

Sept. 30, 1958

D. B. BECKER
ARTIFICIAL HAND

2,853,711

Filed Oct. 6, 1954

2 Sheets-Sheet 1

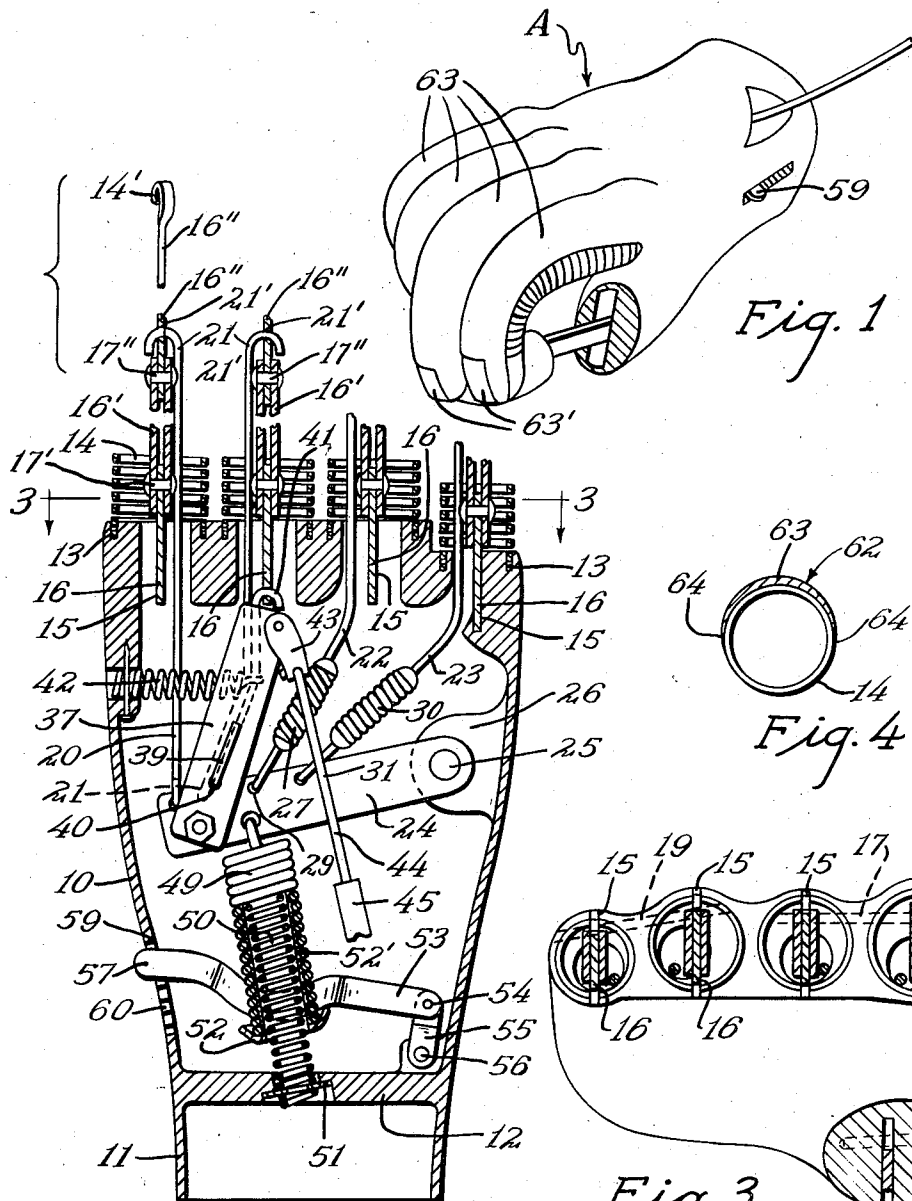


Fig. 2

Fig. 3

Fig. 4

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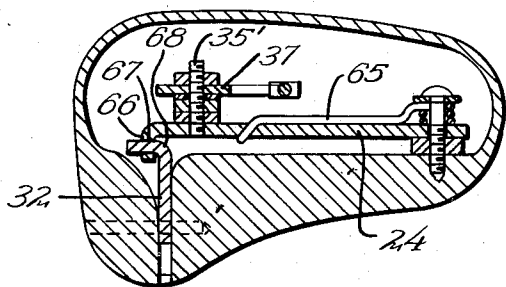
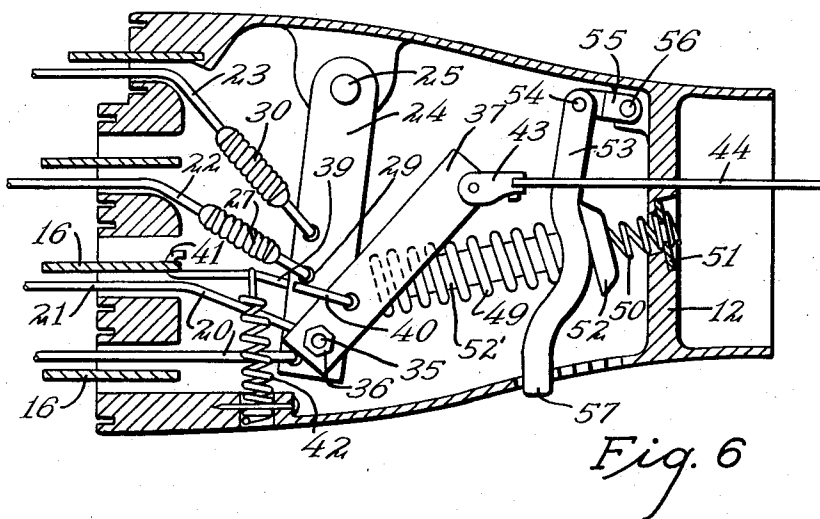
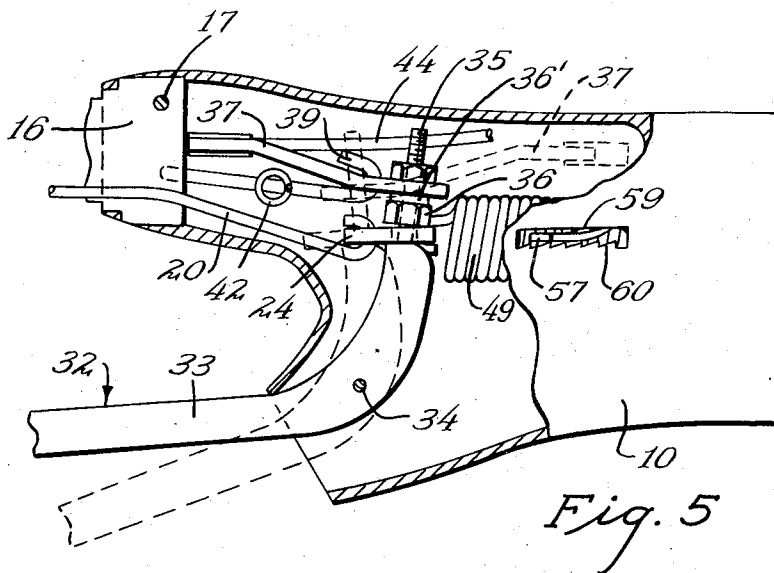


Fig. 7

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This invention relates to an improvement in artificial hands and deals particularly with a hand which may be inexpensively constructed and which is extremely effective in operation.

Various types of artificial hands have been constructed. These hands have for the most part been constructed of wood. While such hands are very serviceable and have been effectively used for years, the cost of construction of the body of the hand is necessarily relatively high because of the fact that each hand must be individually carved. It is a feature of the present invention to provide an artificial hand having a body portion which is made of light weight material, such as aluminum, magnesium or plastic, or a combination of these and like materials, and which, accordingly, may be constructed at relatively low cost once the molds have been made.

A further feature of the present invention resides in the provision of a hand having certain of the fingers which are resiliently actuated. In the past, it has been common practice to provide hands with articulated fingers, the fingers being connected to an operating lever for simultaneous operation thereby. While these hands have been practical and useful, and while the finger movement has been adjusted so that the hand will close in a natural manner, difficulty is sometimes experienced in adapting the hand for holding objects of certain sizes. The gripping action of the hand usually takes place between the first finger and the thumb, or the first and second fingers and the thumb. During the closing operation of the hand, if the little finger or the finger next to the little finger grasps the object before the first or second fingers, difficulty is experienced in handling the object. Accordingly, in the present construction I have provided resilient means connecting the operating lever with the closing links for the little finger and for the next finger so that a more uniform and even grasp may be obtained on objects of certain sizes and shapes.

A further feature of the present invention resides in a novel and effective means of controlling the closing pressure of the hand. One of the difficulties which is usually experienced with artificial hands lies in the fact that the fingers are normally drawn into a closed position by resilient means and are opened by a shoulder harness or the like. As the hand is called upon to handle articles of various weights and of various sizes, it is necessary for the resilient means urging the hand into closed position be sufficiently strong to close the hand to support relatively heavy objects. For example, if the hand is used to support a suitcase or the like which is relatively heavy, the weight of the suitcase is exerted directly upon the fingers tending to move these fingers into open position. At the same time it should be understood that the hand is called upon to hold fragile articles such as glassware and the like where the pressure of the springs against the fingers might be sufficient to cause breakage. It is an object of the present invention to provide an artificial hand which is provided with a

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series of articulated fingers which are drawn into closed position by means of an operating lever and which is pulled into closed position by means of a suitable spring. The tension of this spring may be adjusted to regulate the pressure of the fingers against an object being held.

A further feature of the invention resides in the provision of an artificial hand having a series of articulated fingers which are pulled into closed or clenched position by means of the spring and in which an auxiliary spring is provided which may be varied in its strength. By varying the tension of this second spring against the operating lever the pressure of the fingers against an object being held may be controlled, thereby obtaining a multiload spring grip.

Another feature is to provide a flexible covering for the fingers which gives the fingers a more natural appearance and natural action with increased flexibility at the points of greatest bend.

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 the specification:

Figure 1 is a perspective view of the hand in normal position, a portion of the thumb being broken away to show the construction thereof.

Figure 2 is a cross sectional view through the hand showing in general the construction thereof.

Figure 3 is a sectional view through the fingers of the hand, the position of the section being indicated by line 3—3 of Figure 2.

Figure 4 is a sectional view through one of the fingers of the hand.

Figure 5 is a side elevational view of the hand, portions thereof being broken away to indicate the operating construction thereof.

Figure 6 is a view similar to Figure 2 but illustrating in simplified form the finger operating mechanisms.

Figure 7 is a sectional view through the hand showing a modified form of construction.

The hand is indicated in general by the letter A. As indicated in Figure 2 of the drawings, it includes a body portion 10 which is preferably die cast magnesium or a similar suitable light metal. The hand body includes a wrist portion 11 and a partition wall 12 extends across the body in a point spaced from the end of the portion 11.

A series of circular grooves 13 are provided in the finger end of the hand body. These grooves 13 are designed to accommodate spirally wound strip material 14 which forms the inclosure of each finger. The hand body is also provided with a series of slots therein which intersect the ring like grooves 13 and which extend to a substantial depth into the body. These grooves are indicated by the numeral 15 and are designed to accommodate anchoring plates such as 16 which form the base of each finger and are connected through intermediate linkage 16' to finger end linkage 16''. The plates are shown in section in Figure 2 and in Figure 3 of the drawings and a side view of one such plate 16 is shown in Figure 5 of the drawings. Two of the plates are held in place by a pin 17 extending through the hand body transversely of the plates and the remaining plates 16 are held in place by a similar pin 19 extending into the hand body from the opposite side thereof. As illustrated, the intermediate linkages 16' are connected by pins or rivets 17' and 17'' to plates 16 and finger end linkages 16''. The plate linkage 16'' extends into a flat hook end 14' which serves to anchor the plastic fingernail covering as hereinafter described.

The general spring construction of the fingers is not illustrated in detail as it has been disclosed in previous patents. However, each finger is formed of a series of

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the pivotally connected links 16' and 16'' which are enclosed within the spirally wound enclosure of each finger. The links 16' and 16'' forming each finger are operated by a suitable operating rod. A first rod 20 is connected and pivoted through aperture 21' to the link 16'' of the first finger to operate the same. A second rod 21 is similarly connected to the links of the second finger to operate the same. A third rod 22 is similarly connected to the links of third finger to operate the same and a fourth rod 23 is connected to the links of the fourth or little finger to operate the same. However, in order to obtain the same range of opening of fingers from 1 to 4, the aperture 21' provided in each of the finger ends 16'' are positioned relative to the pivotal rivet 17'' at predetermined distances. That is, from the first finger linkage aperture 21' to the fourth finger linkage 21' the distance between the apertures 21' and rivets 17'' decreases as much as $\frac{3}{16}$ inch. This range of finger movement may vary according to the size of the hand and the amount of lever action given to the hand mechanism as hereinafter described.

The rods 20 and 21 which operate the first and second fingers are directly pivotally connected to a plate or lever 24. This lever 24 is pivotally connected at 25 to a suitable boss 26 forming a part of the interior structure of the hand body. A compression or expansion limit spring 27 is connected to the end of the third rod 22 and this spring is connected at 29 to the lever 24. The fourth rod 23 is also connected to a similar limit spring 30 which in turn is connected at 31 to the lever 24. It will be noted that the various rods are connected in order to the lever 24, the first finger being connected to the lever at the greatest distance from the pivot 25, and the last rod 23 being connected at the nearest distance from the pivot 25. As a result, the fingers are arranged to open naturally. The shorter angle of rotation of plate 24 near its pivot 25 necessitates the lesser distance between aperture 21' and rivet 17'' of the third and fourth fingers in order to obtain the natural opening action.

As is indicated in Figure 5 of the drawings, the thumb 32 of the hand includes a lever 33 which is pivoted at 34 on a transverse pivot to the hand body 10. The inner extremity of the lever 33 is provided with a threaded shank 35 which extends through the end of the lever 24 and is held in place by a locking nut 36 or other suitable means. A spacer or washer 36' separates the plate 24 and lever 37. The threaded shank 35 fits through the lever 24 with sufficient play to permit the thumb to pivot through its necessary degree of angularity.

As is best indicated in Figures 2 and 6 of the drawings the lever 24 is operated by a connected lever 37. The lever 37 has one end encircling the threaded end 35 of the thumb member and is thus connected through the threaded shank 35 to the lever 24. The center part of the lever 37 is connected by a link 39 to the hand body, one end 40 of the link 39 extending through the lever 37 and the other end of the link 39 being connected at 41 to the anchoring plate 16 of the second finger. This permits the lever to pivot near its center point and at the same time provides sufficient flexibility so that the lever may actuate the pivoted lever 24. A spring 42 extends between the side of the hand body and the link 39 so as to hold this link in position.

A clevis 43 is connected to the free end of the lever 37 and this clevis is connected either to a cord or to a wire cable 44 designed to extend through a tubular flexible conduit 45 to a shoulder harness or other operating means. By exerting a pull upon the wire or cable 44, the lever 37 may be pivoted in a clockwise direction as viewed in the figures and the lever 24 may similarly be moved in a clockwise direction to exert a pushing force against the various rods connected to the fingers.

The lever 24 is biased in a counterclockwise direction by a pair of springs 49 and 50, both of which are connected together at the end thereof connected to the lever

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24 and one of which is preferably inclosed within the other in order to save space. In the particular arrangement illustrated, the spring 50 is inclosed within the spring 49.

A split washer 51 is threaded onto the end of the spring 50 and this washer 51 bears against the partition wall 12 to hold the spring 50 in place. Rotating the washer 51 in one direction, this washer may be threaded onto the spring a greater distance thus increasing the tension of the spring. By rotating the washer 51 in the opposite direction, the spring tension may be correspondingly decreased.

A washer 52 with shim 52' extending between the springs 49 and 50 is secured to the free end of the spring 49. A lever 53 is pivotally connected at 54 to a short link 55 which in turn is pivoted at 56 to the hand body. The end 57 of the lever 53 extends through a slot 59 in the side of the hand body. This slot 59 is provided with a series of teeth which may be best indicated in Figure 5 of the drawings and which are designed to hold the free end of the lever 53 in an adjusted position. By pivoting the lever 53 in a counterclockwise direction, the tension upon the spring 50 may be increased. By engaging the lever with a suitable notch or tooth of the series of teeth 60, the lever may be held in any adjusted position.

From the foregoing explanation, it will be clear that the operation of the hand is quite similar to the operation of hands which are the subject of my previous patents. However, in the present construction, there are certain definite improvements and additions. In the first place, the limit springs 27 and 30 which are interposed in the linkage between the fingers and the lever 24 permit these fingers to be held in a slightly open position when the hand is grasping an object of a certain shape. The fingers are normally held in a closed position by the springs 49, 50. If an object being grasped by the hand engages the third and fourth fingers before it is engaged by the first and second fingers, the springs 27 and 30 will flex sufficiently to permit all of the fingers to properly grasp the object. This is a decided advantage as it is desired that the object be actually held by the first and second and by the thumb rather than by the third and fourth fingers.

The second important advantage of the structure described lies in the simplicity with which the pulling tension upon the lever 24 may be adjusted. If the hand is to be used for carrying a heavy object, the lever 53 may be pivoted in a counterclockwise direction so as to increase the tension upon the spring 49. As a result, a considerably greater force is necessary in order to open the fingers. However, in the event the hand is to be used for grasping a fragile object or a more delicate object, the lever 53 may be pivoted in a clockwise direction so as to relieve the tension upon the spring 29, therefore, causing a lighter spring force to be employed in enclosing the hand.

As illustrated in Figure 4, a flexible or soft skin like appearing plastic 62 covering is provided for the flexible finger springs 14. As illustrated, the back of the fingers are covered with a thickened body portion 63, ending in fingernail 63', and each of the sides 64 are tapered to paper thinness. This flexible plastic covering is cemented to the finger springs 14 and covers the top and sides leaving the underside of the finger springs exposed as shown in Figure 1. By tapering the sides of covering 62 and leaving the underside exposed I have improved the flexibility of the fingers. If desired, however, a glove may cover the hand or in some instances a thin flesh like flexible and elastic plastic covering may be secured to the exposed underside of the fingers. This underside covering may be provided for the sake of appearance with a sacrifice in flexibility when secured in tight relationship to the enclosing springs 14. It is preferred, therefore, when necessary to cement this covering on with a looseness under the bends of the finger sections

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resembling the folds of the natural skin under the knuckles.

In Figure 7 of the drawings I disclosed a modified form of construction. In the arrangement illustrated in Figure 7, the spring 50 is not employed, and a torsion spring 65 is used in place thereof. The spring 65 merely exerts a force upon the lever 24 tending to rotate this lever in a counterclockwise direction. In other words, Figure 7 merely illustrates that a different type of spring may be substituted for the coil spring illustrated in the preferred embodiment of the invention. In addition, the construction of the thumb connection to plate 24 is different. Herein, the plate 24 is provided with a flange 66 having an aperture 67 and the thumb plate 32 with a right angle bend 68 hooked through aperture 67. A pin 35' is inserted or otherwise secured to plate 24 for mounting lever 37. This pin 35' replaces the threaded shank 35.

In accordance with the patent statutes, the principles of construction and operation of the artificial hand have been described and while it has been endeavored to set forth the best embodiment thereof, it is desired to have it understood that obvious changes may be made within the scope of the following claims without departing from the spirit of the present invention.

I claim:

1. An artificial hand of which each of the fingers and thumb are simultaneously and relatively movable comprising a hand body provided with a wrist section, a movable thumb, and movable fingers, including mechanical means for actuating said thumb and each of said fingers comprising a first control lever pivoted at one end on said hand body, means fastening said thumb and each of said fingers to said first control lever, a second pivotal lever connected at one end to the free end of said control lever, a draw cord attached to the free end of said second pivoted lever, and spring means for resisting the pull of the draw cord against pivotal movement of said first control lever and said second pivotal lever opening said thumb and each of the fingers, and additional spring means effecting a pull on the closing of the third and fourth fingers.

2. The structure of claim 1, wherein each of the fingers is provided with an anchoring plate in the said connecting means fastening said thumb and each of said fingers to said first control lever.

3. The structure of claim 2, wherein the said second pivotal lever is rotatable on linkage near its center point.

4. The structure of claim 3, wherein the said linkage is connected to spring means resisting movement of said linkage and said second pivotal lever.

5. An artificial hand of which each of the fingers and thumb are simultaneously and relatively movable, comprising a hand body provided with a wrist section, a movable thumb and movable fingers including mechanical means for actuating each of said fingers, said mechanical actuating means comprising a first and second pivotal lever means pivoted with respect to one another and the hand body, attaching means connecting said thumb and each of said fingers to said pivoted lever means, a draw cord attached to said pivoted lever means, and spring means resisting the pull of said draw cord against the pivotal movement of said lever means opening said thumb and each of the fingers and additional spring means effecting a flexible resistance on the closing of the third and fourth fingers.

6. An artificial hand of which each of the fingers and thumb are simultaneously and relatively movable, comprising a hand body provided with a wrist section, a movable thumb and movable fingers including mechanical means for actuating each of said fingers, said mechanical actuating means comprising a first and second pivotal lever means pivoted with respect to one another and the hand body, attaching means connecting said thumb and each of said fingers to said pivoted lever means, a draw cord attached to said pivoted lever means, an adjust-

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able spring means connecting said lever means to said hand body to vary the tension on the pull of said draw cord and the relative closing force of said thumb and said fingers, and additional spring means, said adjustable spring means resisting the pull of said draw cord against the pivotal movement of said lever means opening said thumb and each of the fingers and said additional spring means effecting a flexible resistance on the closing of the third and fourth fingers.

7. The structure of claim 6 in which said adjustable spring means includes a pair of adjustable coil springs.

8. The structure of claim 7, wherein the tension on the pair of adjustable coil springs is varied by separate adjusting means.

9. The structure of claim 8, wherein the tension on one of the said pair is adjustable by screw turns of a hand body fastening means and the tension on the other of said pair is adjustable by a setting lever.

10. An artificial hand of which each of the fingers and thumb are simultaneously and relatively movable comprising a hand body provided with a wrist section, a movable thumb and movable fingers including mechanism for simultaneously and relatively actuating said thumb and each of said fingers comprising anchoring means connected to each of said fingers, connecting linkages attached at one end to each of said fingers, a finger operating lever pivotally attached to said hand body, said connecting linkages and said thumb, a pivotal lever connected to said thumb and the free end of said finger operating lever, off-center pivotal attaching means for said pivotal lever, a pull cord connected to the free end of said pivotal lever, adjustable spring means attached to said finger operating lever, and additional spring means for permitting flexing of at least one of said fingers relative to said thumb.

11. In the structure of claim 10, wherein said additional spring means include tension springs in said linkages connecting the third and fourth fingers to said finger operating lever.

12. An artificial hand comprising a hand body, a series of articulated fingers carried by said body, means collectively urging said fingers in one direction, and spring means associated with at least one of said fingers for permitting displacement of said one finger relative to the others when caused to do so by the shape of an object being grasped by the artificial hand, and a rigid connection between said means and at least one of said fingers.

13. An artificial hand comprising a hand body, a series of fingers articulatively carried by said body, a first control lever pivotally mounted at one end thereof to said body, respective connecting means connected to said first control lever and to said fingers for moving said fingers when said first control lever is pivoted in one direction, spring means biasing said first control lever in said one direction, a second control lever having one end pivotally connected to the free end of said first control lever, fixed means providing a pivot point for said second control lever intermediate the ends thereof, actuating means connected to the other end of said second control lever for overcoming the biasing action of said spring means, and additional spring means included in one of said respective connecting means for permitting the finger actuated by that particular connecting means to yield in relation to the other fingers.

14. An artificial hand comprising a hand body including a wrist section, a movable thumb and movable fingers with interconnected spring and lever means for simultaneously moving said thumb and each of said fingers, said lever means comprising pivoted thumb and finger lever means, an operating lever connected to said thumb and finger lever means, spring means resisting the movement of said lever means, and additional resilient spring means connecting the third and fourth fingers to said finger lever means.

15. In the structure of claim 14 an adjustable spring

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connected to said finger lever means for varying the gripping tension between said thumb and said fingers.

16. An artificial hand having a movable thumb and movable fingers including a pivotal lever connected to said thumb and finger sections, an operating lever, an adjustable spring for holding said pivoted lever under different desired tensions, and additional spring means associated with said operating lever for resisting the movement thereof.

17. An artificial hand comprising a wrist section, a hand section and a finger and thumb section simultaneously movable with respect to said hand section, said finger section comprising pivoted connected linkages for each finger enclosed by flexible finger spring members having plastic flexible top surface coverings and all of which fingers are proportionally simultaneously movable with said thumb.

18. The structure of claim 17, wherein the pivotal connected linkages are provided with operating mechanism comprising pivotal levers, spring members resisting the moving of said pivotal levers, a pull cord for moving said pivotal levers against the resistance of said springs, interconnecting linkage between said operating levers and said pivotal connected linkages for each

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finger, and limit springs cooperable with said pivotal levers and the connecting linkages for the third and fourth fingers.

19. A movable thumb and finger section for an artificial hand comprising flexible linkages for the first, second, third and fourth fingers, a movable thumb, lever arms and connecting linkages for moving sections of each of said fingers relative to said thumb, flexible springs covering said flexible linkages and a flexible plastic covering having a thickened top portion with sides of decreasing thickness covering the top and sides of said flexible springs.

20. The structure of claim 19, wherein the said connecting linkages for moving the said finger sections are of decreasing length from the first finger to the fourth finger to simultaneously obtain the same range of opening for each of the four fingers.

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