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3,413,658

ARTIFICIAL HAND HAVING A BODY CONSTRUCTED FROM SEPARATE MOLDED
PLASTIC PARTS FOR EASIER REPLACEMENT OF DAMAGED PARTS

Filed Oct. 20, 1965

2 Sheets-Sheet 1

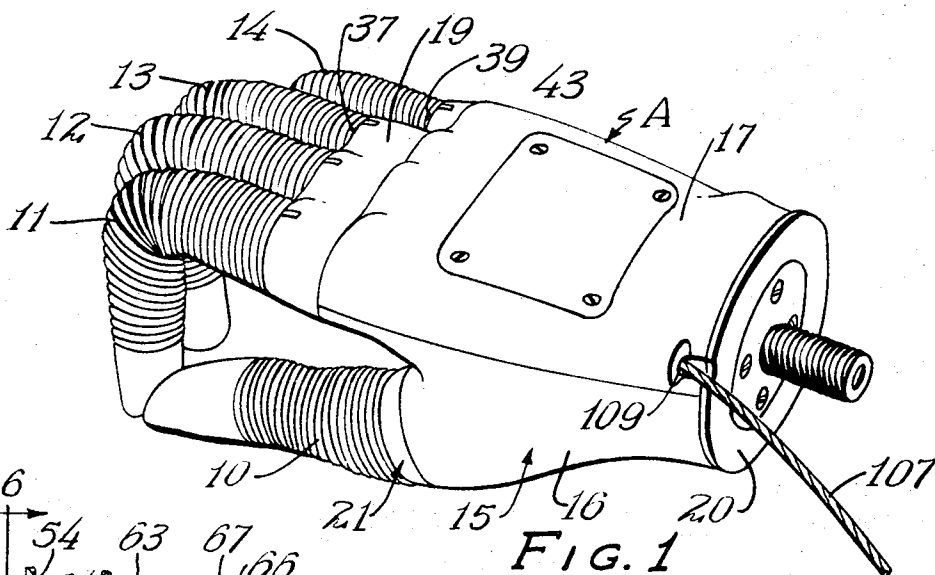


FIG. 1

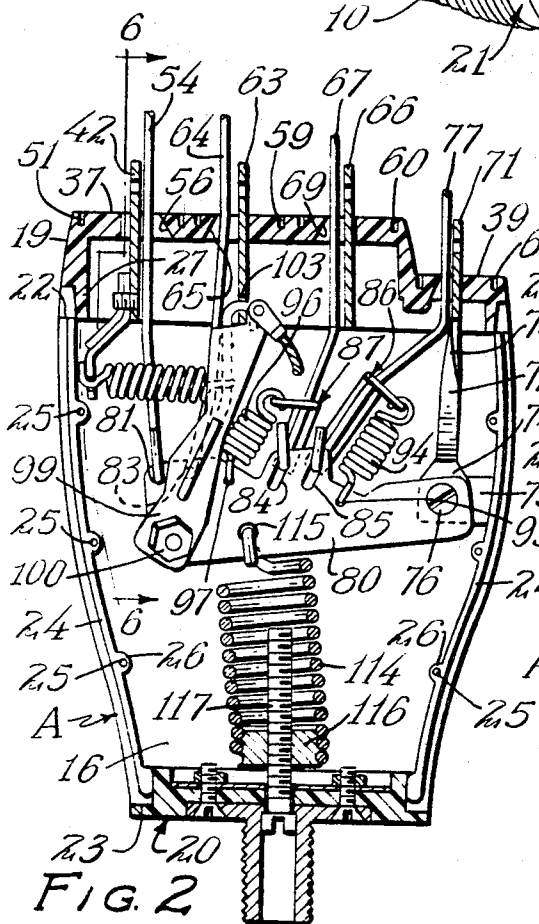


FIG. 2

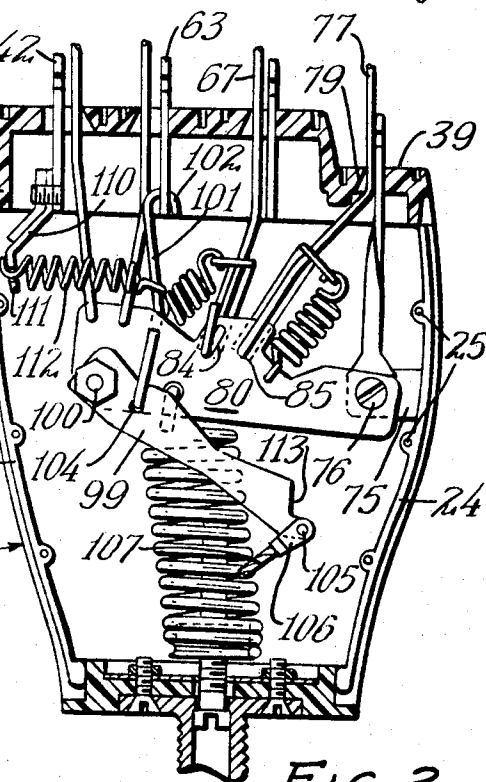


FIG. 3

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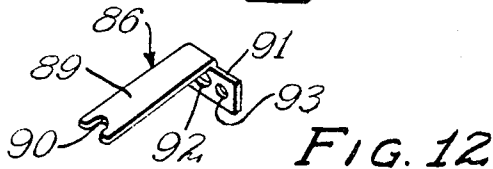


FIG. 12

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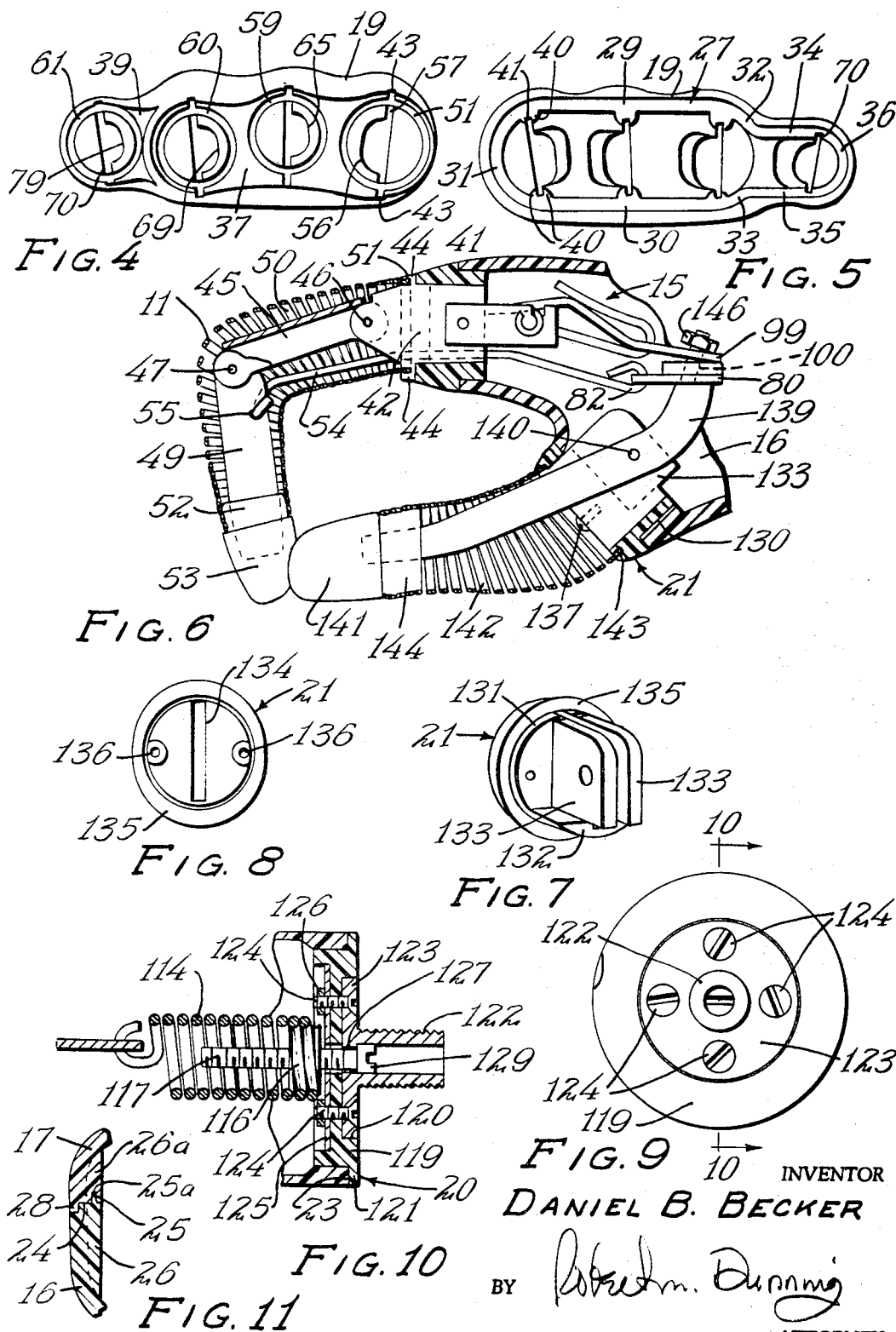
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ARTIFICIAL HAND HAVING A BODY CON- STRUCTED FROM SEPARATE MOLDED PLASTIC PARTS FOR EASIER REPLACEMENT OF DAMAGED PARTS

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12 Claims. (Cl. 3—12.7)

ABSTRACT OF THE DISCLOSURE

An artificial hand, the body portion of which is made of molded plastic. The body is made up of a first portion shaped to simulate the palm portion of the hand, a second portion shaped to simulate the back of the hand, and a knuckle forming section interfitting to the palm and hand back portions. Flexible fingers are supported by the knuckle forming section. The fingers are flexed by a level means within the hand body connected to the fingers by links.

This invention relates to an improvement in artificial hand and deals particularly with a hand body made of molded plastic.

Artificial hands have, for the most part, been mainly formed of wood or metal. In some instances parts of the hand have been made of plastic, and in other instances the hand bodies have been formed of sheet metal. There are numerous advantages in the forming of artificial hands of plastic. However, as it is desirable to maintain the hand in a life-like form, considerable expenses involved in the molding operation. Furthermore, difficulty is also experienced in forming the hand body in a plurality of parts so that the hand may be disassembled if necessary and so that individual parts of the hand body may be replaced if they become broken or damaged.

A feature of the present invention resides in the provision of a hand body in which the palm portion of the hand and the base of the thumb are formed in one section, the shell forming the back of the hand is formed in a second section, the portion forming the knuckles of the hand is formed in the third section, and the end closure at the wrist of the hand is formed in a fourth section. A mounting member for supporting the thumb forms a fifth molded part. The portion of the hand forming the knuckle section and the wrist closure include telescoping portions which extend between the two portions forming opposite sides of the hand and provide a mechanism chamber within a hollow hand body.

A further feature of the present invention resides in the provision of an artificial hand in which the four fingers of the hand may open and close simultaneously, and in which the third and fourth fingers of the hand are connected to the operating lever through a lost motion connection. Spring means are provided for normally connecting the finger actuating mechanism of the third and fourth finger for movement in unison with the first and second fingers. However, the springs may expand if the third and fourth fingers are held from movement toward closed position to a greater extent than the first and second fingers, allowing the fingers to close more naturally about an uneven object.

A further feature of the present invention resides in the provision of a novel and effective means of anchoring the butt end of the fourth or little finger. Due to the fact that this finger is a smaller size than the others and due to the fact that the link operating this finger must be bent at a considerable angle, this finger has been more susceptible to injuries than the others. The difficulty is increased by the fact that the finger is more susceptible to lateral

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forces in the normal movements of the hand. The anchoring member for this finger is accordingly extended into the hollow body of the hand and anchored at a point considerably spaced from the butt end of the finger and is accordingly capable of withstanding much greater strain.

A further feature of the present invention resides in the provision of an improved manner of adjusting the tension on the springs used to bias the fingers toward closed hand position. When the hand is detached, the spring tension may be adjusted by use of a screwdriver, making it possible to adjust the tension more readily than in previous structures.

A further feature of the present invention lies in the provision of a novel form of locking spring bracket. This bracket is attached to the butt end of the first finger rather than to the body of the hand.

An added feature of the present invention resides in the formation of the fingers of resilient wire which is of oval cross-section. In the past resilient finger bodies have been formed by helically wound wire of round section and also wire of rectangular section. Wire of oval cross-section has been found superior to either of the previous constructions.

These and other objects and novel features of the present invention will be more clearly and fully set forth in the following specification and claims:

In the drawings forming a part of the specification:

FIGURE 1 is a perspective view of the assembled hand in closed position.

FIGURE 2 is a view of the hand with the bodies of the fingers removed and with the knuckle forming portion in section and hand back body portion removed.

FIGURE 3 is a view similar to FIGURE 2 but showing the position of the mechanism when the fingers are in open position.

FIGURE 4 is a front elevational view of the knuckle forming section of a hand body.

FIGURE 5 is an elevational view of the end of the knuckle forming portion of the body opposite that illustrated in FIGURE 4.

FIGURE 6 is a diagrammatic vertical sectional view through a thumb and finger showing the arrangement of the parts.

FIGURE 7 is a perspective view of the thumb mounting member.

FIGURE 8 is an outside end view of the thumb mounting members shown in FIGURE 7.

FIGURE 9 is an end elevational view of the mounting end of the hand.

FIGURE 10 is a sectional view on the line 10—10 of FIGURE 9.

FIGURE 11 is a sectional detail of the manner in which the body sections are connected.

FIGURE 12 is a perspective view of a detail portion of the mechanism.

The artificial hand A includes a hand body to which are articulated a thumb 10 and first, second, third, and fourth fingers 11, 12, 13 and 14. In general, the mechanism used for flexing the individual fingers is similar to that illustrated in Patent 2,301,009 issued to me on November 3, 1942. Accordingly, the finger structure is not shown in detail.

The hand body is indicated in general by the numeral 15, and includes a lower or a palm forming section 16, a hand back forming portion 17, a knuckle forming portion 19, and a wrist closure 20. The thumb mounting 21 is also a separately molded part.

The knuckle end 22 of the hand sections 16 and 17, and the wrist end 23 of these sections terminate on substantially parallel planes. The upper edge of a lower section 16 and the butting lower edge of the upper section 17 are connected along tongue and grooved joints.

Tongues 24 or flanges are shown in figures 2 and 3 and in detail in figure 11, extending upwardly from the butting edges of the lower section 16 along the inner sides of these edges. Similar downwardly extending tongues or flanges 28 are provided on the upper section 17 which telescope with the flanges 24 to form an overlapping edge seam. Locating pins 25 are also provided projecting upwardly from bosses 26 on the inner surfaces of the side walls of the lower section 16, and these pins 25 engage in sockets 25a in similar bosses 26a in the upper section 17. This arrangement is indicated in FIGURE 11 of the drawings.

The knuckle forming section 19 terminates on parallel planes and is shown in section in FIGURES 2 and 3 and in end elevation in FIGURES 4 and 5. A flange 27 is provided on the inner end of the knuckle section 19, the shape of the flange being similar to the shape of the forward end of the body sections 16 and 17. The flange 27 has a substantially flat upper portion 29 and a parallel lower portion 30. The flange portions 29 and 30 are connected by a rounded side portion 31. The upper and lower flange portions 29 and 30 curve inwardly as indicated at 32 and 33 which continue into the parallel portions 34 and 35 which are connected by a rounded side wall 36.

The flange 27 telescopes into the forward end of the hand body as formed by the section 16 and 17, and the knuckle section 19 forms a connection between the two body sections 16 and 17 and the individual fingers which are anchored to the knuckle portion 19.

As is indicated in FIGURE 1 of the drawings, the forward end 37 of the knuckle section 19 lies in substantially a common plane in the area thereof from which the first, second, and third fingers project. The end 39 of the area from which the little finger 14 projects as of somewhat shorter length. This is done so that the fourth finger may be located in a more natural position. A pair of opposed parallel ribs 40 project inwardly from the inner surface of the knuckle section 19 and are longitudinally grooved as indicated at 41. A flat finger supporting plate 42 is forced into the groove 41 as indicated in FIGURE 6. The outer end 37 of the knuckle section 19 is notched as indicated at 43 to accommodate lateral extensions of the plates 42.

A first link 45 has a first bifurcated end pivotally connected at 46 to the outward end of the plate 42 and has a second bifurcated end pivotally connected at 47 to a second link 49. A substantially helically wound spring 50 has a large diameter end and anchored in a circular groove 51 in the forward 37 of the knuckle section 19. The smaller diameter end of the spring 50 encircles a reduced diameter end 52 of a finger tip member 53 supported on the free end of the second link 49.

As is also evident from FIGURE 6 of the drawings, a finger operating rod 54 is loosely pivoted at 55 to the second link 49 near the pivot 47. The other end of the operating lever 54 extends into the hollow hand body and attaches to an operating lever in a manner which will be later described in detail.

While the major portion of the forward end 37 of the knuckle section 19 is closed, an aperture 56 is provided to accommodate the operating rod 54, and a transverse slot 57 is provided through the front closure at the forward ends of the grooves 41. In view of the fact that the finger operating linkage is, for the most part, not a part of the present invention, it is believed sufficient to state that the linkage within the fingers 12, 13, and 14 is similar to that described in conjunction with the finger 11. The forward end 37 of the knuckle section 19 is recessed to provide circular grooves 59 and 60 to accommodate one end of the helically wound wires forming the fingers 12 and 13. The surface 39 is also provided with a ring-shaped groove 61 to accommodate an end of the helically wound wire enclosing the mechanism of the finger 14. As is indicated in FIGURE 6 of the drawings, the wire form-

ing all of the fingers is of oval cross-section with a major axis of the oval parallel to the axis of the helix.

With reference to FIGURES 2 and 3 of the drawings, it will be noted that a finger mounting plate 63 projects from the end 37 of the knuckle section 19 extending axially through the ring-shaped groove 59, the plate 63 acting to support the finger 12. A finger operating rod 64 extends through an aperture 65 in the section end 37 to connect with the second link of the finger 12. A third finger mounting plate 66 projects from the knuckle section 19 extending axially of the groove 60 to support the finger 13, and an operating rod 67 similar to the operating rod 54 extends through an aperture in the section end 37, the aperture being indicated at 69. As the means of supporting the little finger is somewhat different, it will be separately described.

As indicated in FIGURE 5 of the drawings, and as may also be seen in FIGURE 4, a diametrically extending slot 70 extends through the end portion 39, the groove intersecting the slot 61. A finger mounting plate 71 extends axially of the groove 61 and its edges are engaged in the grooves 70. The mounting 71 includes a relatively narrow extension 72 which extends into the hollow body of the hand. The extension 72 is twisted at right angles at 73 and is provided with an enlarged end extremity 74. The extremity 74 is anchored by means of an anchoring bolt 76 to a boss 75 projecting inwardly from the wall of the lower section 16. This arrangement provides stability for the finger 11. The mounting plate 71 would otherwise be substantially weaker than the mounting plates 42, 63 and 66 because of the shorter length which would be supported by the knuckle section.

A finger operating rod 77 extends through an aperture 79 in the end portion 39 as indicated in FIGURES 2 and 3. This rod 77 is connected to the second link of the finger operating mechanism in the same manner the rod 54 is connected to the second link 49 of the finger 11.

With reference now to FIGURES 2 and 3 of the drawings, it will be noted that a lever 80 is pivotally supported by the anchoring bolt 76 to the boss 75 forming a part of the lower section of the hand. All of the four fingers as well as the thumb of the hand, are operated by movement of the lever 80 from the position shown in FIGURE 2 of the drawings to the position shown in FIGURE 3. When in the position illustrated in FIGURE 2, the hand is closed, or in the position illustrated in FIGURE 1 of the drawings. When in the position illustrated in FIGURE 3, the fingers are in partially extended position so as to grasp an object in the hand.

The lever 80 includes an aperture 81 through which an end of the rod 54 extends. As indicated in FIGURE 6, the rod 54, as well as the other finger operating rods, is provided with a loop 82 which extends through the operating lever 80 so that movement of the lever 80 may be transmitted to the rod 54. The lever 80 also includes an aperture 83 through which the end of the operating rod 64 is looped. The lever 80 is provided with a pair of slots 84 and 85 through which the ends of the operating rods 67 and 77 extend. The slots 84 and 85 are designed to provide a lost motion linkage which permits the fingers 11 and 12 to close to a somewhat greater extent than the fingers 13 and 14, this permitting the fingers to fit more readily about an uneven object.

In order to normally operate the third and fourth fingers 13 and 14 in unison with the fingers 11 and 12, a bracket 86 of the type described is mounted on the rod 77. A similar link 87 which is merely a reversal of the bracket 86 is used on the rod 67. Both of the brackets 86 and 87 include a flat arm 89 which extends longitudinally of the operating rod to which it is attached, and includes a notched end 90 which extends into the looped end of the operating rod to engage a portion of the loop. The end of the arm 90 is provided with a right angularly turned flange 91 containing an aperture 92 through which the rod 77 or 67 extends. The flange 91 includes a second aperture

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93. A spring 94 is connected between the aperture 93 and an aperture 95 in the lever 80. A spring 96 extends from the flange of the arm 87 to an aperture 97 in the arm 80. As a result, the springs 94 and 96 tend to draw the operating rods 77 and 67 against an end of the slots 85 and 84 respectively. However, if the shape of the object is such that the third or fourth fingers, or both of these fingers, must be extended to a greater degree than the first and second fingers in order to grasp the object, the springs 94 and 96 may extend to permit this action.

The lever 80 is mounted for pivotal movement about the axis of the anchor bolt 76. The pivotal movement is effected by a second lever 99 which is connected to the free end of the lever 80 by a pivot bolt 100 which is actually the threaded end of a thumb lever to be described. A floating axis about which the lever 99 is pivoted is provided by a link 101, one end 102 of which is looped through an aperture 103 in the anchoring plate 63 of the second finger 12, and the other end of which is looped through an aperture 104 in the lever 99 at a point spaced from the pivot bolt 100. The free end of the lever 99 is pivotally attached at 105 to a clevis 106 forming the terminal end of a flexible cable 107 by means of which the hand is controlled. As indicated in FIGURE 1 of the drawings, the cable 107 extends through an aperture 109 in the upper section 17 of the hand body and connects with a shoulder sling usually extending about the arm opposite the one supporting the artificial hand.

A bracket arm 110 is bolted or otherwise secured to the finger supporting plate 42, and is provided with an apertured offset end 111 which extends near the side of a hollow hand body. A spring 112 is anchored at one end to the bracket 110 and at its other end is looped about the link 101. The purpose of the spring 112 is merely to insure the pivoting of the lever 99 into the locking position illustrated in FIGURE 2 of the drawings. Thus, when tension upon the operating cable 107 is released, the fingers cannot be extended.

The end of the lever 99 is provided with a shoulder 113 which is designed to engage against the end of the mounting plate 63 for the second finger 12 when the lever 99 is in the position illustrated in FIGURE 2. As a result, any external pull on any of the operating rods 54, 64, 67 and 77 cannot pivot the lever 80 about its axis.

The lever 80 is urged toward the position shown in FIGURE 3 of the drawings by a spring 114, one end of which is looped through an aperture 115 in the lever 80. The other end of the spring 114 is anchored to a collar 116 which is threaded upon a screw shaft 117. The screw shaft 117 extends through the wrist closure 20 as will be described.

The wrist closure includes a disk-shaped body having a circular recess 120 in its outer surface. The disk 119 is provided with a peripheral flange 121 which engages against the end of the hand body sections 16 and 17. This end of the hand body has been identified by the numeral 23.

For attaching the artificial hand to a suitable member on the end of the arm, an externally threaded sleeve is provided as indicated at 122, the sleeve being provided with a circular flange 123 at one end which fits into the groove 120 in the outer end of the disk 119. Anchoring bolts 124 extend through the flange 123, the disk 119, a metal reinforcing disk 125 inwardly of the disk 119, and are provided with anchoring nuts 126 to hold the mounting sleeve in place.

The threaded bolt 117 extends through an aperture 127 in the flange 123 at the base of the sleeve 122, and the slotted head 129 of the bolt 117 is within the sleeve 122. By rotation of the bolt 117, the collar 116 may be moved toward or away from the wrist closure 20, increasing or decreasing the tension of the spring 114.

As is indicated in FIGURE 6 of the drawings, the palm forming body portion 16 of the plastic hand body 15 is provided with a cylindrical opening 130 extending there-

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through. The thumb mounting 21 is supported in this opening 130. As is indicated in FIGURES 7 and 8 of the drawings, the thumb mounting member 21 is provided with a cylindrical portion 131 which fits within the opening 130. An arcuate segment 132 forms an extension of the cylindrical portion 131 and extends to a greater extent into the hand body.

A pair of spaced parallel ears 133 extend at right angles to the cylindrical portion 131 of the thumb mounting 21. The cylindrical portion 131 is slotted between the ears 133 as indicated at 134. The outer end portion 135 of the thumb mounting member 21 is tapered and is of larger diameter to connect the opposite sides of the thumb mounting.

A lever 139 is supported intermediate its ends by a pivot pin 140 extending through the ears 133. A thumb tip 141 is mounted on the end of the lever 139, and the helically wound coil 142 is anchored at one end in a groove 143 in the thumb mounting 21 and at its other end encircles a reduced diameter inner end portion 144 of the thumb tip 141. Screws 137 extend into diametrically opposed apertures in the thumb mounting 21 to hold the last convolution of the coil 142 in the groove 143. The other end of the lever 139 is provided with a cylindrical shank 100 which is threaded. The shank 100 extends through an end portion of the lever 80 and also through an end portion of the lever 99 to form a pivotal connection or bolt 100 connecting the two levers. A nut 146 on the threaded shank holds the parts connected together.

FIGURE 2 of the drawing illustrates the position of the various parts of the hand when no pull is exerted upon the operating cord 107. FIGURE 3 of the drawings illustrates the position of the parts in the other extreme position thereof. When a pull is exerted upon the cord 107, the lever 99 pivots about the axis of the aperture 104, swinging the shank or pivot bolt 100 in a clockwise direction about the axis of the aperture 104. This action swings the lever 80 in a clockwise direction about the axis of the pivot bolt 76. This movement swings the thumb lever 139 in a counter clockwise direction as viewed in FIGURE 6, and applies force to the rods 54, 64, 67 and 77. This movement therefore straightens out the various fingers, and moves the thumb away from the fingers.

If the fingers are closed about an object, in such a manner that the little finger or the finger adjoining the little finger contact the object before it is engaged by the other fingers, the springs 94, 96, or both may stretch to some extent due to the slots 84 and 85. This permits the hand to adopt itself more readily to various surfaces and insures a grip on a large object by more than one finger at a time. The force with which the fingers and thumb may grip an object may be regulated by changing the tension on the spring 114. This is done by merely removing the artificial hand and rotating the adjustment screw 117.

When the hand is in closed position, it is locked in this position by the engagement of the shoulder 113 against the mounting plate 63. This arrangement is of considerable importance when the hand is being used to support a suitcase or similar piece of luggage. Any pull upon the fingers tending to open them and to extend the fingers is prevented by the engagement of the shoulder 113 against the plate 63. As a result, the hand may only be opened from its closed position by pivotal motion of the lever 99.

In accordance with the patent statutes, I have described the principles of construction and operation of my improvement in "Artificial Hand," and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. An artificial hand comprising a hollow plastic body including:

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- a first concavo-convex plastic body portion shaped to simulate the palm portion of a hand,
 a second concavo-convex plastic body portion shaped to simulate the back of a hand,
 marginal side edges on said body portions secured in edge abutting relation,
 the forward ends of said sections being spaced to define an opening,
 a plastic knuckle forming section telescoping into said opening and projecting forwardly from said body portions,
 a thumb aperture in the forward portion of said palm forming section,
 a plastic thumb support telescoping into, and projecting from said thumb openings,
 flexible fingers secured to, and projecting from, said knuckle forming section,
 a flexible thumb secured to, and projecting from, said thumb support, and
 means within said body connected to said fingers and said thumb for flexing the same.
2. The structure of claim 1 and in which said first and second body portions define at their rearward ends a generally cylindrical wrist opening, and a plastic closure telescoped into said wrist opening.
3. The structure of claim 1 and including a disc connected to said closure and supporting a threaded shank.
4. The structure of claim 1 and in which said first and second body portions include interfitting edges.
5. The structure of claim 1 and in which said first and second body portions are shaped to provide a substantially cylindrical wrist opening, and including a wrist closure extending into said wrist opening.
6. An artificial hand body including:
 a first concavo-convex plastic body portion shaped to simulate the palm portion of the hand,
 a second concavo-convex plastic body portion shaped to simulate the back portion of the hand,
 contiguous abutting side edges on said sections, said body portions defining a knuckle opening at one end and a wrist opening on the other end,
 a plastic knuckle forming section telescoping into and projecting from said knuckle openings, and
 a plastic plug telescoping into, and projecting from, said wrist opening.
7. The structure of claim 6 and including finger anchoring means embedded in said knuckle forming section.
8. An artificial hand body including:
 a first concavo-convex plastic body portion shaped to simulate the palm portion of the hand,
 a second concavo-convex plastic body portion shaped to simulate the back portion of the hand,
 contiguous abutting side edges on said sections, said body portions defining a knuckle opening at one end and a wrist opening on the other end,
 a plastic knuckle forming section telescoping into and projecting from said knuckle opening, and

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- a plastic plug telescoping into, and projecting from, said wrist opening,
 metal finger supports attached to, and supported by, said knuckle forming section, and
 an extension on the metal finger support for supporting the little finger and anchored to said first body portion at a point spaced from said knuckle forming section.
9. The structure of claim 8 and including a series of helically wound flexible fingers connected to said finger supports,
 said fingers being formed of wire of substantially oval cross-section with the major axis of the oval substantially parallel to the axis of the finger.
10. An artificial hand including,
 a hollow body simulating the body of a hand,
 a series of flexible hollow fingers secured to said hand body,
 finger actuating rods connected to said fingers to flex the same toward extended position,
 a lever to which said rods are pivotally secured and pivotally supported in said body,
 a second lever pivotally connected to said first lever at a point spaced from the pivotal support of said first lever,
 a link pivotally connecting said second lever to said hand body,
 at least one of said finger actuating rods having a slidable as well as pivotal connection with said first named lever, and spring means connecting said one finger actuating rod and said first lever to resiliently hold said one rod from sliding relative to said first lever.
11. The structure of claim 10 and in which said one finger actuating rod comprises the rod actuating the finger corresponding to the little finger of the hand.
12. The structure of claim 10 and in which said finger actuating rods having a slidable as well as pivotal connection with said first named lever comprises the finger actuating rods actuating the fingers corresponding to the little finger of the hand and the next adjacent finger thereto.

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