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J. E. CONZELMAN, JR., ET AL
PROSTHETIC DEVICE SENSORY ATTACHMENT

2,656,545

Original Filed June 28, 1948

FIG. 1

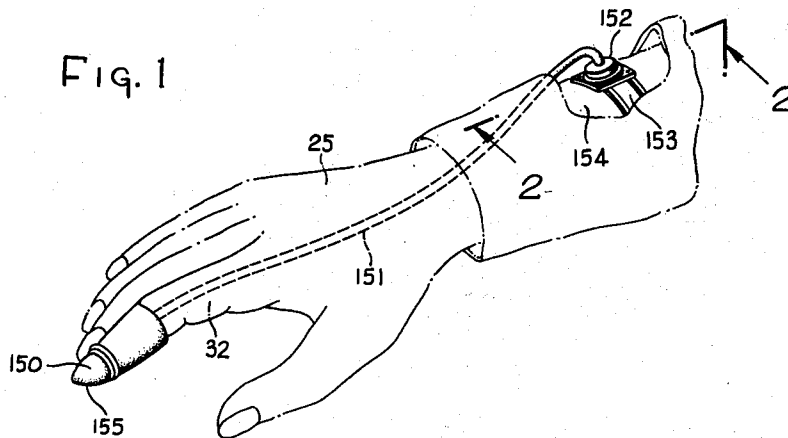


FIG. 2

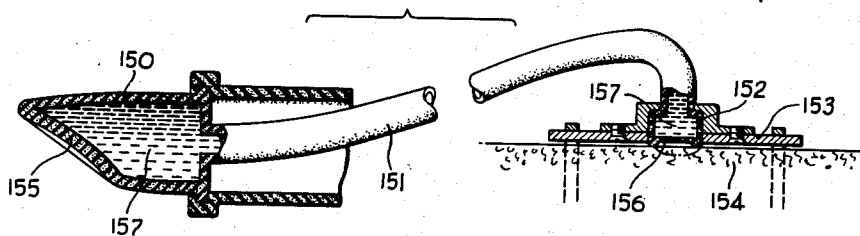


FIG. 4

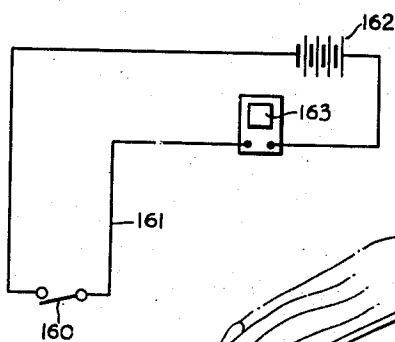
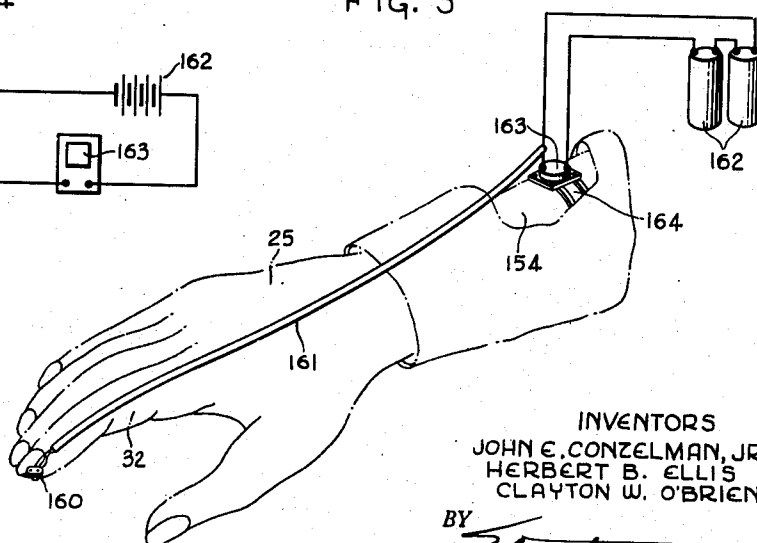


FIG. 3



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2,656,545

PROSTHETIC DEVICE SENSORY
ATTACHMENTJohn E. Conzelman, Jr., Sierra Madre, Herbert B.
Ellis, La Canada, and Clayton W. O'Brien, Los
Angeles, Calif.Original application June 28, 1948, Serial No.
35,634, now Patent No. 2,582,234, dated January
15, 1952. Divided and this application January
10, 1952, Serial No. 265,872

1 Claim. (Cl. 3—12)

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This invention relates to prosthetic devices and more particularly to a sensory device for transmitting to the wearer of an artificial hand, or other prosthesis, an indication of contact made by the artificial member.

An object of our invention is to provide a sensory mechanism for a prosthetic device, which is capable of transmitting to its wearer an indication not only that the artificial member is touching something, but also an indication of the degree of pressure being exerted during that contact.

This application constitutes a division of our co-pending application, Serial No. 35,634, filed June 28, 1948, now Patent No. 2,582,234, issued January 15, 1952.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred forms of our invention which are illustrated in the drawings accompanying and forming part of the specification. It is to be understood that we do not limit ourselves to the showing made by the said drawings and description, as we may adopt variations of the preferred forms within the scope of our invention as set forth in the claim.

Referring to the drawings:

Figure 1 is a perspective view of a prosthetic hand illustrating a preferred form of the sensory device of our present invention.

Figure 2 is a sectional view drawn to an enlarged scale, taken in part on the line 2—2 of Fig. 1 and in part through the tip of one of the fingers of the artificial hand.

Figure 3 is a perspective view similar to Fig. 1 but showing a modified form of sensory device incorporating principles of the present invention.

Figure 4 is a schematic view of the electrical circuit associated with the sensory device of Fig. 3.

The sensory device of our present invention is adapted for constructional incorporation into, and use in conjunction with substantially any prosthetic device. However, it was designed primarily for the artificial hand disclosed in our co-pending application, hereinabove identified, to which it is an especially valuable and desirable accessory, because of the powerful grip which this particular hand is made capable of exerting by means of the force multiplier with which it is provided. Because of the powerful grip which this hand can exert, any article which is grasped by it would be apt to be crushed were it not provided with a sensory device, such as that of the

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present invention, which keeps the wearer constantly informed of the magnitude of the force with which the hand is pressing against the article held. Particularly true is this specific hand, since the design, construction, and manner of incorporation of the said force multiplier into the hand, and its manner of being operably coupled to actuating muscles of the wearer, make it possible to exert a gripping force of considerable magnitude with relatively little effort—so little, in fact, that the wearer is apt not to realize how much force the artificial hand actually is exerting. Moreover, this situation is even further intensified by the fact that the ratio of the exerted gripping force of the hand to the muscular effort required to effectuate it, is not constant, but is subject to variation by adjustment of a simple control; and in the absence of means for keeping the wearer informed of the extent, or magnitude of the pressure imposed by the hand upon the article being grasped thereby, it would be entirely possible for the wearer to be under the impression that the force multiplier is adjusted to low ratio of gripping force to muscular effort when in fact the opposite adjustment obtains, and thus inadvertently cause the hand to grip with damaging force. The incorporation of the sensory device of the present invention with an artificial hand characterized by such a force multiplier greatly reduces this hazard, because of its capability of imparting to the wearer a dependable, and easily interpreted indication of the magnitude of the force which the artificial hand is, at any time, exerting against the article being gripped.

With these considerations in view, we prefer to provide the prosthetic hand forming part of the subject-matter of our aforesaid co-pending application, with our improved sensory device as embodied in the modification thereof illustrated in Figures 1 and 2. Here we have illustrated a form of sensory device adapted to indicate contact pressure by tactile sensation and based upon hydraulic principles of operation. A bladder 150 on the end of a finger of the prosthesis 25, preferably the index finger 32, is connected by a flexible tube 151 to a second bladder 152 held by suitable harness 153 to a normally sensitive part of the skin of the stump of the amputee, indicated at 154. The bladders 150 and 152 have, respectively, flexible diaphragms 155 and 156, but are otherwise so rigid as to be substantially non-expandable. The flexible tube 151 may be of rubber but has a wall of such thickness and tensile strength that it, also, is substantially non-

expandable. The bladders 150 and 152 and the tube 151 are filled to capacity with a non-compressible fluid, shown at 157 in Figure 2. Consequently, any pressure upon the diaphragm 155 tends to dilate the diaphragm 156 and the pressure is transmitted to the skin of the amputee in proportion to its intensity at the finger tip. The tube 151 may be disposed entirely within the fingers and casings of the prosthesis, to maintain the aesthetic appearance of the hand, and the prosthesis may be covered by a cosmetic glove without seriously impairing the effectiveness of the sensory device.

A sensory device modified to operate on electric principles is illustrated in Figures 3 and 4. A switch 160, of spring-resisted push-button type, is attached to the end of a finger 32 of the prosthetic hand 25, so as to close an electric circuit 161 in response to finger-tip pressure. The circuit 161 includes a suitable battery 162 which may be located at any convenient point in the amputee's clothing, and a vibrator disc 163 attached by harness 164 to the skin of the amputee's stump. Pressure at the finger tip sufficient to close the switch 160 is indicated to the amputee by the sensation of vibration on his skin. By making the switch 160 of the rheostat or variable bridge type, with its movable element spring-urged to the high resistance end and thence to open position, the intensity of vibration may be made to coincide with the intensity of pressure.

By having his prosthetic hand equipped with a sensory device of either of the hereinabove modifications, either of which is capable of transmitting to the amputee a signal the intensity of which is proportionate to the magnitude of force exerted by the hand against an article held thereby, he will be enabled to learn, when handling a non-compressible object or a fragile one, to exert only the moderate force required by the existing circumstances. He will, therefore, be enabled to educate himself in the use of the prosthesis, so as to avoid over-stressing the operating mechanism of the prosthesis, and also liability

of crushing an article grasped thereby, since in his estimation of the force required to perform any certain act of grasping an object, he will be guided, at least in part, by the signal transmitted to a sensitive part of his skin, by the sensory device.

It will be readily understood, therefore, that the sensory device of our present invention constitutes a valuable aid in the rehabilitation of an amputee, as well as a valuable working tool enabling an amputee to overcome the handicap of amputation.

We claim:

In a prosthetic device, a sensory mechanism for indicating to the wearer by tactile sensation pressure exerted extraneously upon a portion of said device, and comprising an electric switch of spring-opened type secured to said portion of said prosthetic device so as to be closable by pressure of said portion upon an extraneous object, an electric vibrator secured to the skin surface of the wearer, and electric circuit connections between said switch and said vibrator, including connections to a source of electric power.

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