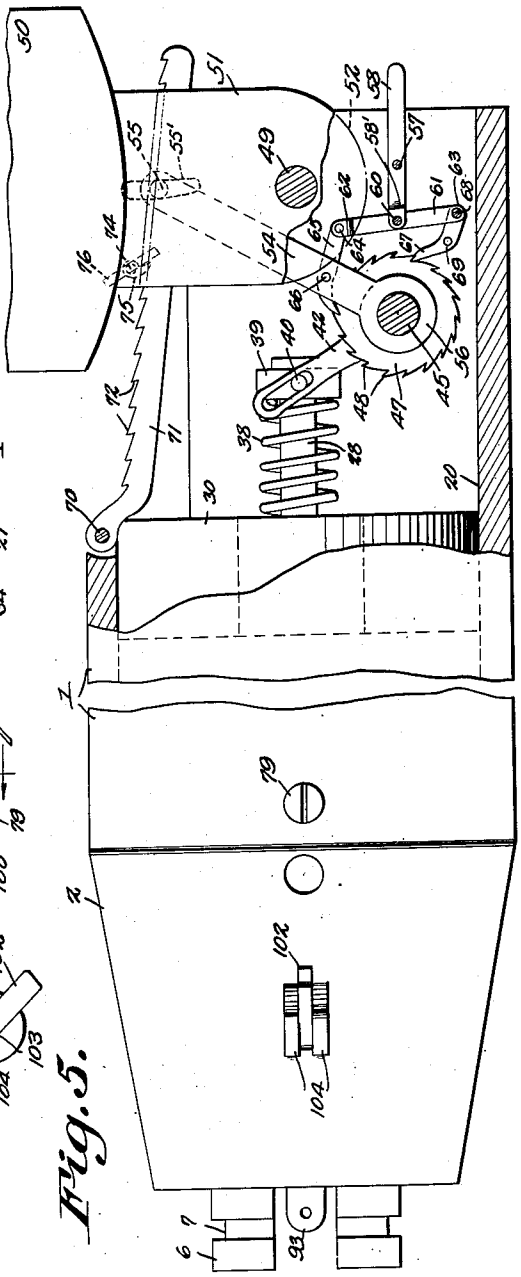


Fig. 5.

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MECHANICAL HAND

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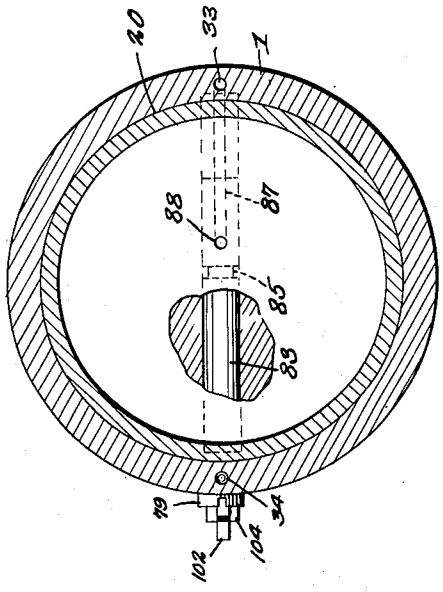


Fig. 7.

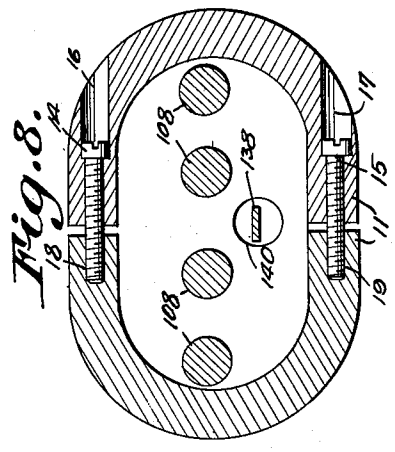


Fig. 8.

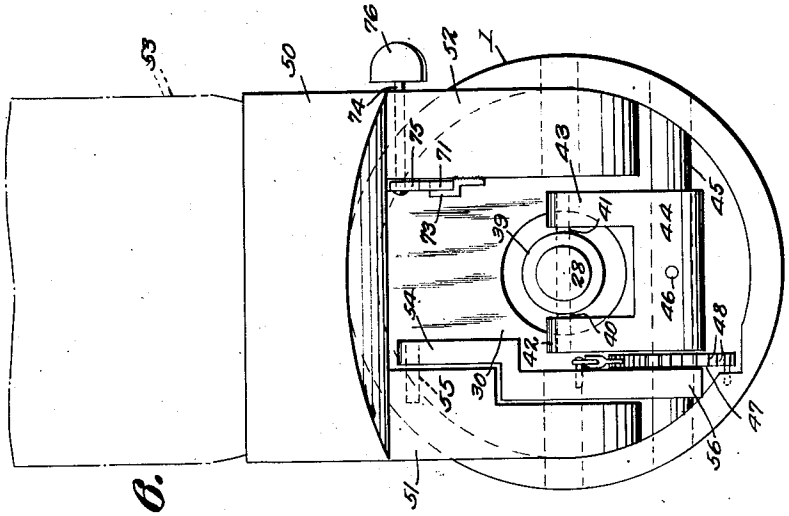


Fig. 6.

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Patented May 26, 1953 2,639,437

UNITED STATES PATENT OFFICE

2,639,437

MECHANICAL HAND

Thomas C. Harry, Ferndale, Mich.

Application December 1, 1947, Serial No. 789,098

12 Claims. (Cl. 3—12.6)

1

This invention relates to improvements in artificial or mechanical hands.

An object of the invention is to provide an improved artificial or mechanical hand and forearm construction which will be secured in any desired manner to the stump of an amputee.

Another object of the invention is to provide an improved construction of artificial or mechanical hand and forearm, which will be securely strapped to the stump of an amputee, said hand being hydraulicially operated by pumping the forearm up and down to build up pressure upon the hydraulic fluid to force the same from a storage tank contained in the forearm past a control valve and into a small cylinder to operate a piston and the fingers and thumb of the hand operatively connected with said piston.

A further object of the invention is to provide an improved artificial or mechanical hand and forearm construction which will be securely strapped to the stump of an amputee, said hand being hydraulically operated by pumping the forearm up and down to build up pressure upon the hydraulic fluid contained in a storage tank in the forearm, whereby the fluid will be forced into a small control cylinder to operate a piston slidably mounted therein, which in turn will operate the interconnected fingers and thumb of the mechanical hand, said fluid under pressure being released by the operation of a control valve associated therewith to permit a compressed spring to force the piston to its original position and the hydraulic fluid back into the storage tank.

A still further object of the invention is to provide an improved construction of hydraulically operated artificial or mechanical hand and forearm which may be held at any desired angle, and the fingers and thumb of the hand operated as desired.

Another object of the invention is to provide an improved hydraulically operable artificial or mechanical hand and forearm which will be highly efficient in operation and relatively inexpensive to manufacture and produce.

Other objects will appear as the description proceeds.

In the accompanying drawings which form a part of this application,

Figure 1 is a side elevational view of the improved artificial or mechanical hydraulically operated hand and forearm construction;

Fig. 2 is a partial vertical sectional view through the improved artificial or mechanical hand and the adjacent portion of the forearm connected therewith;

Fig. 3 is a plan view of the improved artificial

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hand and the adjacent portion of the forearm, with portions thereof being broken away and in section to show the operating mechanism for the fingers and thumb of the hand;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is an enlarged side elevation of the artificial or mechanical forearm, with parts thereof being broken away and in section to more clearly show the ratchet operating mechanism for actuating the piston for controlling the hydraulic fluid used for operating the fingers and thumb of the hand;

Fig. 6 is an end elevation of the elbow end of the forearm portion of the artificial or mechanical hand, showing the attaching pad therefor attached to an arm stump;

Fig. 7 is a sectional view taken on the line 7—7 of Fig. 4, with a portion thereof being broken away to show the control valve, and

Figure 8 is a sectional view taken on the line 8—8 of Fig. 1.

Like characters of reference are used throughout the following specification and the accompanying drawings to designate corresponding parts.

In carrying out the invention, there is provided an improved construction of artificial or mechanical hand and forearm which will include a hollow cylindrical forearm portion 1 which may be cast from a light weight material such as aluminum, and the forward or outer end thereof will be slightly tapered as at 2.

A hand portion 3 of hollow construction is also cast from aluminum, and is formed at its inner end with a cylindrical bearing sleeve 4 and which is formed with an annular locking groove or slot 5 which cooperates with a similarly formed cylindrical wrist forming bearing sleeve 6 also formed with an annular locking groove 7 and having a reduced inner end 8 which is externally threaded at 8' to screw into the internally threaded bore 10 in the outer end of the tapered front end 2 of the forearm portion 1.

A split connecting clamp 11 having spaced internally disposed ribs 12 and 13 is adapted to be positioned about the sleeves 4 and 6 with the ribs 12 and 13 being received in the annular locking slots or grooves 5 and 7. Securing screws 14 and 15 are disposed in parallel bores 16 and 17 formed in one portion of the split clamp 11 and are threadable in threaded bores 18 and 19 in the other portion of the clamp 11 when disposed about the sleeves 4 and 6 for locking the hand portion 3 to the wrist forming bearing sleeve 6 supported by the forearm portion 2.

The internal bore 20 formed in the hollow fore-

arm portion 1 is internally threaded at 21 to support the externally threaded locking ring 22 which holds the closed inner end 23 of the large cylinder 24 in position within the inner end of said bore 20. An inwardly extending externally threaded sleeve or bushing 25 is formed integrally with and centrally of the closed end 23 of the cylinder 24, and connected with a central opening 26 formed through said closed end 23. A packing nut 27 is internally threaded for screwing upon the threaded sleeve or bushing 25, and provides a backing for the piston rod 28 which is reciprocably mounted through the packing and supports a piston 29 on its forward end for operation in the cylinder 24.

An annular hydraulic fluid containing tank 30 will be supported within the bore 20 in the forearm portion 1, and will be provided with an oppositely disposed outlet port 31 and return port 32 which connect respectively with the fluid passages 33 and 34 formed in the wall of the forearm portion 1.

A coil spring 35 will be disposed about the piston rod 28 between the packing nut 27 and the sleeve 36 secured about the piston rod 28 by means of the cross pin 37.

A larger and heavier coil spring 38 will be disposed about the inner end of the piston rod 28 between the sleeve 36 and the sleeve 39 secured to the inner end of said piston rod 28 and the oppositely extending trunnions 40 and 41 upon which the arms 42 and 43 of the piston operating yoke 44 are mounted.

The yoke 44 is secured to a cross shaft 45 fixed transversely of the inner end of the forearm portion 1 by means of the pins 46, whereby the yoke 44 will rock back and forth to reciprocate the piston 29 in the cylinder 24.

A ratchet wheel 47 will be fixed to the cross shaft 45 at one end of the yoke 44, and will be formed with a plurality of teeth 48.

A transversely extending pivot shaft 49 will be disposed horizontally across the center of the inner end of the forearm portion 1, and will serve as an elbow pivot joint. A stump engaging cup 50 will be formed with the spaced depending arms 51 and 52, which will be pivotally supported at their lower ends upon the pivot or elbow joint shaft 49. The cup 50 may be attached to the stump 53 of the amputee by means of straps (not shown) or in any other desired manner.

An offset operating lever 54 will be pivoted at its upper end upon a pin 55 operating in the elongated opening 55', the pin being supported by the arm 51 with its lower end formed into a bearing 56 disposed about the shaft 45.

An inwardly extending supporting post 57 will be supported from the inner surface of the forearm 1, and will pivotally support the trip arm 58 having a yoke 58' on its inner end which supports a pin 60 upon which the arm 61 is pivotally mounted. The arm 61 is formed with the yokes 62 and 63 at its opposite ends, said yoke 62 supporting a cross pin 64 upon which the pawl or dog 65 is also mounted. The pawl or dog 65 is also pivotally mounted upon the pin 66 supported by the operating lever 54.

A second pawl or dog 67 is pivotally mounted on the cross pin 68 supported by the yoke 63, and is further pivoted upon the pin 69 secured to the forearm portion 1. It will be understood that the pawls or dogs 65 and 67 engage the teeth 48 on the ratchet wheel 47 when the trip arm 58 is moved to its upper position, and the pawls or dogs 65 and 67 will be released from the ratchet wheel 47 when the trip arm 58 is in a lowered position.

Extending rearwardly from the inner end of the forearm portion 1 and pivoted upon a pin 70, is a rack bar 71 having teeth 72 upon the upper edge. The rack bar is slidably supported adjacent its rear end in a bracket member 73 secured to the inner surface of the depending arm 52 supported by the cup 50. An operating shaft 74 is rotatably disposed through the depending arm 52 and supports a pawl or dog 75 on its inner end engageable with the teeth 72 on the rack bar 71, and an operating handle 76 on its outer end, the function of the rack bar 71 and pawl or dog 75 being to support the forearm portion 1 in the desired angular relation with respect to the cup 50 attached to the stump 53.

A valve seat 77 is formed at the forward end of the fluid passage 34 and cooperates with a ball check valve 78. A screw closure 79 is provided for gaining access to the ball check valve 78. A port 80 is formed through the cylinder 24 and is adapted to register with the valve seat 77.

An outlet port 81 is formed through the forward end or closure 82 of the forearm portion 1, and is adapted to cooperate with a control valve 83 reciprocably mounted in a transverse bore 84 formed through the forearm portion 1. An annular groove 85 is formed about the valve 83 and is adapted to register with the outlet port 81 when the valve 83 is moved inwardly against the compression of the coil spring 86 reclined in the inner end of the bore 84. An L-shape outlet passage 87 is formed in the inner end of the valve 83, and when the valve is in its outer position, connects the return passage 33 in the forearm portion 1 with the passage 88 formed in the forearm portion 1, diametrically opposite the bore or passage 81.

A small cylinder 89 is received in a small bore 90 formed axially in the tapered portion 2 of the forearm portion 1, and cooperates with a piston 91 having a forwardly extending piston rod 92, forked at 93 at its outer end, and extending through the bore 94 in the closed outer end 95. A threaded packing nut 96 is threaded upon the forward reduced end 97 of the cylinder 89. A coil spring 90' is disposed about the piston rod 92 within the cylinder 89, and extends the full distance between the piston 91 and closed outer end 95 of the cylinder 89.

The tapered portion 2 of the forearm 1 is longitudinally slotted to receive the valve actuating lever 98 pivoted at 99 in the outer end of the slot and having its opposite end pivotally attached by the pin 100 to the outer end of the valve 83. A cam 101 is formed on the lever 98 and is engageable by the valve actuating finger or control piece 102 pivotally mounted upon the pin 103 between the ears 104 on the tapered portion 2. In the position shown in Fig. 4 the valve is in position to permit the hydraulic fluid to pass from the cylinder 89 through the passages 88 and 87, and through the passage 33 back into the fluid supply tank 30. Obviously when the finger piece is moved in the opposite direction the port or passage 81 will be aligned with the annular groove 85 and the passage 88 to permit the hydraulic fluid from the cylinder 24 to be pumped into the cylinder 89 as the forearm portion 1 is moved up and down, thus actuating the ratchet mechanism arm advancing the large pis-

ton 29 in the cylinder 24, thereby building up the pressure on the hydraulic fluid in the small cylinder 89.

Secured between the forked ends 93 of the piston rod 92 is an ear 105 held by a pin 106 and connected to a transversely extending bar 107 which supports the four spaced forwardly extending finger operating rods 108, which have reduced outer extremities 109 for being telescopically received in the bores 110 in the tubular connecting members 111. Coil springs 112 are disposed in the hollow connecting members 111 at the forward ends of the reduced extremities 109 of the finger operating rods 108, and pins 113 are supported by each of said extremities 108 and extend upwardly through slots 114 formed in the inner ends of each of said connecting members 111.

The outer ends of the connecting members 111 are slotted at 115 to receive the ears 116 on the inner ends of the fingers forming plates 117, and lower ears 118 are also formed on the plates 117, the same being slotted at 119 to receive the cross pins 120. The outer ends of the plates 117 are formed with a toothed segment 121 engageable or meshable with a like toothed segment 122 on the finger tip plates 123. Spaced connecting plates 124 and 125 are disposed on the opposite sides of the toothed segments 121 and 122 and are secured in position by the pins 126 and 127 extending therethrough and through the plates 123 and 117. Finger tip control links 128 are pivoted at their inner ends on the rivets 129 supported by the hand portion 3, and are also pivoted at their outer ends on the pins 130 supported by the connecting plates 125. If desired a flexible cover 131 colored to simulate flesh color may be disposed about the several fingers and thumb 132, hereinafter described.

A thumb 132 will be pivotally supported upon a threaded screw 133 secured to the hand 3, and will also support the interconnected toggle links 134 and 135, mounted respectively upon the pins 136 and 137. A thumb control lever 138 will be forked at its outer end and connected by means of the pins 139 with the toggle link 135. The lever 138 will extend through an opening 140 in the hand 2, and will be secured by means of the screw 141 to the cross bars 107.

In operation, when it is desired to hold an object in the fingers of the mechanical hand, the finger control 102 will be moved to connect the large cylinder 24 by way of the annular groove 85 in the valve 83 with the small cylinder 89. The arm is then pumped up and down and hydraulic fluid from the tank 30 will be pumped under pressure to move the piston 91 outwardly in the cylinder 89. This movement will cause the rods 111 and 108 to move outwardly and the finger plates 117 and 123 to move inwardly to grasp the desired article. Upon the movement of the finger control 102 in the opposite direction, the valve 83 will be shifted by means of the spring 86 so that the several springs which were compressed, will force the hand and fingers to open position and return the hydraulic fluid to the tank 30. As before mentioned, the rack bar 70 will determine the angular position of the forearm portion 1, and may be readily changed by shifting its contact with the pawl or dog 75.

From the foregoing description it will be apparent that there has been devised and provided a highly efficient and relatively inexpensive artificial or mechanical hand and interconnected forearm for amputees.

While the preferred embodiment of the instant invention has been illustrated and described, it will be understood that it is not intended to limit the scope of the invention thereto, as many minor changes in detail or construction may be resorted to without departure from the spirit of the invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. An artificial limb including a forearm portion and a hand portion detachably connected therewith, a stump supporting cup pivotally attached to the inner end of said forearm portion, axially disposed cylinders of different sizes in said forearm portion, pistons operable in said cylinders, piston rods attached to said pistons, a hydraulic fluid storage tank in said forearm portion, means for admitting hydraulic fluid from said tank to said cylinders, ratchet operating means connected with one of said piston rods operable upon reciprocating movement between said forearm portion and said stump supporting cup, gear connected finger sections supported by said hand, and means disposed between said finger sections and the second piston rod for actuating said finger sections when hydraulic fluid is pumped from said fluid storage tank into said cylinder.

2. An artificial limb including a forearm portion and a hand portion detachably connected therewith, a stump supporting cup pivotally attached to the inner end of said forearm portion, axially disposed cylinders of different sizes in said forearm portion, pistons operable in said cylinders, piston rods attached to said pistons, a hydraulic fluid storage tank in said forearm portion, means for admitting hydraulic fluid from said tank to said cylinders, ratchet operating means connected with one of said piston rods operable upon reciprocating movement between said forearm portion and said stump supporting cup, gear connected finger sections supported by said hand, means disposed between said finger sections and the second piston rod for actuating said finger sections when hydraulic fluid is pumped from said fluid storage tank into said cylinders, and a separate means for returning said hydraulic fluid from said cylinders to said fluid storage tank.

3. An artificial limb including a forearm portion and a hand portion detachably connected therewith, a stump supporting cup pivotally attached to the inner end of said forearm portion, axially disposed cylinders of different sizes in said forearm portion, pistons operable in said cylinders, piston rods attached to said pistons, a hydraulic fluid storage tank in said forearm portion, means for admitting hydraulic fluid from said tank to said cylinders, ratchet operating means connected with one of said piston rods operable upon reciprocating movement between said forearm portion of said stump supporting cup, gear connected finger sections supported by said hand, means disposed between said finger sections and the second piston rod for actuating said finger sections when hydraulic fluid is pumped from said fluid storage tank into said cylinders, separate means for returning said hydraulic fluid from said cylinders to said fluid storage tank, and a shiftable valve between said cylinders for admitting fluid to operate said pistons and for returning the fluid to the fluid storage tank.

4. An artificial limb including a forearm portion and a hand portion detachably connected

therewith, a stump supporting cup pivotally attached to the inner end of said forearm portion, axially disposed cylinders of different sizes in said forearm portion, pistons operable in said cylinders, piston rods attached to said pistons, a hydraulic fluid storage tank in said forearm portion, means for admitting hydraulic fluid from said tank to said cylinders, ratchet operating means connected with one of said piston rods operable upon reciprocating movement between said forearm portion of said stump supporting cup, gear connected finger sections supported by said hand, means disposed between said finger sections and the second piston rod for actuating said finger sections when hydraulic fluid is pumped from said fluid storage tank into said cylinders, separate means for returning said hydraulic fluid from said cylinders to said fluid storage tank, a shiftable valve between said cylinders for admitting fluid to operate said pistons and for returning the fluid to the fluid storage tank, and resilient means for returning said pistons to their retracted positions in said cylinders.

5. An artificial limb including a forearm portion and a hand portion detachably connected therewith, a stump supporting cup pivotally attached to the inner end of said forearm portion, axially disposed cylinders of different sizes in said forearm portion, pistons operable in said cylinders, piston rods attached to said pistons, a hydraulic fluid storage tank in said forearm portion, means for admitting hydraulic fluid from said tank to said cylinders, ratchet operating means connected with one of said piston rods operable upon reciprocating movement between said forearm portion of said stump supporting cup, gear connected finger sections supported by said hand, means disposed between said finger sections and the second piston rod for actuating said finger sections when hydraulic fluid is pumped from said fluid storage tank into said cylinders, separate means for returning said hydraulic fluid from said cylinders to said fluid storage tank, a shiftable valve between said cylinders for admitting fluid to operate said pistons and for returning the fluid to the fluid storage tank, resilient means for returning said pistons to their retracted positions in said cylinders, and cam actuated means for operating and shifting said shiftable valve.

6. The subject matter as claimed in claim 5, and resilient means for returning said shiftable valve to its original position.

7. The subject matter as claimed in claim 5, resilient means for returning said shiftable valve to its original position, and adjustable means for varying the angular relation between said forearm portion and said stump supporting cup.

8. The subject matter as claimed in claim 5, a thumb pivotally supported on said hand portion, and actuating means therefor connected with said finger actuating means.

9. The subject matter as claimed in claim 5, a thumb pivotally supported on said hand portion, actuating means therefor connected with said finger actuating means, and finger tip control links pivotally connected between said hand portion and said fingers.

10. The subject matter as claimed in claim 5, a thumb pivotally supported on said hand portion, actuating means therefor connected with said finger actuating means, finger tip control links pivotally connected between said hand portion and said fingers, and resiliently cushioned connecting members between said fingers and said finger actuating means.

11. The subject matter as claimed in claim 1, and a clamp engageable with said hand portion and forearm portion for securing the same together.

12. The subject matter as claimed in claim 2, and means for engaging and disengaging said ratchet operating means.

THOMAS C. HARRY.

No references cited.