June 9, 1942. D. B. BECKER 2,285,885

MECHANICAL HAND

Filed Dec. 20, 1938 2 Sheets-Sheet 1

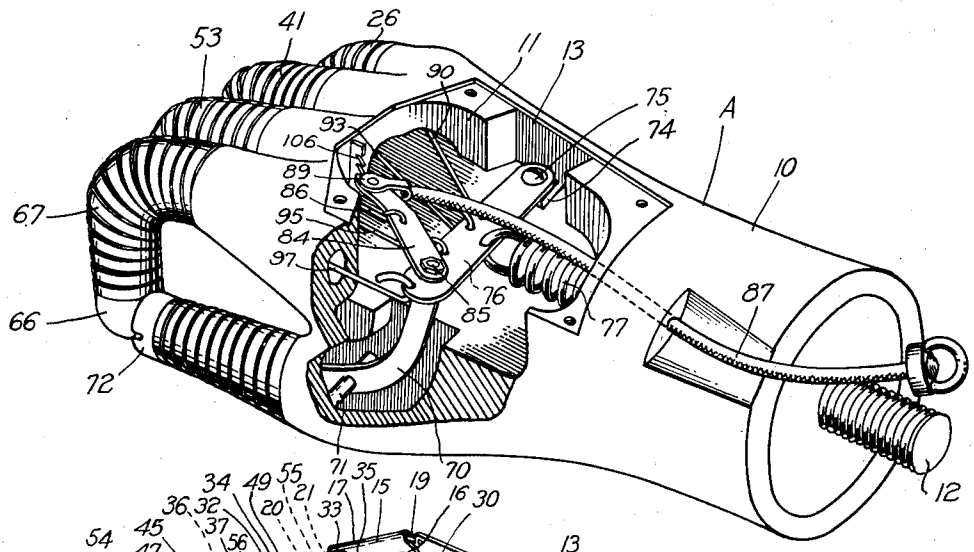


Fig. 1

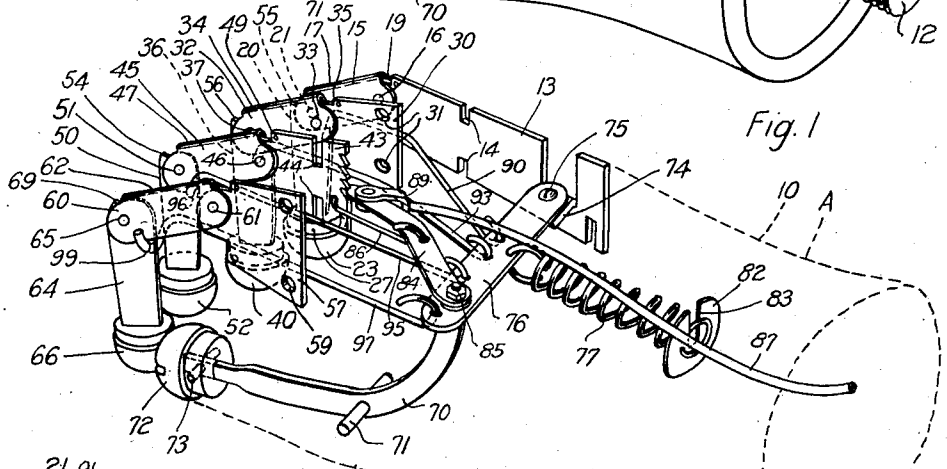


Fig. 2

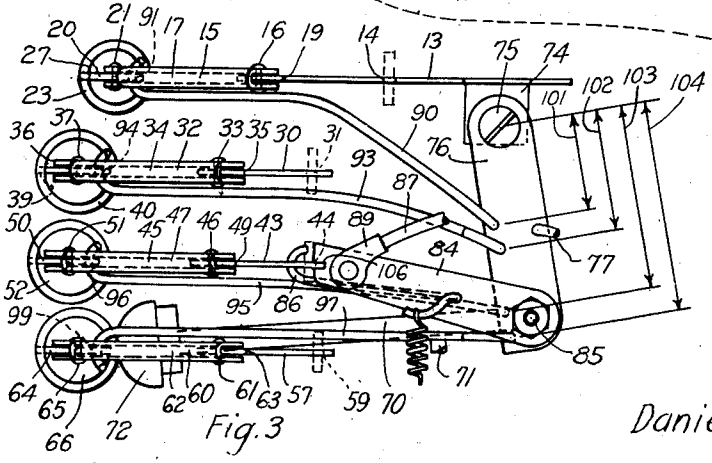


Fig. 3

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MECHANICAL HAND

Filed Dec. 20, 1938 2 Sheets-Sheet 2

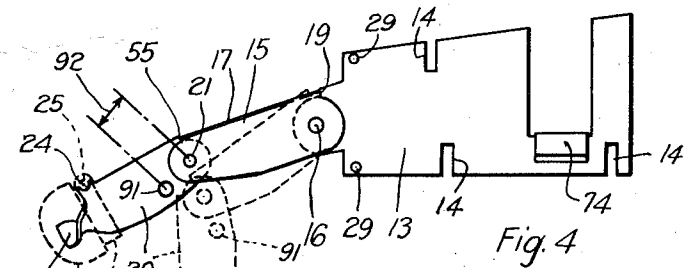


Fig. 4

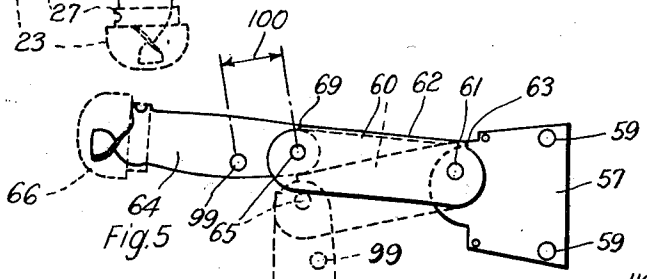


Fig. 5

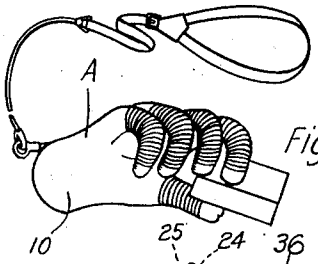


Fig. 8

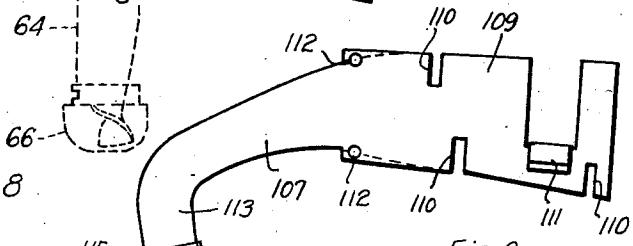


Fig. 9

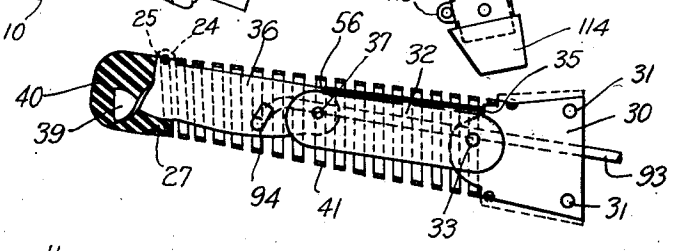


Fig. 6

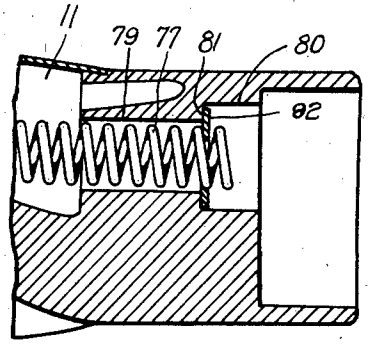


Fig. 7

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Patented June 9, 1942

2,285,885

UNITED STATES PATENT OFFICE

2,285,885

MECHANICAL HAND

Daniel B. Becker, St. Paul, Minn.

Application December 20, 1938, Serial No. 246,815

15 Claims. (Cl. 3—12)

My invention relates to an improvement in artificial hand, wherein it is desired to provide an artificial hand which will, as nearly as possible, provide the appearance and action of a natural hand.

During the past years various types of artificial hands and arms have been invented and manufactured. These appliances range in design from merely a hook formation to a construction in which all of the fingers are movable. Some of these latter devices are formed with resilient fingers which may be bent in certain predetermined directions. Others are arranged for manual operation in both directions, and by operating suitable cords may be moved from extended position in which the fingers are extended to bent position in which the fingers are bent to hold an article. It has been usual practice to operate the fingers by means of operating cords; and if the fingers are held normally in any position, they are ordinarily held by springs or resilient means in extended position.

It is a purpose of my invention to provide a hand construction in which the fingers are normally bent. I provide means which normally holds the fingers bent, and a locking means to prevent the fingers from opening accidentally. Thus when the hand is used for carrying an article, such as a bag or suitcase, the weight of the bag which tends to straighten the fingers cannot accidentally act in this manner. Physical force or strain on the fingers cannot open the same when the fingers are locked in bent formation; but by pulling upon an operating cord the fingers may be unlocked or pulled into extended position.

I have found that the hand is used less often in extended position than in bent position. The only time when it is necessary to extend the fingers is to engage an article in the hand. Therefore, I retain the fingers of my hand normally in bent position, and provide spring means tending to close the hand. When the operating cord is pulled, the fingers will be extended; and when the cord is released, the fingers will be pulled toward closed position. If an object is being supported by the hand, it will be held there by spring tension until the operating cord is again pulled to extend the fingers and release the object.

It is a purpose of my invention to provide an artificial hand having fingers which act as nearly as possible to the fingers of a human hand. In place of the bones of the human finger, I provide links pivotally connected together. These links are so arranged and connected to the lever means in such a manner that the fingers will open and close in an extremely natural manner. In other words, the rate at which the fingers bend into extended or closed formation simulates very closely the action of the human hand.

It is a feature of my invention to provide a hand having fingers which are formed by a substantially helically wound flat spring wire from the finger tip to the base of the finger. This flat wire provides a substantially flat surface on the external surface of the fingers. When the fingers are concealed by a glove, the appearance of the hand simulates very closely the appearance of a human hand.

It is a feature of my invention to form my hand in normally closed position; and that in this position the thumb and forefinger contact. When the hand is bent into extended position, not only does the forefinger bend straight, but the thumb pivots back, to provide more ready entrance into the hand of any object.

It is a further feature of my invention to provide a hand which is retained in one extreme position by means of a suitable resilient spring means, and to provide a means of adjusting the tension of this spring. In this way the tension tending to close the hand may be adjusted; and therefore the "grip" of the hand, or the pressure tending to hold an object in the hand, is arranged.

It is an added feature of my invention to provide a finger construction in which a series of links support a finger tip portion of rubber or any desired material. The means anchoring the links to the body of the hand support one end of the substantially helical springs, while the other ends of these springs are secured to the finger tip portions by means of a projection on the last link of each finger.

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

In the drawings forming a part of my specification:

Figure 1 is a perspective view of my hand with a portion of the same broken away to disclose a part of the mechanism thereof.

Figure 2 is a perspective view of the operating mechanism in operating position, but removed from the body of the hand.

Figure 3 is a top plan view of the operating mechanism of my hand, the body of the hand being omitted.

Figure 4 is a side elevation view of the operating mechanism of the fourth or little finger.

Figure 5 is a side elevational view of the operating mechanism of the first or forefinger.

Figure 6 is a side elevational view of one of the fingers in extended position, showing the manner of attachment of the finger body forming spring.

Figure 7 is a cross-sectional view through the wrist end of my hand, illustrating the tension spring adjusting mechanism.

Figure 8 is a perspective view of the hand and the shoulder strap by means of which the fingers of the hand may be controlled or operated.

Figure 9 illustrates an alternate form of little finger construction.

The hand A comprises a hand body 10 which is shaped as nearly as possible to simulate the shape of the human hand, from the wrist to the base of the fingers. A portion of the back of the hand is hollowed out to provide an aperture 11 or recess in which much of the operating mechanism for the hand may be positioned. The wrist end of the hand may be provided with any suitable attaching mechanism such as 12; and may be fastened to the stump of the forearm, or may be connected to an artificial arm.

In the part of the hand adjacent the base of the fingers, I provide an anchoring means to which the fingers may be pivoted. Along one edge of the recess 11, I secure an anchoring plate 13. The plate 13 has anchoring notches 14 through which screws or pins, not shown, may extend to hold the plate in proper position in the hand body 10. The extreme front tip end of this finger anchoring plate 13 is rounded, and extends beyond the body portion of the hand.

A link 15 is pivotally connected at 16 to the tip end of the plate 13. This link 15 is formed by folding a strip of metal to provide a pair of parallel side portions connected along the top edge of the link. This top edge 17 of the link 15 holds the sides of the link in proper relation, and has the added function of engaging a shoulder 19 on the anchoring plate 13 to limit the extension of the finger. Engagement of the end of the top edge 17 with the shoulder 19 will limit the pivotal movement of the link 15 thereupon in one direction.

A second link 20 is pivoted at 21 between the opposed sides of the link 15. This second link is formed as is perhaps best illustrated in Figures 4 and 6 of the drawings. It will be noted that the end of the link 20 is narrowed down and twisted to form a twisted anchoring portion 22 which is preferably cast directly into the body of the finger tip 23. This tip 23 may be of rubber, plastic, or any suitable means.

On the link 20 directly adjacent the twisted end 22, I form an ear 24 best shown or indicated by dotted outline in Figure 6 of the drawings. While Figure 6 does not illustrate the little finger, the construction of which has been described, all of the links are similarly formed. The ear 24 is provided with an opening 25 therethrough through which the end of the substantially helical coil such as coil 26 of the little finger, or the coil 41 of the third finger shown in Figure 3, and which is formed of flat wire, may extend. It will be noted that each finger tip, such as the tip 23 of the little finger or the tip 40 of the third finger, is provided with a cylindrical shank portion 27 of slightly smaller diameter than the tip 23. The ear 24 projects from this portion of the tip. The spring coil must be stretched slightly to encircle the shank portion 27 of the tips, and therefore engages this portion of the tip under spring tension. After the spring coil 26 is attached to the top, the ear 24 is ground down until the ear is merely notched to hold the spring coil 26.

The other end of the spring coil 26 is likewise anchored to the anchoring plate 13. As seen in Figure 4, the plate 13 is provided with a pair of holes 29 therethrough, through which the end of the coil is wound. However, in order to make the surface of the hand adjacent the fingers flush with the surface of the fingers, the anchoring plate 13 is ground down until the upper and lower edges of the anchoring plate 13 are merely notched. The principle involved may be seen in Figure 6 of the drawings. In full lines is shown the shape of the plate in the finished hand, while in dotted outline is shown the original shape of the anchoring member.

An anchoring plate 30 is provided for the third finger. This plate has holes 31 therethrough, through which anchoring pins may be driven to hold the plate 30 in proper position in the hand body 10. This anchoring plate 30 is provided with a rounded tip end to which a link 32 is pivoted by means of a pivot 33. The link 32 is formed with opposed sides and a connecting top edge 34 designed to engage a shoulder 35 on the anchoring plate 30 in extended position of the fingers to limit the pivotal movement in one direction.

A second link 36 is pivoted at 37 between the sides of the link 32. This link 36 is similar to the link 20, and, as shown in Figure 6, is provided with an anchoring tip 39 moulded into the finger tip 40. The substantially helical wire coil 41 is attached to an ear similar to the previously described ear 24 on the link 36, and is connected in the manner previously described to the anchoring plate 30.

The second finger is provided with an anchoring plate 43 having apertures 44 through which anchoring pins may be driven to hold the plate in adjusted position. A rounded end is provided on the plate 43, and a link 45 is pivoted thereto at 46. The link 45 is formed of opposed sides and a connecting top portion 47 which is designed to engage a shoulder 49 to limit pivotal movement in one direction.

A second link 50 is pivoted at 51 between the sides of the link 45, and a finger tip 52 is cast upon the end thereof. A coil 53 is secured to the link 50, and to the anchoring plate 43 in the manner described in detail, forming the body of the finger. A shoulder 54 on the link 50 is designed to engage the top portion 47 of the link 45 in extended position of the finger to limit pivotal movement between the links 45 and 50. A similar shoulder 55 is provided on the link 20 to engage the top edge 17 of the link 15; and a shoulder 56 on the link 36 limits the pivotal movement of this link by engaging the top edge 34 of the link 32.

The first or forefinger construction is seen in Figure 5 of the drawings, and is similar to the constructions described. An anchoring member 57 is provided with apertures 59 through which means may extend to anchor the plate 57 in the hand body 10. A rounded end is provided on plate 57, and a link 60 is pivoted thereto at 61. The link 60 is provided with opposed sides and a connecting top edge 62, which in extended position engages a shoulder 63 on plate 57 to limit pivotal movement.

A second link 64 is pivoted at 65 between the sides of the link 60, and supports a finger tip 66.

A coil spring 67 connects the link 65 with the anchoring plate 57 in the manner previously described. A shoulder 69 on the link 64 engages the top edge 62 in extended position of the finger to limit pivotal movement.

The thumb of the hand is formed by a long curved lever 70 which is pivoted upon a pivot pin 71 supported by the body of the hand 10. A thumb tip 72 is either cast directly on the end of the lever 70, or is secured thereto in any desired manner, as by the dowel pin 73.

An ear 74 is provided on the anchoring plate 13, and a pivot bolt or pin 75 secures a lever 76 pivotally thereto. This lever is urged into one extreme position by a tension spring 77, one end of which is secured to the lever 76. The other end of the spring, as may be seen in Figure 7 of the drawings, extends through a longitudinally extending aperture 79 extending from the mechanism aperture 11 to the wrist end of the hand. One end of the aperture 79 is enlarged to form a portion of larger diameter 80, forming a shoulder 81 between the portions of different diameter.

A washer 82 is provided to adjust the tension of the spring 77. The washer is shown in Figures 2 and 7 of the drawings, and comprises a disk of metal which is provided with a notch 83 extending from one edge of the disk to a point beyond the center of the disk. The disk is bent slightly to conform with the pitch of the spring 77, which extends through the notch 83 as seen in Figure 2 of the drawings. By inserting a tool such as a screw driver into the notch 83 within the spring 77, the disk may be rotated in either direction, thereby screwing the disk farther onto the spring, or farther off the spring, thereby changing the tension of the same.

A lever 84 is pivoted at 85 to the free end of the lever 76. This lever is connected by a link 86 to a fixed point on the body 10, such as the anchoring member 43. A cord 87 is connected to a yoke 89, which is pivotally attached to the end of the lever 84 opposite the end thereof pivoted to the lever 76. Obviously, by pulling on the cord 87, the lever 84 is pivoted about its pivot point, which is in this case the point of attachment with the link 86. As this pivot point is in front of the lever 76, the pivoting of the lever 84 acts to move the end of the lever 84 attached to lever 76 forwardly toward the fingers, therefore pivoting the lever 76 toward the fingers.

A connecting push rod 90 is pivotally linked through the lever 76, and to the link 20 forming a part of the fourth or little finger of the hand. The rod 90 is bent to pass through an opening 91 in the link 20 which, as may be best noted in Figure 4 of the drawings, is a distance 92 from the pivot 21 connecting the link 20 to the link 15. Upon forward movement of the lever 76, the little finger is thus pivoted into extended position, illustrated in full lines in Figure 4 of the drawings. When the pressure on the cord 87 is released, the spring 77 pivots the lever 76 back, drawing on the connecting push rod 90 and pivoting the little finger into the position illustrated in dotted outline in Figure 4, which is its normal position.

A push rod 93 connects the lever 76 to the link 36 to operate the links 36 and 32. The push rod is bent to extend pivotally through the lever 76, and extends through the link 36. Forward movement of the lever 76 acts to push the lines 36 and 32 into extended position. The opening 94 in the link 36 is at a distance from the pivot 37 connecting the links 32 and 36 which is slightly greater than the distance 92, so that the third finger is pivoted into extended position slightly slower than the little, or fourth, finger.

A push rod 95 is loosely linked through the lever 76, and connects this lever with the link 50 of the second finger. The rod 95 extends through an aperture 96 in the link 50 which is at a distance from the pivot 51 greater than the distance 92, and greater than the distance between the opening 94 and the pivot 37 of the third finger.

A push rod 97 is loosely linked through the lever 76 and is bent to extend through an opening 99 in the lever 64 of the first or forefinger. The distance 100, as shown in Figure 5, is greater than the distance between any of the other corresponding openings and the corresponding adjacent pivots. Accordingly, if the push rods moved equal distances, the forefinger would pivot a greater amount, and move slower than the other fingers, as the hand was opened. As will be later described, however, the push rods do not move equal distances.

Openings are provided through the body 10 to permit the various push rods to operate their respective fingers. The manner in which this can be accomplished is clearly understood from an observation of Figure 1 of the drawings. A plate, not shown in the drawings, covers the aperture 11, and a glove is preferably used to cover the entire hand A.

With reference to Figure 3 of the drawings, it will be noted that the lever 76 pivots about its pivot 75. The point at which the various push rods are connected to the lever 76 determines the amount of movement of the push rods. The connecting push rod 90 is connected to the fourth, or little finger; and as the push rod is connected at a short distance 92 from its adjacent pivot, it is connected to the lever 76 at a distance 101 from the pivot 75. The push rod 93 is connected to the lever 76 at a distance 102 from the pivot 75 which is greater than the distance 101. This greater distance 102 compensates for the greater distance between aperture 94 and the adjacent pivot. The push rod 93 operating the second finger is connected at a distance 103 greater than the distance 102 from the pivot 72. This greater distance compensates for the greater distance between aperture 96 and the adjacent pivot 51. The push rod 95 connected to the forefinger is connected at an even greater distance 104 from the pivot 75 and therefore moves a greater distance than any other push rod. This compensates for the greater distance between the aperture 99 and its adjacent pivot 65. The variation of the distances between the pivots between the first and second links of each finger, and the connection with the push rod compensates for this difference in speed of operation, as it is desired to open up the fingers equally.

The thumb is operated by the lever 70 pivoted at 71. The inner end of the lever 70 is loosely extended through the lever 76, and forward movement of the lever 76 pivots the top end of the lever forwardly, thereby pivoting the thumb away from the other fingers.

A ratchet 106 is provided on the anchoring plate 43 which engages the forward end of the lever 84. Movement of the lever 76 tends to raise the lever 84 upwardly to some extent. Such upward movement can take place when the lever 84 has been pivoted out of engagement with the ratchet 106. However, strain on the fingers tend-

ing to open the same acts to create a tendency to raise the lever 84. As this lever is engaged with the ratchet, however, the fingers cannot open until the cord 87 is pulled. This ratchet 106 therefore acts as a lock to hold the fingers in closed position.

In Figure 9 of the drawings, I have disclosed an alternate form of construction. This figure shows a construction of little finger which is alternative with the construction shown in Figure 4 of the drawings. In this alternate construction, the finger is not formed of a series of links, as in Figure 4, but is formed of a single rigid member permanently bent. This alternative construction is particularly designed for use when heavy articles are to be carried in the hand. As may be seen, a suitcase could be carried in the hand, and the hook formation of the little finger will support most of the weight thereof, relieving the strain on the links, push rods, lever 76, and spring 77.

The little finger 107 includes an anchoring portion 109 which is similar in formation with the anchoring plate 13, including apertures 110 for anchoring pins, and an ear 111 similar to the ear 74 on the plate 13. The lever 76 is pivoted to the ear 111 when this type of finger is used, and the anchoring plate 109 is positioned in place of the plate 13. Holes 112 are formed through the plate 109 for admission of the end of the spring coil 26, and the plate 109 is subsequently ground down as indicated by the dotted lines to conform with the surface of the hand 10, and to leave notches in place of the holes 112.

Integrally extending from the anchoring portion 109 I provide a hook-shaped little finger portion 113 having the end thereof embedded in a finger tip 114. An ear 115 near the end of the finger 113 is drilled to accommodate the outer end of the spring 26, which ear is later ground off to provide merely a notch flush with the surface of the spring 26.

The formation of the finger permits heavy articles to be suspended from the hand, the little finger supporting most of the weight of the articles. Strain is therefore relieved on the remaining fingers, and accordingly on the remaining mechanism. The finger 107 is merely substituted for the little or fourth finger previously described; and the push rod 90 omitted. The operation of the hand other than the little finger remains exactly as previously described.

In accordance with the patent statutes, I have described the principles of operation of my artificial hand; and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that obvious changes may be made within the scope of the following claims without changing the spirit of my invention.

I claim:

1. In an artificial hand, a hand body, a series of links pivotally secured thereto, individual means for operating each of said links, a pivoted lever in said hand body connected to each of said individual means, coil spring means for holding said lever in one position, rotatable means of greater diameter than said spring through which said spring means extends engaging between convolutions of said coil spring means.

2. In an artificial hand, a hand body, fingers thereon including pivoted links, a lever in said hand body pivoted at one end thereto providing a free lever end, rigid link pivoting means directly connecting one of said links of each finger with said lever at spaced intervals in the same direction from the pivot point of said lever with said body, spring means urging said lever to close said fingers, a second lever pivoted adjacent one end to said free end of said first named lever, means pivotally supporting said second lever intermediate its ends, ratchet means engaging the other end of said second lever to lock the same from movement, and means for pivoting said second lever out of engagement with said ratchet means.

3. In an artificial hand, a hand body, a series of fingers secured thereto, each including a first link pivotally secured to said body, a second link pivotally secured to each said first link, individual rigid means pivotally secured to each of said second links, a lever pivoted adjacent one end to said hand body movable between two extreme positions, said individual rigid means pivotally secured to said lever at spaced intervals in the same direction from the pivot point of said lever, whereby a different length of travel is imparted to each of said individual rigid means, a thumb lever pivoted between its ends to said hand body, one end of said thumb lever pivotally secured to said first named lever, resilient means normally holding said first named lever in one extreme position to hold said fingers in one position, and means actuating said first named lever to move the same in the opposite direction.

4. In an artificial hand, a hand body, a series of first links pivotally secured thereto, a second link pivotally secured to each said first link, a finger tip secured to each said second link, a flexible coil connecting each said finger tip to said hand body, encircling said first and second links, rigid means enclosed by each said coil and pivotally secured to said second link enclosed thereby, lever means pivotally secured at one end to said body and movable between two extreme positions, said rigid means being pivotally secured to said lever means at spaced intervals in the same direction from the pivot point of said lever whereby a different length of travel is imparted to each rigid means, a second lever means pivotally mounted between its ends having one end pivoted to said first named lever means, resilient means holding both of said lever means normally in one extreme position to hold all of the fingers connected thereto in one position, locking means engaging the other end of said second lever means in said extreme position, and lever actuating means for drawing said lever toward the other extreme position.

5. In an artificial hand, a hand body, a series of first links pivoted thereto, a second link pivoted to each of said first links, means connected to each of said second links for pivoting the same, a lever means pivotally secured at one end to said body, said connected means being secured to said lever at spaced intervals in the same direction from the pivot point of said lever to said body to impart a different length of travel to each said connected means, a pivotally mounted thumb lever, said thumb lever being pivotally secured to said lever means at a point substantially spaced from the pivot of said lever means to said body to pivot said thumb lever simultaneously with said second links.

6. In an artificial hand, a hand body, a series of first links secured pivotally thereto, a second link pivoted to each said first link, a pivoted lever pivoted at one end to said hand body, a rigid means pivoted at one end to each of said second links, said rigid means pivotally secured to said lever at spaced intervals in the same di-

rection from the pivot point thereof to impart a different length of travel to each of said rigid means upon pivotal movement of said lever, a second lever pivoted between two extreme positions to said first named lever for actuating the same, means pivotally connecting said second lever intermediate its ends to said hand body, and a latch engaging said second lever in one extreme position thereof to prevent movement of said second lever by movement of said first named lever.

7. An artificial hand comprising a hand body having a series of fingers articulated thereon, a lever pivoted at one end to said body, members connecting said fingers with said lever, said members engaging said lever at points spaced from the point of pivotal attachment thereof to said body, a second lever pivoted to said first named lever and extending forwardly and upwardly therefrom, a link loosely and pivotally connected to said second lever intermediate the ends thereof, a pull cord secured to the forward end of said second lever and extending rearwardly therefrom, and a locking means engaging the forward end of said second lever to prevent said forward end of said second lever from being pulled upwardly by pressure on said fingers.

8. An artificial hand comprising a hand body having a series of fingers articulated thereon, a lever pivoted at one end to said body, members connecting said fingers with said lever, said members engaging said lever at points spaced from the point of pivotal attachment thereof to said body, a second lever pivoted to said first named lever and extending forwardly and upwardly therefrom, a link loosely and pivotally connected to said second lever intermediate the ends thereof, a pull cord secured to the forward end of said second lever and extending rearwardly therefrom, and ratchet means including a series of teeth engageable with the forward end of said second lever to prevent said second lever from being pulled upwardly by pressure on said fingers.

9. In an artificial hand, a hand body, a series of fingers pivotally secured thereto, individual means for operating each of said fingers, connecting means in said hand body connected to each of said individual means, coil spring means for resiliently holding said connecting means in one position, a rotatable disc of greater diameter than said spring having a slot therein through which said spring extends, and shoulder means on said hand body against which said disc engages, said disc means extending between convolutions of said spring means.

10. In an artificial hand, a hand body, a series of fingers articulated thereon, a connecting means movably mounted in said hand body, members connecting said fingers with said connecting means, a rotatable disc of a diameter greater than said spring, a substantially radially extending slot in said disc extending to a point adjacent the center of the disc, and a shoulder on said hand body against which the periphery of said disc may engage said spring extending between convolutions of said spring.

11. In ar artificial hand, a hand body, a series of fingers articulated thereupon, finger actuating means secured to said fingers, a connecting means movably mounted in said hand body secured to all of said finger actuating means, a coil spring secured to said connecting means, said hand body having an elongated passage through which said spring extends, a shoulder encircling said passage on the end thereof most distant from said connecting means, a disc engageable with said shoulder, said coil spring extending through said disc so that said disc extends between convolutions of said spring.

12. In an artificial hand, a hand body, a series of fingers articulated thereon, rigid means secured to each of said fingers, a connecting member connected to all of said rigid means, a thumb, a lever having one end extending into said thumb for actuating the same, a pivot connecting said hand body to said lever intermediate its ends, the other end of said lever being directly secured to said connecting member, and means for actuating said connecting member.

13. In an artificial hand, a hand body, a series of fingers articulated thereon, a transversely extending connecting means movably supported within said hand body, rigid means connecting said fingers to said connecting means, spring means secured between said hand body and said connecting means to hold said fingers normally closed, a thumb on said hand body, a lever pivoted intermediate its ends to said hand body having one end thereof extending into said thumb to actuate the same, the other end of said lever being secured directly to said connecting means, and means for moving said connecting means forwardly in said hand body to open said fingers and to pivot said lever in said thumb.

14. In an artificial hand, a hand body, fingers articulated thereupon, finger actuating means secured to each finger, connecting means connecting said finger actuating means, spring means secured to said connecting means to urge said fingers toward one extreme position, a lever pivoted intermediate its ends, said lever being pivoted at one end to said connecting means, means secured to said lever for manually actuating said lever and a locking means engageable with the other end of said lever in one pivotal position thereof.

15. In an artificial hand, a hand body, fingers articulated thereupon, finger actuating means secured to each finger, connecting means connecting said finger actuating means, spring means secured to said connecting means to urge said fingers toward one extreme position, a lever pivoted intermediate its ends, said lever being pivoted at one end to said connecting means, means secured to said lever for manually actuating said lever, and a ratchet comprising a series of suporposed teeth engageable with the other end of said lever in one pivotal position thereof.

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