June 16, 1953 G. B. ROBINSON 2,641,769

MECHANICAL HAND

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Fig. 1

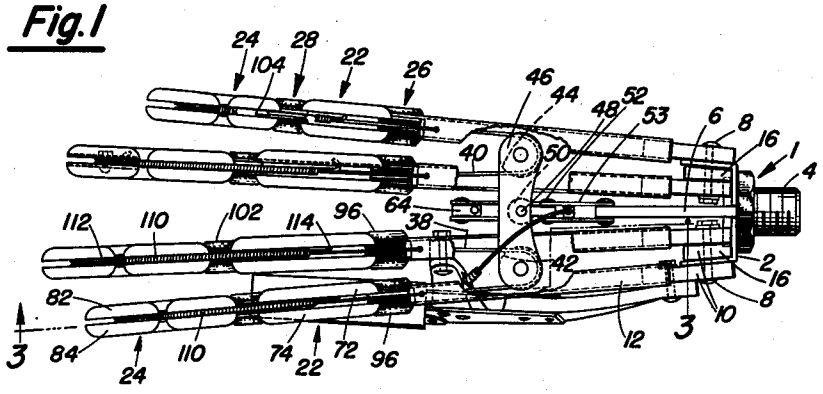


Fig. 2

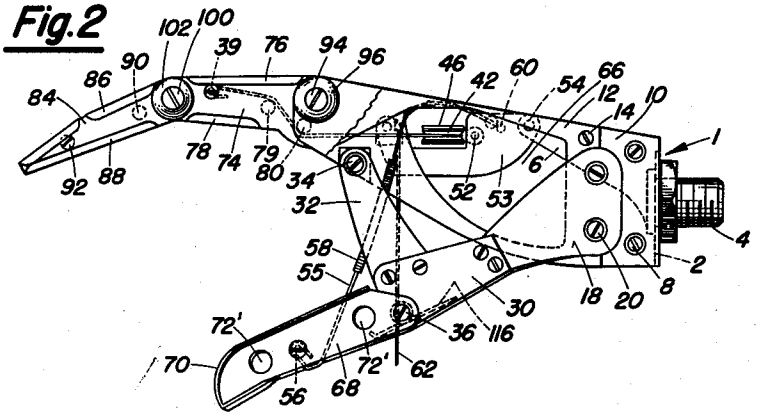
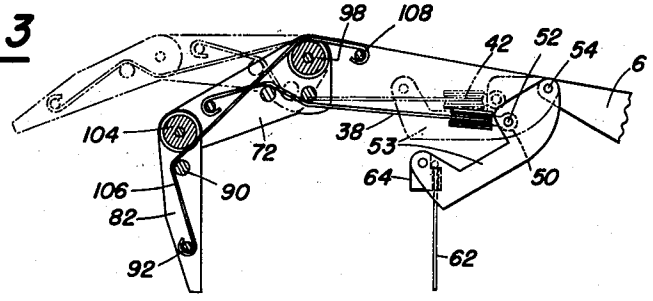


Fig. 3



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MECHANICAL HAND

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6 Claims. (Cl. 3—12.7)

(Granted under Title 35, U. S. Code (1952), sec. 266)

1

The invention described herein may be manufactured and used by and for the Government of the United States of America for Governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to prostheses and, more particularly, to an artificial, mechanical hand.

Prior art artificial hands usually suffered from the deficiencies of being quite complicated mechanically, thus requiring frequent repair, and failing to provide means for equalizing the grip of the several fingers. An object, therefore, of the present invention is to provide an artificial hand of relatively simple construction in which the grip of the various fingers is automatically equalized to facilitate gripping irregular objects.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a view of the dorsal aspect of a preferred embodiment of this invention;

Fig. 2 is a lateral side view of the mechanical end of Fig. 1, partially broken away to show details of the operating mechanism; and

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1 showing the phalange actuating arrangement.

Reference is now made to the drawings wherein the numeral 1 indicates generally the wrist of the artificial hand, including a U-shaped metal member 2 having a threaded extension 4 for attaching the wrist to a bucket or socket applied to the stump of the amputee, and having rigidly attached thereto also a supporting arm 6. Attached to the wrist by means of screws 8 are flexible mounts 10, made of laminated rubber and fabric material to carry the metacarpal pieces 12 which are attached thereto by screws 14. Spacers 6 keep the metacarpals in their proper relation to each other. The metacarpal of the thumb is fastened with a similar rubber-fabric laminate 18 to the rubber mount of the forefinger metacarpal by means of screws 20. Each of the four fingers includes two phalanges generally indicated at 22 and 24, the first phalange being articulated as at 26 to its corresponding metacarpal and the second phalange being articulated as at 28 at its proximal end to its corresponding first phalange. The thumb member is comprised of the metacarpal 30 carried by the laminated mount 18 and further supported in somewhat extended position by a similar laminated bridge 32, attached to the distal palmar region of the metacarpal of the middle finger as by a screw 34. The single phalange of the thumb is articulated at 36 to the metacarpal of the thumb.

The actuating mechanism for simultaneously flexing the fingers and thumb comprises a system of cables. This system includes a first cable 38, opposite ends of which are anchored at corresponding points to the distal regions of the first phalange of the forefinger (as at 39) and the first phalange of the middle finger. The system also includes a second cable 40, the opposite ends of which are similarly anchored to the distal regions of the first phalange of the ring finger and the first phalange of the little finger. The cables pass around pulleys 42 and 44, respectively, carried by an equalizer bar 46 pivoted at 48 on a short link 50, which, in turn, is pivoted at 52 to a lever 53, which, in its turn, is pivoted to the supporting arm 6 at 54. The bar 46 operates as an equalizer to permit all fingers to flex simultaneously different amounts if necessary. The thumb is actuated by a cable 55 anchored at 56 to the intermediate region of the phalange of the thumb member and passing through a sheath 58 which extends through an aperture in the bridge 32 and thence through an aperture (not shown) in the metacarpal piece of the middle finger, terminating at its other end at an anchored point 60 on the lever arm 6. At the distal end of lever 53 a cable 62 is fastened by means of articulated fitting 64. The cable 62 is adapted for connection to any of the conventional hand-operating cables ordinarily supplied with artificial arms, such as a cable arranged for actuation by a harness responsive to shrugging of the shoulder of the amputee.

2

To permit motion of the lever arm 53 with its equalizer bar mechanism under the action of cable 62, the metacarpal pieces are each cut away to form a large aperture 66 (Fig. 2). The provision of this aperture serves the additional purpose of making the metacarpal piece lighter in weight. Despite the material removed to form the aperture, the metacarpal does, however, provide sufficient strength and rigidity by virtue of its flanged construction. The material used is preferably aluminum or aluminum alloy or the like. The thumb and fingers are similarly made of the same material, also flanged for strength. The thumb phalange 68, for example, is flanged as evident at 70, and lightened in weight by being pierced as at 72'. The other four fingers are structurally similar to each other, each phalange being made generally of two flanged, structural sections, roughly channel-like, placed back to back and fastened together with spacers between them. As seen in Figs. 1 and 2, particularly, the construction is typified by the forefinger where the first phalange includes the medial structural member 72 and the lateral structural member 74 having turned-over flanges 76 and 78. The two members 72 and 74 are fastened together by two pins 79 and 80, riveted or spot-welded or the like. The ungual phalange is similarly constructed of a medial member 82 and a lateral member 84 flanged as at 86 and 88, the two members being fastened together by pin 90 and screw 92. The first phalange is articulated, as previously described, at 26 to its corresponding metacarpal, this being accomplished by means of a screw 94

provided with washers 96 and extending through a cylindrical pulley-like grooved spacer 98. Similarly, the ungual phalange is articulated as at 28 to the first phalange by means of a screw 100, washers 102, and grooved spacer 104.

For causing automatic flexion of the ungual phalange in response to flexion of the first phalange a cable 106 (Fig. 3) is provided, anchored at its distal end to the screw 92, passing over the pin 90 and under and tangent to the spacer 104, thence over the spacer 98, finally being anchored at its proximal end to the metacarpal at screw 108. To assist in returning the fingers to an extended position after flexion, a coil spring 110 is provided for each of the four fingers. The spring is anchored at one end 112 to the ungual phalange, and at its other end 114 to the first phalange. For a similar purpose, the spring 116 is provided on the thumb.

Operation

In using the illustrated embodiment of the invention, the hand is attached to the arm piece of the amputee by means of the threaded connection 4, the actuating cable 62 is attached to the cable from amputee's shoulder harness and a glove of rubber-like material, preferably simulating a natural hand, is slipped onto the hand. This glove is molded in the open position and, when flexed, tends to return to that position by virtue of its resiliency.

With no tension on the cable 62 the hand remains in a natural-appearing somewhat extended position, being held in that position by the combined action of the resilient glove and the springs 10, although the glove alone may be quite sufficient for the purpose. To grip an object the amputee tenses the cable 62 causing the lever arm 53 to move from the position shown in phantom line in Fig. 3 to the solid line position. This moves bodily the equalizer bar 46 carried by the lever arm 53 and thus tends to draw the cables 38 and 40 to the right, as viewed in Fig. 3, tending to flex the first phalange of the fingers attached to those cables. However, by virtue of the pivot at 48 it is possible for one pulley with its cable to move a different distance than that moved by the other pulley and cable, which condition would obtain if one pair of the four fingers meets an obstruction sooner than the other pair, as would be the case in gripping irregular objects. Furthermore, of each pair it is possible that one finger can move a different distance than the other of that pair by virtue of the pulleys and the fact that a single cable is anchored at opposite ends to the two adjacent fingers, rather than having a separate cable from each finger.

Flexing of the first phalange of a finger causes the typical cable 106, Fig. 3, to tend to shorten by wrapping itself around the guide 98, thus, in effect, pulling on the ungual phalange and causing the ungual phalange to flex in proportion as the first phalange flexes. Simultaneously with the flexing of the four fingers the thumb is also flexed by tension exerted on the cable 55, thus bringing the thumb in opposition to the other fingers in a natural manner adapted for the gripping of an object. To release the grip on the object, the amputee simply releases the tension on cable 62 and the resilient glove, either alone, as the case may be, or with the aid of the springs 110 and 116, restores the hand to extended position.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A hand prosthesis comprising a wrist; a plurality of metacarpals; resilient means for mounting said metacarpals on said wrist; a plurality of phalanges articulated to said metacarpals; a second plurality of phalanges articulated to the phalanges of said first plurality; an equalizer bar pivotally mounted on the hand; a pair of pulleys mounted on said equalizer bar on opposite sides of the pivot axis of said bar; a first cable passing over one of said pulleys and anchored at one end to one of said first plurality of phalanges and anchored at its other end to a second of said first plurality of phalanges; a second cable passing over said second pulley and anchored at one end to a third one of said first plurality of phalanges and anchored at its other end to a fourth one of said first plurality of phalanges; means for bodily moving said equalizer bar to apply tension to said cables; and means connected between said metacarpals and said second plurality of phalanges for automatically flexing said second plurality of phalanges in response to flexion of said first plurality of phalanges.

2. The prosthesis of claim 1 including a support arm rigid with said wrist; a lever arm pivoted to said support arm about a lateral-medial axis; said equalizer bar being pivoted to said lever arm about a dorsal-volar axis; the said means for bodily moving said equalizer bar including a cable connected to said lever arm for rotating said lever arm about said lateral-medial axis and adapted for actuation by the wearer.

3. The prosthesis of claim 2 including a thumb phalange articulated to one of said metacarpals; and a cable connected between said thumb phalange and said lever arm whereby said thumb phalange is flexed simultaneously with flexion of the finger phalanges.

4. The prosthesis of claim 3 including resilient means for extending said phalanges upon release of tension on said wearer-actuated cable.

5. The prosthesis of claim 1 wherein said first cable is anchored at its one end to a phalange of the little finger and at its other end to a phalange of the ring finger and wherein said second cable is anchored at its one end to a phalange of the middle finger and at its other end to a phalange of the forefinger.

6. A prosthesis element including a base member; a first phalange articulated proximally about a first axis to said base member; a second phalange articulated to said first phalange about a second axis in the distal region of said first phalange; a cylindrical guide described about said first axis; a cylindrical guide described about said second axis; a cable anchored at its one end to said base member, passing dorsally over and in contact with said first guide and thence volarly over and in contact with said second guide and being anchored at its other end to said second phalange; and a third guide, carried by said second phalange, for maintaining said cable always in contact with said second guide during relative flexion and extension of said phalanges.

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No references cited.