

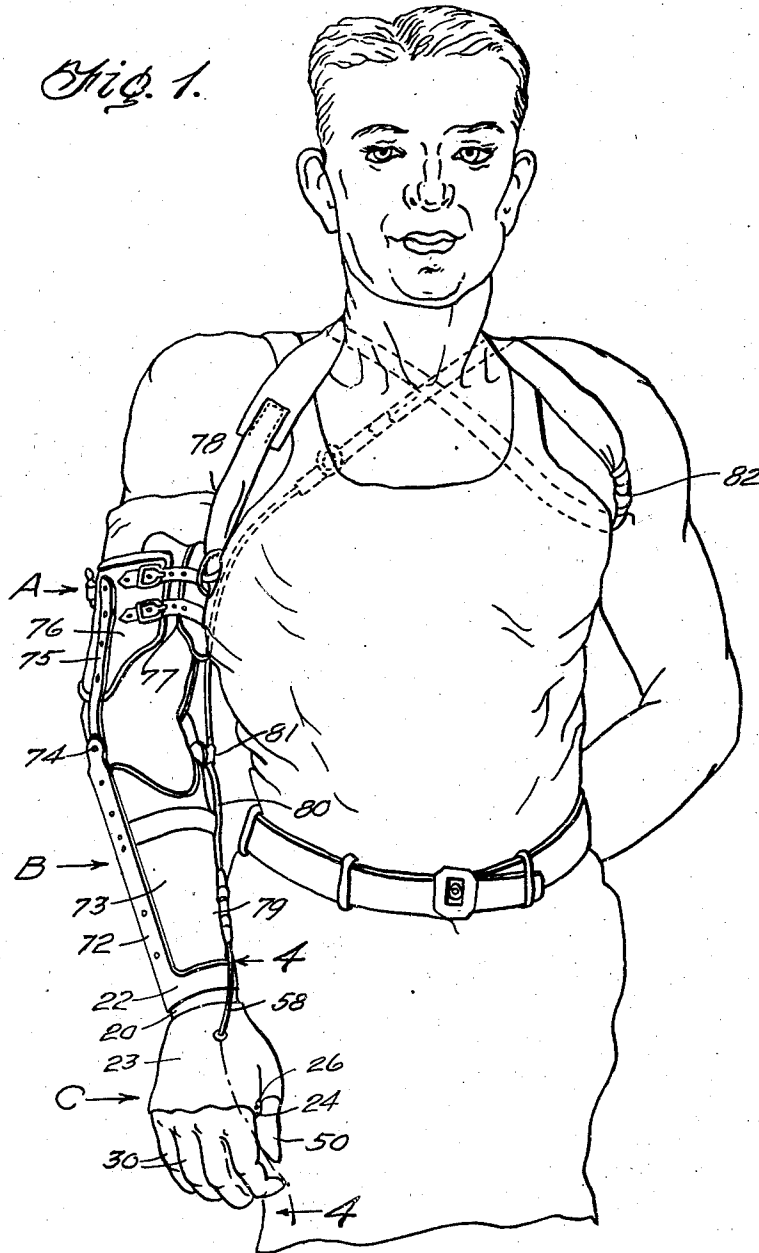
Oct. 22, 1946.

D. C. MOLLENHOUR
ARTIFICIAL ARM AND HAND

2,409,884

Filed April 4, 1945

5 Sheets-Sheet 1



Inventor

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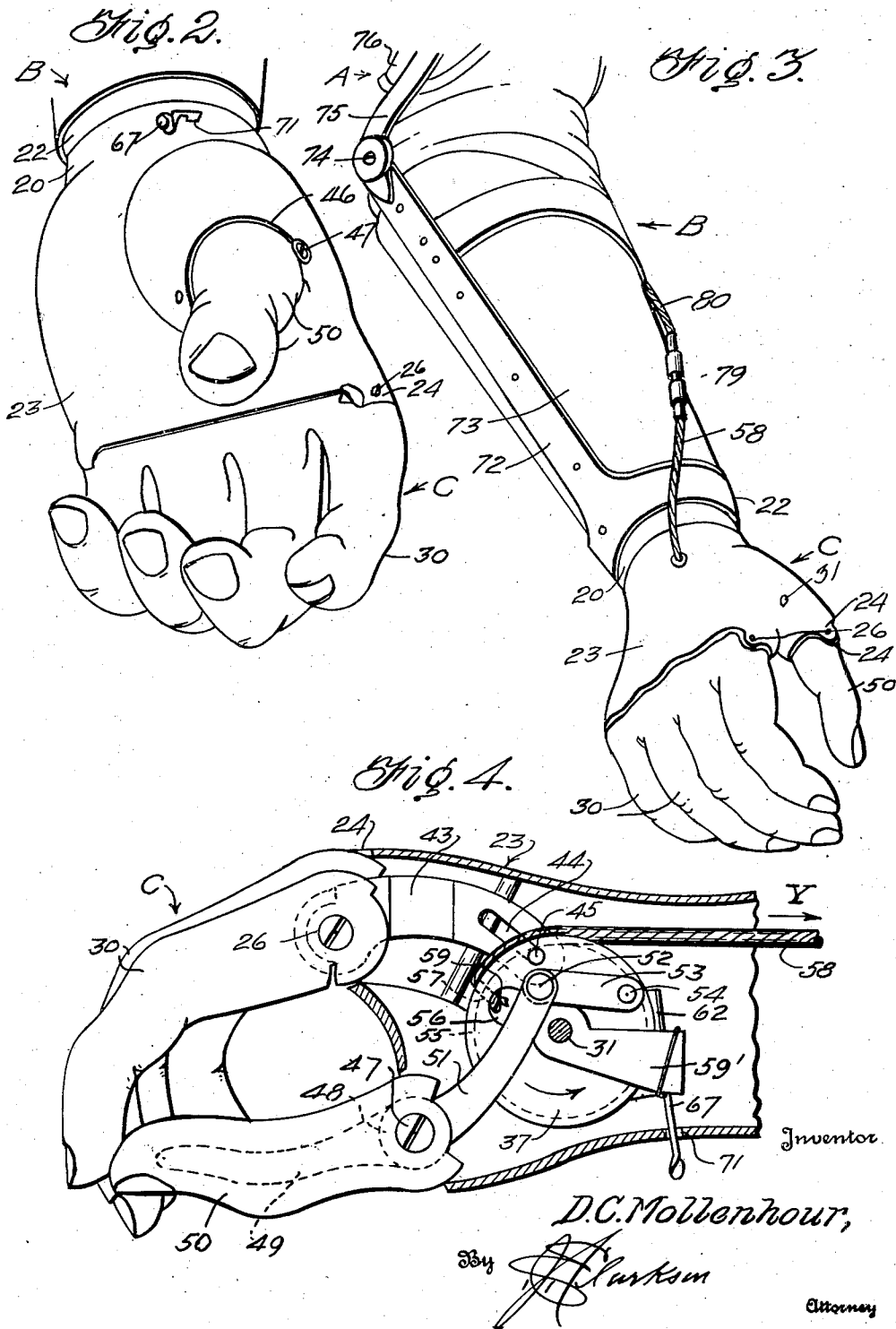
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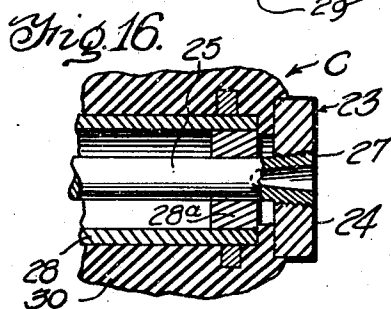
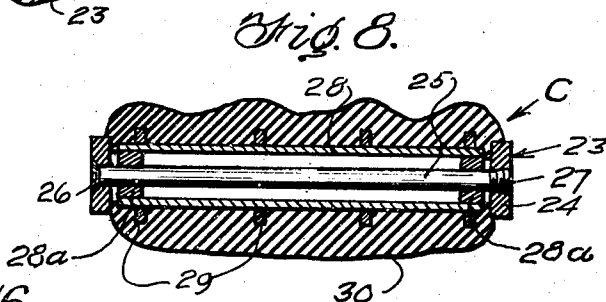
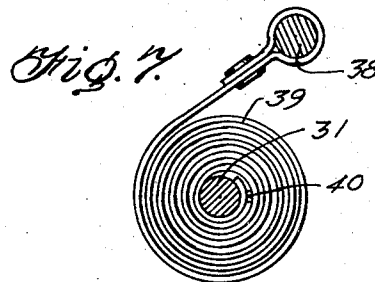
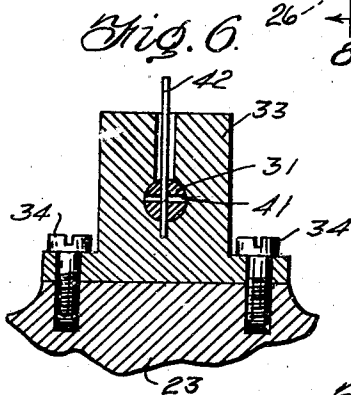
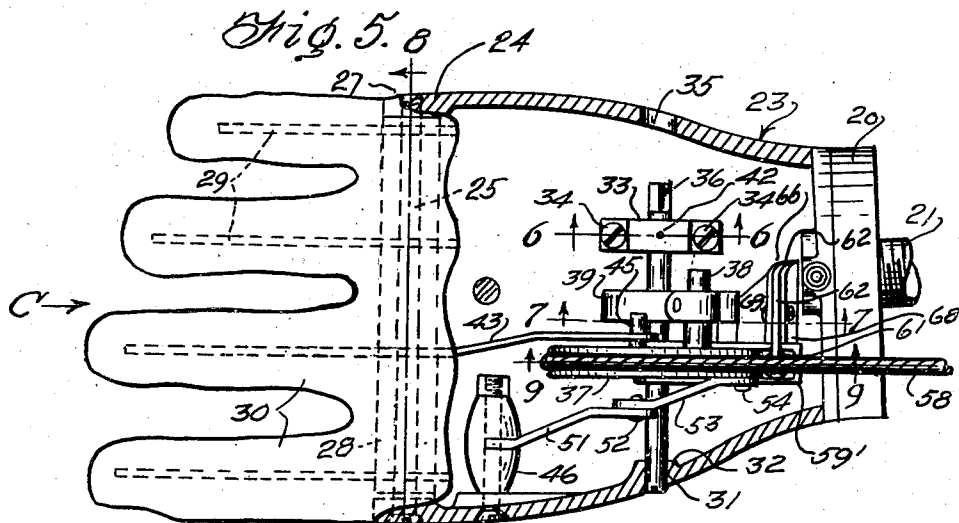
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5 Sheets-Sheet 3



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Fig. 9.

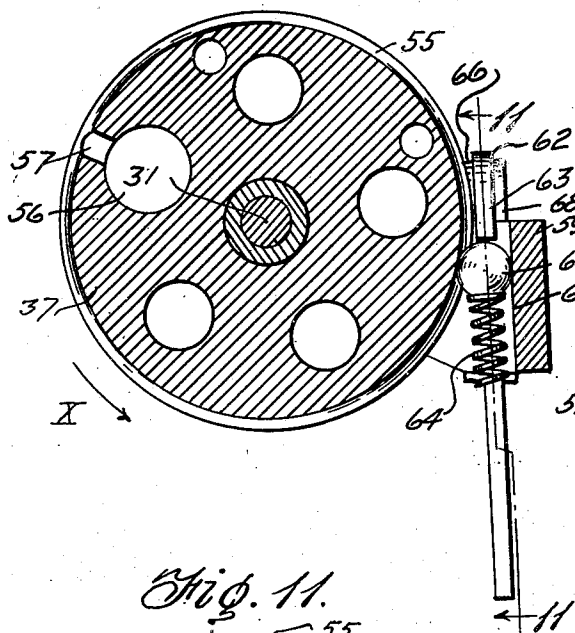
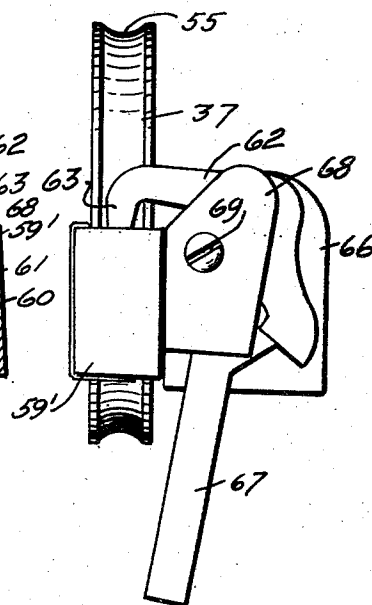


Fig. 10.



Exp. 11.

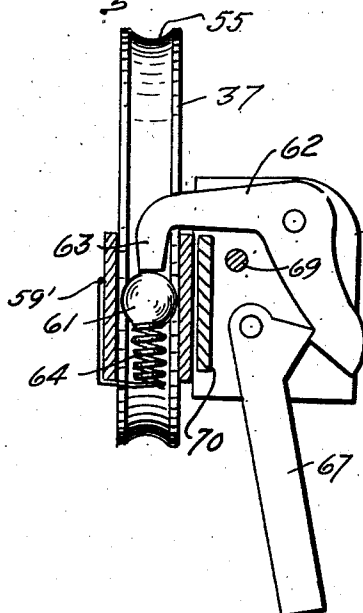
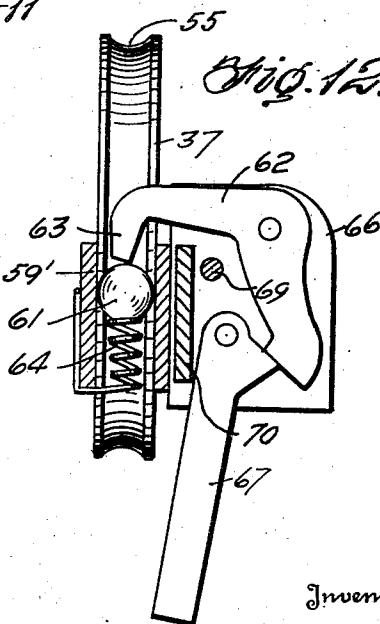


Fig. 12.



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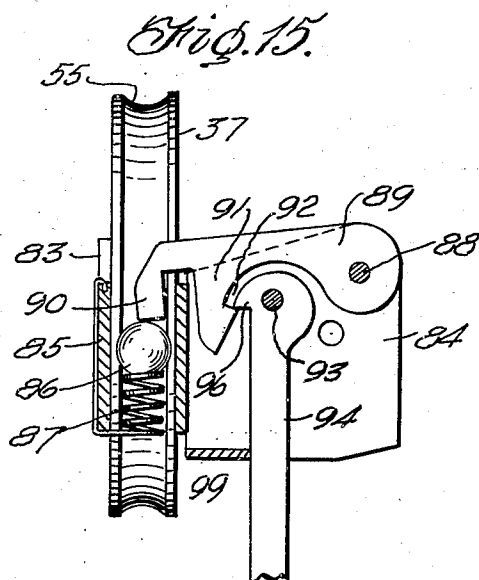
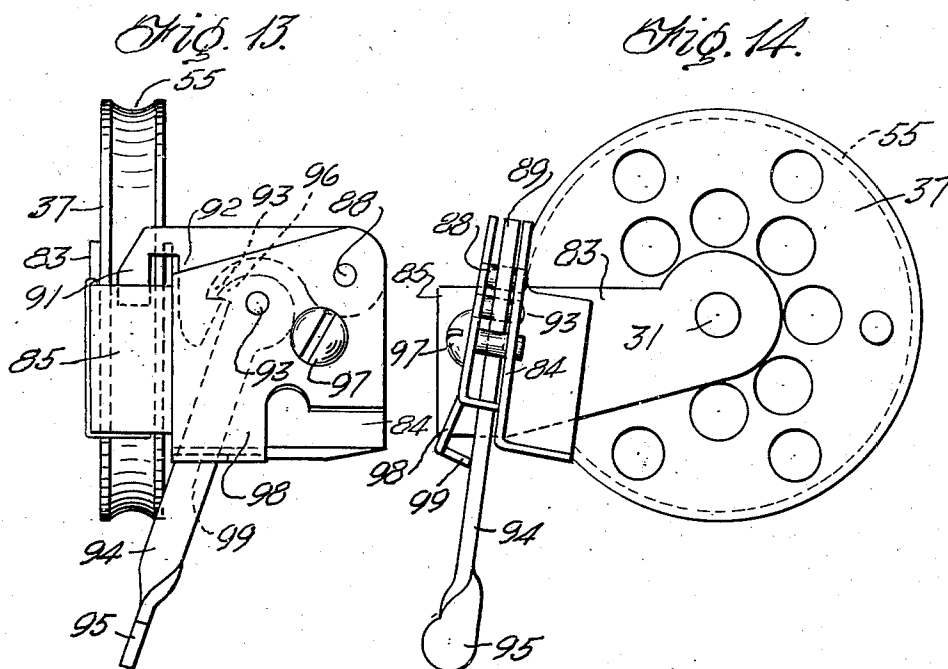
D. C. MOLLENHOUR

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ARTIFICIAL ARM AND HAND

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5 Sheets-Sheet 5



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2,409,884

ARTIFICIAL ARM AND HAND

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Application April 4, 1945, Serial No. 586,505

8 Claims. (Cl. 3—12)

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This invention relates to artificial arms and hands.

The invention relates particularly to an improvement on the original hands as illustrated in the patents to Henning, No. 1,981,698, of November 20, 1934, and No. 1,366,453, of January 25, 1921.

The invention furthermore relates to that type of artificial arm which may be correlated with a natural arm stump resulting from the amputation of the arm either above or below the elbow joint.

Finally the invention relates to the operation and mechanical means for such operation enabling the hand of such an arm to be actuated by muscular movements of the wearer to open and close the thumb and fingers of such an artificial hand.

One important object of the invention is to provide means constituting an improvement over the Henning patent above mentioned. In this Henning patent it is to be observed that the closing of the space between the thumb and fingers of the artificial hand is regulated by a step-by-step movement so that only certain definite positions of the thumb and finger portions of such a hand will be able to grasp firmly an object to be held by the hand. The present improvement relates to a mechanism whereby an infinite number of grasping positions may be obtained.

A second important object of the invention relates to the mechanism whereby the thumb and the fingers may be biased toward each other so that an infinite number of grasping positions may be obtained.

A third important object of the invention is to provide, in the hand-closing mechanism, a novel form of friction clutch adapted to enable the grip of the hand-closing mechanism to be adjusted to an infinite number of gripping positions.

A fourth important object of the invention is to provide a novel clutch arrangement for a rotary disc such as is used in connection with the movements of artificial hand members.

A fifth important object of the invention is to provide means whereby, without the use of a natural hand, the hand-gripping mechanism may be controlled.

With the above and other objects in view the invention consists in general of certain novel details of construction and combinations of parts

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hereinafter fully described, illustrated in the accompanying drawings and particularly claimed.

In the accompanying drawings, like characters of reference indicate like parts in the several views and—

Fig. 1 is a face view of a person wearing one type of this artificial arm.

Fig. 2 is a view of the anterior surface of the hand used herewith, the view showing the thumb and fingers in separated position.

Fig. 3 is a perspective view of the lower part of the device showing the relation of the lower arm means and the hand.

Fig. 4 is a section substantially through the line 4—4 of Fig. 1, the view being arranged to show the novel mechanism within the body of the hand.

Fig. 5 is a plan view, part in section, disclosing the back of the hand and the fingers connected thereto together with the mechanism for operating the several parts.

Fig. 6 is an enlarged view on the line 6—6 of Fig. 5.

Fig. 7 is an enlarged detail showing the manner of connection of a certain clock-work spring used herein, the view being somewhat diagrammatic, this view being a partial section on the line 7—7 of Fig. 5.

Fig. 8 is a detail section on the line 8—8 of Fig. 5.

Fig. 9 is an enlarged detail section on the line 9—9 of Fig. 5, with the pull cord omitted.

Fig. 10 is an elevational view showing in detail the arrangement at the right side of Fig. 9.

Fig. 11 is a detail view partly in elevation and partly in section on the line 11—11 of Fig. 9, a certain cover plate shown in Fig. 10 being omitted and the view disclosing the ratchet parts in position to stop rotation, in one direction, of a certain disc used herewith.

Fig. 12 is a view similar to Fig. 11 with the above-mentioned ratchet parts in position to allow free rotation of said disc.

Fig. 13 is a view similar to Fig. 10 but showing a modified form of the clutch.

Fig. 14 is a side view of the construction shown in Fig. 13.

Fig. 15 is a view similar to Fig. 11 but with the clutch modification of Fig. 13.

Fig. 16 is a modification of the locking bolt shown in Figure 8.

In the embodiment of the invention here shown an original arm has been illustrated capable of use whether the entire arm has been amputated above or below the elbow joint.

Obviously the particular construction by means of which this artificial arm is fitted on what remains of the wearer's artificial arm after amputation is variable to a wide degree. Consequently, so far as the application of the artificial arm to the remnant of the natural arm is concerned a wide variety of details in proportion may exist. The invention as herein described is therefore to be considered as broad enough to include its application to an arm amputated in any location from the wrist to the shoulder joint.

As shown in Fig. 1 the novel features of the invention are comprised between an upper arm section A, a lower arm section B, and a hand section C.

Since the hand section is common to both an upper and a lower arm amputation it is deemed advisable first of all to describe in particular this lower arm section. Now referring first of all to Fig. 5 it will be seen that there is indicated in this figure what may be termed a cuff member 20 wherein is centrally located a screw 21 by means of which this cuff member may be screw-attached to a ring 22 on the lower end of the lower arm portion B. This cuff member 20 supports a hollow hand body 23 shaped to conform to the body of a human hand. This hollow member 23 extends forwardly to a location corresponding to the first joints of the fingers of such a hand as indicated at 24. Thru the forward extremities of the sides of the member 23 passes a bolt 25 which is provided at one end with a kerfed head 26 for actuation by a screw driver and at its further end is provided with a threaded extremity 27. The side walls of the member 23 are respectively arranged to receive the head 26 and threaded to receive the head 26 and the threaded end 27. This bolt forms a rocker pin on which the four fingers of a hand may rock. Mounted on this bolt is a tubular sleeve 28, having bushings 28a at its ends engaging on the bolt. Fixed on the sleeve 28 is a series of arms 29 constituting the skeletal supports of the finger portion of the hand. These skeletal supports and the sleeve 28 are surrounded and embedded in a rubber or plastic involvement 30 shaped and formed, as shown particularly in Figs. 2, 3 and 4 to represent the fingers of a human hand and the base of these fingers at the first joint. Arrangement is such that this sleeve and the finger involvement covered by the levers 29 may rock on the pivot screw or pin 25.

Extending laterally through the hand body 23 is a shaft 31 which is supported at one end in a bearing lug 32 at thumb side, preferably, of the body 23. This shaft 31 does not extend entirely through the body 23 but is supported at the end interior of said body by a bearing 33 secured to the interior face of the body 23 by screws 34. In alinement with the shaft 31, on the side opposite the bearing 32, is an opening 35 where-thru a common clock key may be inserted to engage the angular head 36 on the shaft 31. By this means the shaft 31 may be rotated. Mounted on the shaft 31 is a disc or wheel 37 wherefrom projects a pin 38, this pin being near the periphery of said wheel 37. Connected to the pin 38 is one end of a clock spring 39 which has its remaining end wound around the shaft 31 and operatively connected thereto by the usual pin 40. This clock-spring, as shown in Fig. 7 is so wound that it tends to rotate the disc or wheel 37 in the direction of the arrow X shown in Fig.

4. Obviously the more the shaft 31 is rotated in the direction of the arrow the greater will be the tendency of the spring to rotate the disc in the same direction. Now the shaft 31 has one or more transverse openings 41 there-thru and the bearing 33 has an opening extending from its top down to the shaft 31 in alinement with the location of the openings 41, these openings extending entirely through the shaft. A pin 42 may be inserted thru the opening in the bearing 33 and down thru one of the openings 41 of the shaft 31 so that after adjustment of the spring the shaft may be held in position and thus cause, to a greater or less degree, rotation of the disc 37 in the direction of said arrow.

One of the skeletal supports 29, preferably that relating to the second finger, is extended rearwardly toward the disc 37 as at 43 and is provided in its rearwardly extending end with a slot 44 wherein is engaged a pin 45 projecting laterally from the disc or wheel 37. Under these circumstances rotation of the disc 37 in one direction will rock the fingers of the device upwardly of the hand and, in another direction, will rock such fingers downwardly.

The forward part of the body is provided with an opening 46 and thru the body sides at this opening extends a pivot screw 47 similar to the arrangement of the screw 25. On this screw 47 is rotatably mounted a sleeve 48 having a forwardly projecting arm 49 representing the skeleton of the thumb of the device and covered by rubber or other elastic material 50 representing the contour of that thumb. Extending rearwardly from the sleeve 48 is an arm 51 having a pivot 52 at its upper end and to this pivot is connected one end of a link 53 extending to a pin 54 fixed in the disc 37 adjacent its periphery. The rotation of the disc 37, with this arrangement, in the direction of the arrows biases the free end of the thumb downwardly and at the same time biases the free ends of the fingers upwardly. The disc 37 is grooved as at 55 and is provided adjacent its periphery with an opening 56 communicating with the groove by an opening 57. A pull cord 58 extends over the anterior or back portion of the groove 55, down through the opening 57 and is provided with a knot 59 in the opening 56. The pull to be exerted on this cord or wire 58 is in the direction of the arrow Y of Fig. 4 and is thus against the action of the clock-spring 39.

Mounted on the shaft 31 is a yoke 59 which is so positioned that it has a surface 60 closer to the periphery of the disc 37 at its upper end than at its lower end. Between this yoke and the disc 37 is located a ball 61 which, in its upper position jams between the surface 60 and the groove 55 as shown clearly in Fig. 9. In its lower position this ball is loose between the surface 60 and the bottom of the groove 55. In order to control the position of this ball there is mounted on the yoke a lever 62 of generally U-shape having a finger 63 projecting downwardly between the walls of the yoke and engaging on the top of the ball 61. Referring now to Figs. 11 and 12 it will be seen that this lever 62 in one position pushes the ball downwardly (Fig. 11) while in another position allows the ball to rise upwardly. A coiled compression spring 64 is held in the rear end of the yoke beneath the ball and has its terminal end 65 hooked over the top of the yoke. This spring constantly urges the ball upwardly. The lever 62 is mounted on a plate 66 extending laterally

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from the yoke and pivoted to the lower portion of this plate is a control arm 67 arranged, when in the position shown in Fig. 11 to push the ball downwardly but when arranged, as in Fig. 12 to permit the ball to rise upwardly. The levers 62 and 67 are covered by a cover plate 68 secured to the extension 66 by screw 69 and this cover plate has a lip 70 turned inwardly so as to rest against the plate 66 and, when the lever 67 is in the position of Fig. 12, to constitute a stop therefor. This lever 67 projects thru a slot 71 in the wrist portion of the member 23 so that it may be contacted with a disc or other surface by movement of the operator's arm and then may be shifted between the positions of Figs. 11 and 12. Obviously, when in the position shown in Fig. 11 the ball will not act as a pawl to stop movement of the disc 37 in the direction of the arrow but, when in the position of Fig. 12, the ball will jam between the disc 37 and surface 60 and thus prevent rotation in the direction of the arrow X.

Under these circumstances it is obvious that this ball arrangement is such that it may lock the disc 37 against rotation in a direction to open the space between the fingers and thumb at any one of an infinite number of points between the fully open position of such fingers and thumb and the fully closed position thereof. The arrangement thus forms an infinitely adjustable ratchet device for all positions within limits of the gripping operation of the hand.

In the form of the invention shown in Figs. 13, 14 and 15 a shaft 31 has mounted thereon a yoke 83 quite similar to the yoke 59'. Extending laterally from this yoke is a plate 84 and at the rear end of the yoke is a ball guide 85 wherein rests a ball 86 urged upwardly by spring 87, the action of these parts being like those of the analogous parts in the first form of clutch above described. The plate 84 carries a pivot 88 whereon is mounted the rear end of a lever 89 having a finger 90 for engagement with the ball 85. This lever 89 has a depending arm 91 provided with a notch 92. The plate 84 carries a second pivot 93 whereon is mounted a lever 94 having an operating end 95 for engagement by one's fingers or against some fixed object for the shifting of this lever. The lever 94 carries a lug 96 which fits in the notch 92 so that movement of the lever anticlockwise on the pivot 93 pushes the lever 89 downwardly. Secured to the plate 84 by a screw 97 is a cover plate 98 having an intumed lip 99. The lever 94 is free to oscillate slightly on the pin 88 and may move from the position shown in Fig. 14 laterally to engage, in a certain position such as shown in Fig. 15, behind the lip 99 so that the end of this lip forms a stop.

Under normal clutching position as shown in Fig. 13 the disc or wheel 37 is free to turn in clockwise direction of Fig. 14 but is locked by the ball against turning in anticlockwise direction. If it be now desired to release the disc to permit its turning to some extent in anticlockwise direction the lever 94 is moved to force the ball downwardly, thus releasing the disc 37 which is allowed to open as much as may be desired and is again caught upon release of the lever 94 from movement by the ball 85. At times it is desirable to have entire control of the thumb by the pull-cord 58 and in this case the lever 94 is moved in anticlockwise direction until it reaches the position shown in Fig. 15 for engagement behind the lip 99. By this means the

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ball will be held depressed to free the disc 37 and the ball will remain in this position until the lever 94 is disengaged from the lip whereupon the ball will again act as a pawl for checking movement.

As shown in the present instance the device has been illustrated as arranged, in Fig. 1, to fit an arm amputated below the elbow. In this case the cuff or ring has extending upwardly a pair of straps 12 enclosing a leather or other suitable socket member 73 to receive the stump of the arm. The straps are continued upwardly and at their upper ends are pivotally connected as at 74 to a similar pair of straps 75 carrying a cuff 76 which fits around the upper arm and the sides of which may be adjusted by means of a buckle and strap arrangement 77. This upper cuff carries the supporting harness 78, only a part of which is here shown as the style of the harness and the arrangement of the straps thereof may be varied without departing from this invention.

The cord or wire 58 is connected by a coupling 79 to a pull cord 80 which extends around the back of the wearer, one or more guide loops 81 being provided on the arm engaging part of the apparatus. This extension cord 80 is connected as at 82 to the harness in such way that muscular movements of the wearer will serve to pull on the cord 80 and thus actuate the disc 37 in a direction counter to that shown by the arrow X. The result of this will be that the thumb and finger portions of the device will close toward each other and, depending on the extent of muscular movement this closure may be varied at will.

In Figure 16 the bolt 25 is shown drilled on the threaded end after insertion into the aluminum casting 23 and 24. A taper shaped punch (not shown) is driven into the drilled hole thus forcing the outer threads 27 into the threads of the aluminum casting, giving it a friction squeeze.

This step is taken to prevent the threaded hinge pin from wearing into the aluminum and thereby becoming loose and possibly causing the fingers to fall out from the palm casting. With this construction the hinge pin can be retained satisfactorily in the casting and still be removed for replacement.

What is claimed is:

1. In an artificial limb, a hand member having a hollow body, a finger portion and a thumb portion, at least one of said portions being pivoted to the body to bias toward and from the other, spring actuated means in the body urging said pivotal portion to bias away from the other, said spring actuated means including a rotatable disc having a peripheral groove, a ball engageable in said groove, and a ball guide holding said ball and inclined to lie closer to the disc periphery at one end than at the other, the closer end of the guide being spaced from the disc a distance less than the diameter of the ball.

2. In an artificial limb, a hand member having a hollow body, a finger portion and a thumb portion, at least one of said portions being pivoted to the body to bias toward and from the other, spring actuated means in the body urging said pivotal portion to bias away from the other, said spring actuated means including a rotatable disc having a peripheral groove, a ball engageable in said groove, a ball guide holding said ball and inclined to lie closer to the disc periphery at one end than the other, the closer end of the guide being spaced from the disc a distance less than the diameter of the ball, and a spring in said guide urging said ball toward the end closer to the disc.

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3. In an artificial limb, a hand member having a hollow body, a finger portion and a thumb portion, at least one of said portions being pivoted to the body to bias toward and from the other, spring actuated means in the body urging said pivotal portion to bias away from the other, said spring actuated means including a rotatable disc having a peripheral groove, a ball engageable in said groove, a ball guide holding said ball and inclined to lie closer to the disc periphery at one end than the other, the closer end of the guide being spaced from the disc a distance less than the diameter of the ball, a spring in said guide urging said ball toward the end closer to the disc, a rock lever pivoted adjacent said ball guide and having one end bearing against said ball opposite the ball actuating spring, and means to rock said lever on its pivot.

4. In an artificial limb, a hand member having a hollow body, a finger portion and a thumb portion, at least one of said portions being pivoted to the body to bias toward and from the other, spring actuated means in the body urging said pivotal portion to bias away from the other, said spring actuated means including a rotatable disc having a peripheral groove, a ball engageable in said groove, a ball guide holding said ball and inclined to lie closer to the disc periphery at one end than the other, the closer end of the guide being spaced from the disc a distance less than the diameter of the ball, a spring in said guide urging said ball toward the end closer to the disc, a rock lever pivoted adjacent said ball guide and having one end bearing against said ball opposite the ball actuating spring, and means to rock said lever on its pivot, said last means being arranged to force said lever to free the ball from contact with said disc in one position and to hold said ball out of contact with the disc in a second position.

5. In an artificial limb, a hand member having a hollow body, a finger portion and a thumb portion, at least one of said portions being pivoted to the body to bias toward and from the other, spring actuated means in the body urging said pivotal portion to bias away from the other, said spring actuated means including a rotatable disc having a peripheral groove, a ball engageable in said groove, a ball guide holding said ball and inclined to lie closer to the disc periphery at one end than the other, the closer end of the guide being spaced from the disc a distance less than the diameter of the ball, a spring in said guide urging said ball toward the end closer to the disc, a rock lever pivoted adjacent said ball guide and having one end bearing against said ball opposite the ball actuating spring, and means to rock said lever on its pivot, said last means comprising a latch lever pivoted parallel to said rock lever and having one arm engaging the rock lever to move the same between position to force the ball against said spring and position to permit the ball to move under action by said spring.

6. In an artificial limb, a hand member having a hollow body, a finger portion and a thumb portion, at least one of said portions being pivoted to the body to bias toward and from the other, spring actuated means in the body urging said pivotal portion to bias away from the other, said spring actuated means including a rotatable disc

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having a peripheral groove, a ball engageable in said groove, a ball guide holding said ball and inclined to lie closer to the disc periphery at one end than the other, the closer end of the guide being spaced from the disc a distance less than the diameter of the ball, a spring in said guide urging said ball toward the end closer to the disc, a rock lever pivoted adjacent said ball guide and having one end bearing against said ball opposite the ball actuating spring, and means to rock said lever on its pivot, said last means comprising a latch lever pivoted parallel to said rock lever and having one arm engaging the rock lever to move the same between position to force the ball against said spring and position to permit the ball to move under action by said spring, said latch lever being further arranged to latch the rock lever in the first named position when moved in one direction.

7. In an artificial limb, a hand member having a hollow body, a finger portion and a thumb portion, at least one of said portions being pivoted to the body to bias toward and from the other, spring actuated means in the body urging said pivotal portion to bias away from the other, said spring actuated means including a rotatable disc having a peripheral groove, a ball engageable in said groove, a ball guide holding said ball and inclined to lie closer to the disc periphery at one end than the other, the closer end of the guide being spaced from the disc a distance less than the diameter of the ball, a spring in said guide urging said ball toward the end closer to the disc, a rock lever pivoted adjacent said ball guide and having one end bearing against said ball opposite the ball actuating spring, and means to rock said lever on its pivot, said last means being arranged to force said lever to free the ball from contact with said disc in one position and to hold said ball out of contact with the disc in a second position, said last means projecting through said hand body and operable from the exterior thereof.

8. In an artificial limb, a hand member having a hollow body, a finger portion and a thumb portion, at least one of said portions being pivoted to the body to bias toward and from the other, spring actuated means in the body urging said pivotal portion to bias away from the other, said spring actuated means including a rotatable disc having a peripheral groove, a ball engageable in said groove, a ball guide holding said ball and inclined to lie closer to the disc periphery at one end than the other, the closer end of the guide being spaced from the disc a distance less than the diameter of the ball, a spring in said guide urging said ball toward the end closer to the disc, a rock lever pivoted adjacent said ball guide and having one end bearing against said ball opposite the ball actuating spring, and means to rock said lever on its pivot, said last means comprising a latch lever pivoted parallel to said rock lever and having one arm engaging the rock lever to move the same between position to force the ball against said spring and position to permit the ball to move under action by said spring, said latch lever being further arranged to latch the rock lever in the first named position when moved in one direction, said latch lever projecting thru the wall of the hand body and operable from the exterior thereof.

DELBERT CLARK MOLLENHOUR.