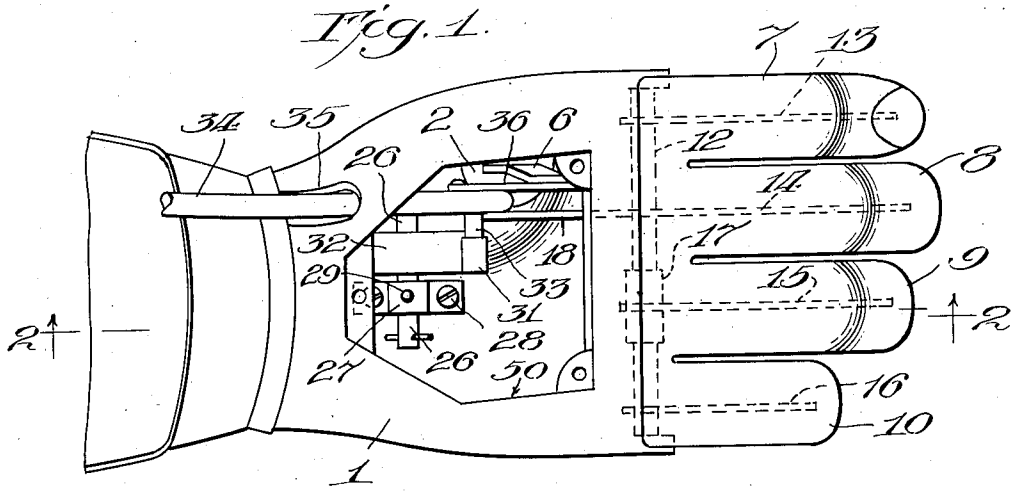
Nov. 20, 1934. F. C. HENNING 1,981,698

ARTIFICIAL HAND

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Fig. 1.



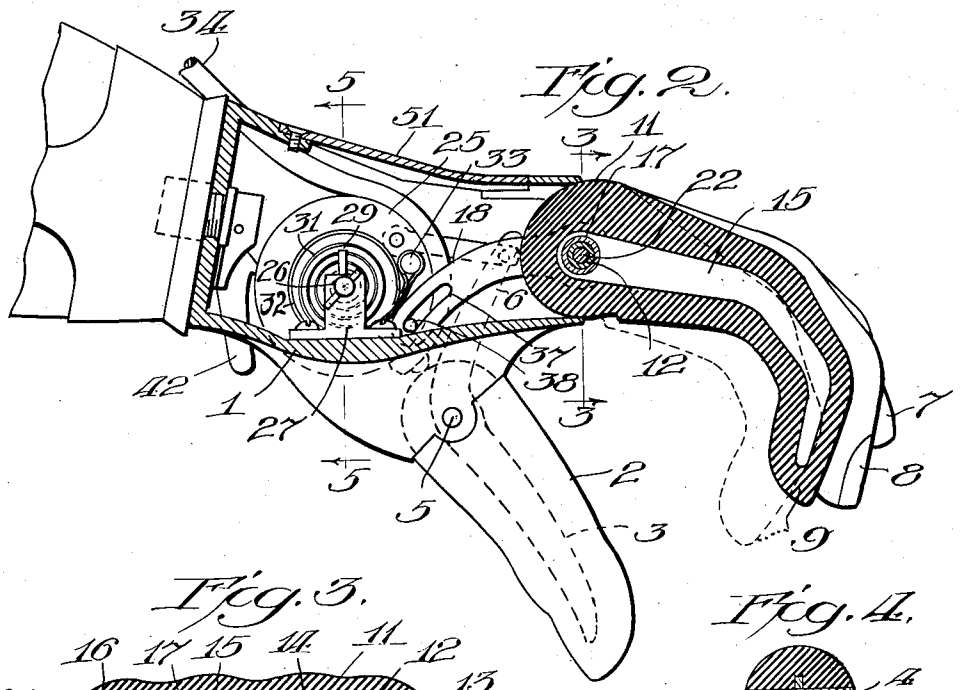


Fig. 2.

Fig. 3.

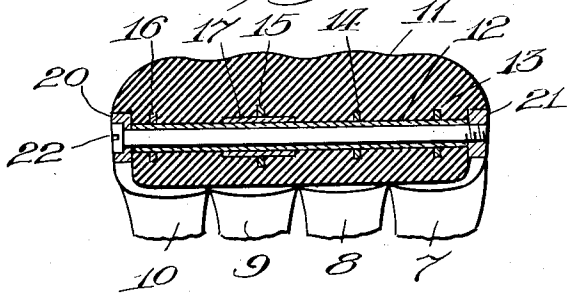
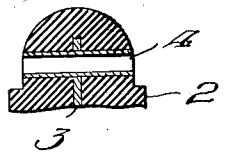


Fig. 4.



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Fig. 5.

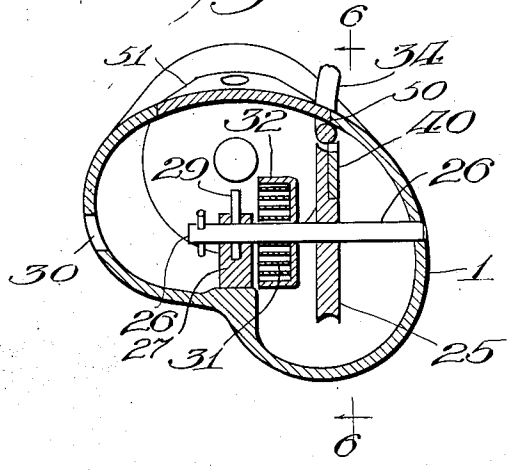


Fig. 6.

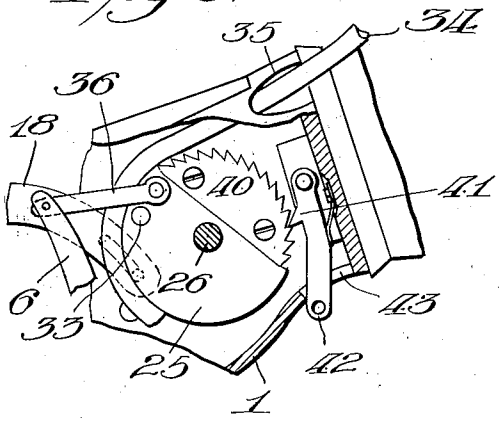


Fig. 7.

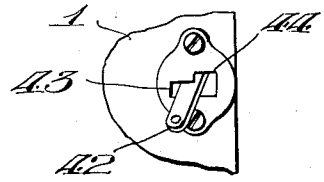


Fig. 9.

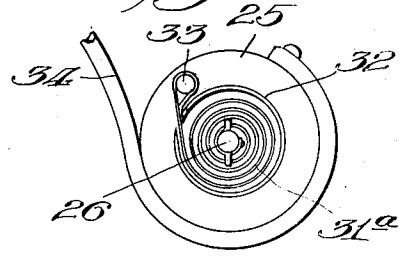
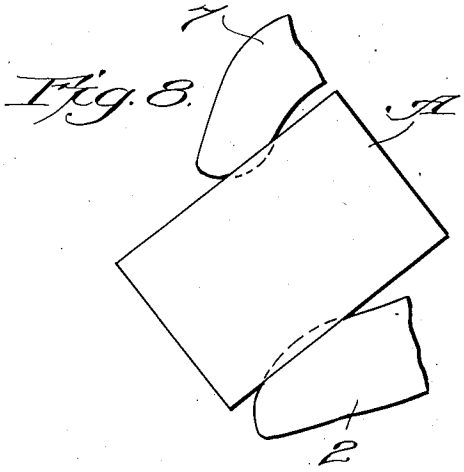


Fig. 8.



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UNITED STATES PATENT OFFICE

1,981,698

ARTIFICIAL HAND

Frederick Charles Henning, Chicago, Ill.

Application January 26, 1932, Serial No. 588,912

6 Claims. (Cl. 3—12)

The present invention has for its object to produce an artificial hand that is very simple in construction, strong and durable, and capable of taking and holding a firm grip on large or small, or thick or thin objects.

A further object of the present invention is to produce a simple and novel artificial hand that will open and close and be capable of taking a grip that is firm while being cushioned at the points of contact between the digits and the object that is being held.

In carrying out my invention, I employ a hollow palm member to which are hinged a thumb and fingers preferably composed of soft rubber; the four fingers being preferably moulded in a single unit so that all of the fingers may be connected to the palm device by a single fastening. The fingers and thumb are supported for swinging movements from and toward each other about parallel axes. By making the thumb and fingers of soft rubber, they will yield when closing upon an object; thereby not only avoiding the danger of marring the object with the finger but providing a grip that is much more secure than is the case where the fingers are of hard material. Rubber that is sufficiently soft to give the yielding character to the grip of the hand is not stiff enough to permit the hand to carry heavy weights or to resist other powerful forces tending to open the hand. I, therefore, incorporate in the thumb and fingers stiff reenforcing elements that extend lengthwise through the same. The reenforcing elements preferably extend from the knuckles to within a short distance of the tips of the fingers and thumb, so that a short section at the tip end of each finger and thumb consists of rubber only. Therefore, when the finger tips are pressed against an object, they yield much in the same manner as the tips of the fingers of a human hand, even though the fingers as a whole remain substantially rigid.

It is not enough that the thumb and fingers be so constructed that they may take a firm cushioned grip, but means must be provided for exerting a strong closing pressure on the thumb and fingers. Artificial hands are commonly closed in either of two ways; some hands being closed by a spring and being opened by a pull exerted upon the hand through a suitable pull cord; and other artificial hands being normally held open by a spring and being closed by means of a pull cord. My improved hand is adapted to be operated in either of these two ways, a strong clock spring being utilized for opening or closing the hand, as the case may be. When the spring serves merely to open the hand, it may be comparatively light spring, whereas, when the grip of the hand is determined by the strength of the spring, a comparatively powerful clock spring must be employed. The mechanism which I have devised for opening and closing the fingers is such that it is only necessary to reverse the direction in which the pull cord leaves a wheel or disk and substitute a different clock spring reversely connected to the wheel or disk, in order to change the hand from one type to another. The power for moving the fingers and thumb is applied to the disk or wheel at or near the periphery of the latter, and this power is delivered to the actuating arms or levers for the thumb and fingers from points near the periphery of the disk or wheel.

The various features of novelty whereby my invention is characterized will hereinafter be pointed out with particularity in the claims; but, for a full understanding of my invention and of its objects and advantages, reference may be had to the following detailed description taken in connection with the accompanying drawings, wherein:

Figure 1 is a top plan view of a hand constructed in accordance with my invention, the cover plate on the back of the hand being removed; Fig. 2 is a section on line 2—2 of Fig. 1 showing, in dotted lines, the manner in which the third finger on the hand may be flexed independently of the other fingers; Fig. 3 is a section on line 3—3 of Fig. 2; Fig. 4 is a longitudinal section through the base or knuckle end of the thumb; Fig. 5 is a section on line 5—5 of Fig. 2; Fig. 6 is a section on line 6—6 of Fig. 5; Fig. 7 is an elevational view showing only a small fragment of the hand looking in the direction of the arrow underneath Fig. 6; Fig. 8 illustrates diagrammatically the hand closed upon a solid block, the dotted line portions of the fingers and thumb representing parts that have been compressed so as to flatten the finger and thumb against the corresponding faces of the block; and Fig. 9 is an elevation of the operating disk or wheel removed from the hand and having the pull cord and spring connected in such a manner that the spring serves to close the hand, whereas the spring holds the hand open when free to do so, in Figs. 1–7.

Referring to the drawings, 1 represents what may be termed a hollow palm or body portion of the hand. The member 1 is open at the front edge and, at one side, has a thumb opening. The thumb 2 is preferably made of a body of soft rubber moulded about a reenforcing bar 3. This

bar is preferably a flat, more or less resilient bar set on edge, as shown in Fig. 2. The rubber extends a short distance beyond the tip of the bar, so that the tip of the thumb is comparatively yieldable. A tubular member 4 passes transversely through and is fixed to the bar at the base end or knuckle of the thumb; this member 4 serving as a long bearing to receive a pin 5 extending transversely through the thumb and into stationary parts of the hand device on opposite sides of the thumb. In other words, the thumb may swing about the pin 5 as an axis. The reenforcing bar extends rearwardly to and beyond the rear end of the thumb to provide an operating arm 6 that extends up into the interior of the hollow palm device.

The four fingers 7, 8, 9 and 10, are preferably moulded as part of a single block or unit, being connected together at their bases or knuckles by a part 11 extending across all four fingers. Moulded within the part 11 is a long tube 12 extending transversely of the fingers. Each finger contains a reenforcing bar similar to the bar 3; these bars being indicated at 13, 14, 15 and 16. All of these bars extend from the tubular member 12 to points a short distance removed from the extreme tips of the corresponding fingers. If the bars in the fingers are fixed to the tubular member, the fingers will all be held in fixed relation to each other, except as they may yield more or less sidewise due to the resiliency of the flat bars. It may sometimes be desirable to insert a pen, pencil or fork or spoon handle between two of the fingers before the hand is closed upon the article. This would not be possible if the fingers were held in rigid relation to each other. Therefore, in the arrangement shown, the bars in all of the fingers except the third finger are fixed to the member 12, whereas the bar 15, in the third finger, is loose on the member 12 so as to be capable of swinging about the latter. In order that the third finger will not be permitted to wobble sidewise, I prefer to provide the bar 15 with a long bearing on the member 12. To this end I have fixed the bar 15 to a short sleeve 17 that fits rotatably upon the member 12. The bar 14 in the second finger is extended rearwardly to form an operating arm or lever 18.

The finger unit is so proportioned that, when its base or rear end is inserted in the open front end of the palm device, the tubular member 12 fits between thickened parts 20 and 21 on the side walls of the palm device. A long pin or screw, extending through the parts 20 and 21 and through the interior of the tubular member 12, serves to secure the finger unit to the palm device, while permitting it to swing or rock about an axis parallel to the hinge axis of the thumb. In the arrangement shown, the pin is in the form of a long screw bolt 22, whose head fits into a socket or recess on the outer face of the thickened part 20 of the palm device, and whose screw-threaded end is screwed into the thickened part 21 at the opposite edge or side of the palm device.

The arms 6 and 18 lie in parallel planes slightly separated from each other. Within the hollow palm device, parallel with, and between said planes, is a wheel or disk 25 rotatable on a transverse stationary shaft 26. In the arrangement shown, as best seen in Fig. 5, one end of the shaft extends into an opening in one of the side walls of the hollow palm device and is rotatably supported by that wall; whereas the other end passes through a stationary block or pedestal 27 that may be detachably held in place by screws or the like 28. A pin 29 extends down through the top of the pedestal and through the shaft to hold the latter against rotary or endwise movements. The side wall of the hollow palm device opposite that in which one end of the shaft 26 is supported contains an opening 30 through which may be inserted a key (not shown) for turning the shaft 26. Surrounding the shaft 26, between the pedestal and the disk or wheel, is a spiral clock spring 31, one end of which is fixed to the shaft and the other end of which is connected to the disk or wheel. In the arrangement shown, the spring is housed in a cup-shaped casing 32, one end of the spring extending through a slot in the periphery of the casing and being bent around a pin or stud 33 projecting laterally from the disk or wheel. The spring, therefore, tends constantly to turn the disk or wheel in one direction. For turning the disk or wheel in the opposite direction, I provide a pull cord 34, one end of which lies upon and extends along the rim or periphery of the wheel and is attached to the wheel; the cord passing out to the outside of the hand device through a hole 35 in the back of the device. By pulling upon the cord 34, the disk or wheel may be rotated in a direction to wind up the spring.

The free end of the actuating arm 6 for the thumb is connected to the disk or wheel by a link 36, one end of which is pivotally connected to the wheel or disk near the periphery of the latter. The actuating arm 18 for the fingers extends rearwardly far enough to overlap and lie beside the wheel or disk. In this arm is a long slot 37 extending lengthwise of the arm. On the wheel or disk is a pin 38 projecting laterally from a point near the periphery through the slot in the arm 18. Therefore, when the disk or wheel is turned, the arms 6 and 18 are swung in a direction to close or open the hand, depending upon the direction in which the wheel is turned. In the arrangement illustrated in the main views of the drawings, the spring turns the wheel or disk in the direction to open the hand, whereas the pull cord turns the wheel or disk in the direction to close the hand. In other words, the strength of the final grip, when the hand is closed upon an object, depends upon the power applied to the pull cord. In this construction, the spring need be made only strong enough to insure that the hand will open quickly when it is free to do so.

It is desirable that, after the hand has closed upon an object, it will maintain its grip without further attention on the part of the wearer. I have, therefore, provided means for locking the thumb and fingers in any one of a variety of positions. In the arrangement shown, this locking means consists simply of a pawl and ratchet. Thus, as best shown in Fig. 6, there is secured to one side of the disk or wheel 25 a toothed segment 40 with which cooperates a toothed pawl 41 having a stem or finger piece 42 extending to the exterior of the hand through a hole 43 on the under side. As best shown in Fig. 7, the hole 43 is in the form of an L-shaped slot. When the part 42 is shifted laterally into the short arm 44 of the L, the pawl is held away from the ratchet teeth so that the hand may be opened and closed without reference to the locking device. However, when the finger piece on the pawl is pressed laterally out of the part 44 of the slot, as shown in Fig. 7, the pawl engages the ratchet teeth and will lock the hand against opening until the pawl is tripped. Of course, the teeth of the ratchet wheel cannot be made

so fine that the hand, if the fingers were rigid, could be locked so as to maintain a firm grip at each and every point in the range of closing movements of the hand. However, by making the thumb and fingers of rubber and, particularly by leaving the finger tips without any internal stiffening means, the finger tips may yield sufficiently after the hand has closed on an object to insure that the pawl may catch a tooth and thus maintain the pressure of the fingers on the object. In other words, by permitting the fingers to yield sufficiently to permit the disk or wheel to turn through an angular length equal to one tooth after the thumb and fingers have come into contact with an object, it makes no difference whether such contact is first made when the pawl is midway between two teeth or in any other position relatively to the teeth; because a pull on the cord will always permit the wheel or disk to be turned far enough to permit the pawl to snap into engagement with the next or following tooth. Furthermore, if the rubber is comparatively soft, the slight compression required of the tips of the fingers to permit the pawl properly to catch will not greatly increase the pressure on the object that is being held, although, if a very powerful grip is desired, the compression may, of course, be carried to a point where the thrust will be directly resisted by the reenforcing bars in the thumb and fingers. In Fig. 8, I have shown the thumb and the forefinger holding between them an object A. It will be seen that both the thumb and the finger have been flattened to the extent indicated by the dotted line portions overlapping the area of the object A.

It will be seen that the pulling force of the cord is applied to the wheel or disk at the periphery, providing a comparatively long lever arm between the axis of rotation and the point at which the power is applied. Furthermore, the pin or stud 33 and the point of connection between the link 36 and the wheel or disk being near the periphery of the latter, the forces that are applied to open and close the hand are effectively transmitted.

Where it is desired to have the spring close the hand and the pull cord open the same, the spring and the pull cord are connected to the wheel or disk in such a manner that they act respectively in opposite directions from those in the construction heretofore described. Such a modified arrangement is shown in Fig. 9 from which it will be seen that the pull cord extends rearwardly from underneath the wheel or disk instead of from above. Furthermore, the spring 31*a*, corresponding to the spring 31 in the other form, is wound in the opposite direction from the spring 31. With this construction it is of advantage to be able to increase the tension of the spring in case it should weaken; this being made possible by the insertion of a key through the hole 30 as heretofore explained. By making it possible to wind up the spring after it has been assembled in the hand, it becomes a simple matter to set the unit, composed of the shaft 26, the wheel or disk and the spring, into the hand and then wind up the spring.

In order to give access to the interior of the palm device, I form in the back thereof a large opening 50 that is normally closed by a removable cover plate 51.

While I have illustrated and described with particularity only a single preferred form of my invention, with a slight modification, I do not desire to be limited to the exact structural details thus illustrated and described; but intend to cover all forms and arrangements which come within the definitions of my invention constituting the appended claims.

I claim:

1. A finger unit for an artificial hand comprising a single body of soft rubber in the form of four fingers joined together at the knuckles by a transverse base member, a reenforcing bar within and extending lengthwise of said base member, long, stiff reenforcing elements embedded in and extending lengthwise of said fingers, a hinge connecting one of said elements to said rod, and the other elements being fixed to said rod.

2. A finger unit for an artificial hand comprising a single body of soft rubber in the form of four fingers joined together at the knuckles by a transverse base member, a reenforcing bar within and extending lengthwise of said base member, long, stiff reenforcing elements embedded in and extending lengthwise of said fingers, a hinge connecting the reenforcing element in the third finger to said rod, and the other elements being fixed to said rod.

3. A finger unit for an artificial hand comprising four fingers and a base joined to the fingers at the knuckles, the whole being formed of soft rubber, a reenforcing bar extending transversely to the fingers through the base, flat bars arranged on edge in said fingers and extending lengthwise thereof from said reenforcing bar, a hinge between one of the bars in the fingers and the said reenforcing bar, and the other bars in the fingers being fixed to the reenforcing bar.

4. In an artificial hand, a hollow palm device, a member extending across the front end of said device and connected thereto for rocking movements about an axis transverse to said device, fingers projecting forwardly from said member, a thumb connected to said device for rocking movements about an axis parallel to the aforesaid axis, a disk mounted in said device for turning movements about an axis parallel to the aforesaid axes, a spring tending constantly to turn said disk in one direction, a cable fixed at one end to the disk and extending circumferentially thereof and then tangentially therefrom to turn said disk in the opposite direction, a slotted lever arm fixed to and extending from said member at right angles to the first-mentioned axis to a position beside the disk, a pin on the disk engaged in the slot in said lever arm, a lever arm fixed to said thumb, and a connecting rod extending between the latter lever arm and the disk.

5. In an artificial hand, a hollow palm device, a member extending across the front end of said device and connected thereto for rocking movements about an axis transverse to said device, fingers projecting forwardly from said member, a thumb connected to said device for rocking movements about an axis parallel to the aforesaid axis, a disk mounted in said device for turning movements about an axis parallel to the aforesaid axes, a clock spring tending constantly to turn said disk in one direction, a flexible pull member connected to and extending circumferentially of the disk to turn the disk in the opposite direction, a slotted lever arm fixed to and extending from said member at right angles to the first-mentioned axis to a position beside the disk, a pin on the disk engaged in the slot in said lever arm, a lever arm fixed to said thumb, and a connecting rod extending between the latter lever arm and the disk.

6. In an artificial hand, a hollow palm device,

a member extending across the front end of said device and connected thereto for rocking movements about an axis transverse to said device, fingers projecting forwardly from said member, a thumb connected to said device for rocking movements about an axis parallel to the aforesaid axis, a shaft mounted in said device for turning movements about an axis parallel to the aforesaid axes, a disk surrounding and loose on said shaft, a clock spring surrounding said shaft and fixed at one end to the disk and at the other end to the shaft, a releasable device to lock the shaft against rotation, one end of the shaft being shaped to receive a key to turn the same when released, a pull cord connected to and extending circumferentially of the disk to turn the disk in opposition to the spring, and connections between said member and thumb and said disk to cause the hand to close and open as said element is turned first in one direction and then in the other.

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