Dec. 7, 1954 G. B. ROBINSON 2,696,010

PNEUMATICALLY OPERATED ARTIFICIAL HAND

Filed June 30, 1952

Fig. 1

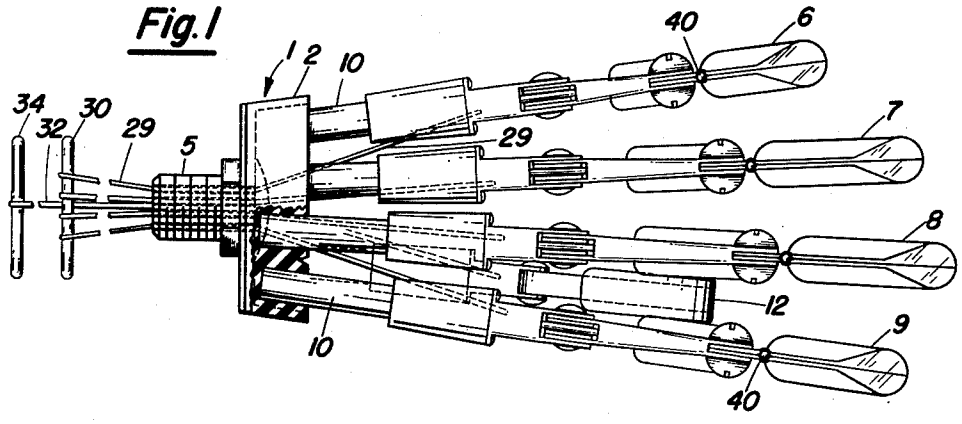


Fig. 2

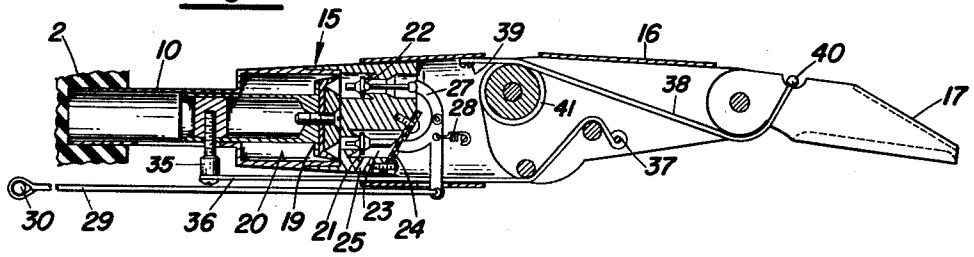
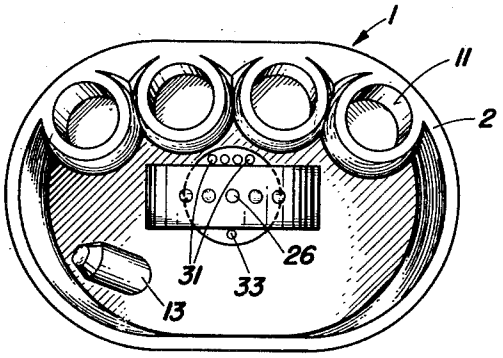


Fig. 3



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PNEUMATICALLY OPERATED ARTIFICIAL HAND

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5 Claims. (Cl. 3—1.2)

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This invention relates to power-driven artificial hands and, more particularly, to pneumatically actuated artificial hands.

Heretofore artificial hands have been actuated by cables connected to various parts of the body, such as the shoulders, or have been actuated by power-driven means such as pneumatic devices which are energized by the muscles of the arm to which the artificial hand is connected. In either event the arrangement has been awkward. It is therefore an object of this invention to provide an artificial hand wherein the power-driven means, such as a pneumatic actuating means, is merely controlled or triggered by the muscles of the arm to which the hand is attached.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a plan view of a device embodying the invention;

Fig. 2 is a sectional view through one of the fingers of the artificial hand and its accompanying power-driven actuating means; and

Fig. 3 is a view showing the resilient wrist member upon which the fingers are mounted.

Briefly, this invention comprises an artificial hand which is actuated by a power-driven device and which has an element for controlling the flow of power to the power-driven device, this control element being connected through a control cable to a muscle of the amputee so as to be operated by that muscle. In a preferred illustrated embodiment, the device is pneumatically driven and the control element is a valve connected to a muscle in the forearm. The cable is attached to the muscle by means of an eyelet formed in the muscle by a cineplastic operation. In this operation the muscle is slit and a tube of skin is positioned in the slit. This piece of skin grows integral with the muscle to form an eyelet through which a pin can be inserted to which pin the control cable is attached. The muscle so adapted is called a cinemotor. Contraction of the muscle displaces the control cable longitudinally. Since the valve, which is the control element of the pneumatically-driven device, is connected to the cable, the device is triggered or set into operation by the muscle contraction and the hand is actuated which, in the illustrated embodiment, involves flexing of the fingers.

For a detailed description of a preferred embodiment, reference is now made to the drawings and particularly to Fig. 1. This embodiment comprises a wrist member gradually indicated at **1**, including a finger mount **2** of rubber-like material held between metal pieces and including also a threaded portion **5** for attaching the hand to the bucket or socket carried by the stump of the amputee. The hand includes fingers **6** through **9**, having hollow stem-like portions **10**, which fit firmly into sockets **11** in the element **2**, thus giving the fingers a more or less resilient mount. For added resiliency, the thumb **12** is mounted over a tongue **13** rather than in a socket. Each of the fingers includes, as shown in the detail drawing of Fig. 2, a metacarpal piece indicated generally at **15**,

to which is articulated a first phalange **16**, to which in turn, at its distal extremity, is articulated a second or ungual phalange **17**. The metacarpal piece **15**, which is rigidly connected to the stem portion **10**, includes a pneumatic piston and cylinder arrangement comprising a piston **19**, reciprocable in a cylinder **20** to flex the phalanges of the finger. For controlling the flow of air in the cylinder, there is provided an inlet valve **21** and an outlet valve **22**, which can conveniently be, as shown, of the type used in conventional pneumatic automobile tires. The high pressure side of inlet valve **21** lies generally in a chamber **23**, which is sealed off from access to the atmosphere by diaphagm **24** and to which air under pressure can be admitted from a source, not shown, through a port **25** connected to the source by any convenient tube or the like which can conveniently lead from opening **26** in the central element of the wrist member serving as a manifold. The valves are operated alternatively by a rocker arm type of valve actuator **27** urged by spring **28** into a position in which the outlet valve **22** is open while the inlet valve **21** remains closed. The rocker arm actuator **27** is connected by means of a cable **29** to a pin or bar **30** to which are attached the valve actuator control cables from each of the four fingers running through guide holes **31** in the wrist member. The bar or pin **30** is adapted to be placed in the eyelet of a cinemotor. The cable **32** from the thumb valve runs through the guide hole **33** and is attached to a pin **34** to be placed in an additional cinemotor operable independently from that of the pin **30**.

The piston **19** is connected through a screw **35**, attached to the piston extension and passing through a slot in the stem portion **10**, to a cable **36**, the distal end of which is fixed at **37** to the volar region of the first phalange. A cable **38** fixed at one end as at **39** to the metacarpal portion of the hand and anchored at its other end as at **40** to the ungual phalange serves to flex the ungual phalange simultaneously with flexure of the first phalange. This is accomplished by virtue of compelling the cable **38** to wrap itself around the cylindrical surface **41** and thus tend to shorten itself as the first phalange is flexed.

Operation

To use the hand of this invention, the device is attached by its threaded portion **5** to the distal end of a bucket or socket worn by the amputee. The bars **30** and **34** are inserted in the muscle eyelet resulting from a cineplastic operation and the appropriate cables are attached to each bar. A tube leading from the compressed air generating system worn by the wearer is connected into the port **25** and the hand is then ready for use. To flex the fingers and thumb in order to grip and object, the amputee contracts the muscles carrying the bars **30** and **34**. In the typical finger shown in Fig. 2 this causes the cable **29** to rotate the valve rocker arm **27** clockwise, as viewed in this figure, against the action of the spring **28**. The rocker arm thereupon releases the pressure on the stem of valve **22**, allowing that valve to close and, through the diaphragm **24**, tilts the valve stem of the valve **21** to open this valve, allowing air under pressure to enter through port **25** into chamber **23** and thence into the cylinder **20** to cause the piston **19** to move to the left as viewed in this figure. This motion of the piston flexes the finger phalanges through the medium of cables **36** and **38**. When the amputee desires to release his grip, he simply relaxes the muscles carrying bars **30** and **34**, allowing the spring **28** to return the rocker arm **27** to a position in which the valve **21** is again free to close and the valve **22** is opened. This allows the compressed air within the cylinder **20** to escape through the open valve **22**. Thereupon, the phalanges are free to return to their extended position. The return of the fingers to extended position automatically draws back the piston **19** toward the right, as viewed in Fig. 2, through the medium of cable **36** and pin **35**.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An artificial hand comprising power-driven means for actuating the fingers of said hand; means for controlling the flow of power to said power-driven means; and means adapted for actuation by a cinemotor muscle for operating said control means; said third named means including a pin for insertion in a canal in said cinemotor muscle and means connecting said pin to said power-flow-controlling means.

2. The device of claim 1 wherein said hand includes a thumb and fingers and wherein said device includes a first cinemotor means for governing actuation of the thumb of said hand and a second cinemotor means operatable independently of said first cinemotor means for governing actuation of the remaining fingers of said hand.

3. The device of claim 1 wherein said power-driven means are pneumatically driven.

4. The device of claim 3 wherein said power-driven means includes a pneumatic piston and cylinder arrangement for flexing the fingers of said hand and said power-flow-control means includes valves for controlling air flow in said cylinder, and said cinemotor means includes a mechanism for operating said valves comprising said pin and said connecting means.

5. An artificial hand comprising a wrist element including a portion for resiliently mounting a plurality of fingers; a plurality of fingers including a thumb mounted on said wrist element; mechanism for flexing each finger comprising a pneumatic piston and cylinder; means connecting said piston to a phalange of a finger whereby motion of said piston in said cylinder flexes said finger; an air inlet valve and an air outlet valve for each cylinder; a rocker arm for alternatively operating said valves; and means for actuating said rocker arm adapted for connection to a muscle eyelet; the mechanism for actuating said thumb being operable independently of the mechanism for operating said fingers.

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