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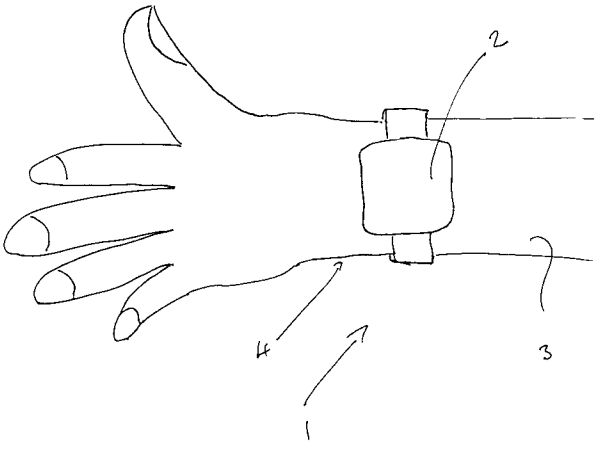
(54) **VETEMENT MUNI D'UN CONTROLEUR ACTIVE PAR UN IMPACT MECANIQUE**

(54) **GARMENT HAVING CONTROLLER THAT IS ACTIVATED BY MECHANICAL IMPACT**



(57) Vêtement autonome porté par un utilisateur afin de contrôler des fonctions par un dispositif électrique ou électronique. Le vêtement comprend un détecteur et un contrôleur électronique, le détecteur révélant des troubles mécaniques transitoires et provoquant le contrôleur électronique à effectuer le contrôle des fonctions par un dispositif électrique ou électronique. Dans une version préférée, le vêtement de stimulation électrique autonome est conçu pour un utilisateur à fonction motrice diminuée. Ce vêtement comprend un détecteur et un stimulateur musculaire électronique, le détecteur révélant des troubles mécaniques transitoires et provoquant un stimulateur musculaire électronique à effectuer la stimulation musculaire de l'utilisateur à l'aide de connexions électriques, situées à l'intérieur du vêtement. De préférence, le vêtement comprend un accéléromètre qui détecte les troubles mécaniques transitoires et active le stimulateur.

(57) A self-contained garment to be worn by a user for control of functions by electrical or electronic means. The garment has a sensor and an electronic controller, the sensor detecting transient mechanical disturbances and causing the electronic controller to effect said control of functions by electrical or electronic means. In preferred embodiments, the self-contained electrical stimulation garment is intended for a user of reduced motor ability, the garment having a sensor and an electronic muscle stimulator, with the sensor detecting transient mechanical disturbances and causing an electronic muscle stimulator to effect muscle stimulation of the user through electrical connections associated therewith that are internal to said garment. Preferably, the garment has at least one accelerometer which detects the transient mechanical disturbances and activates the stimulator.

ABSTRACT OF THE DISCLOSURE

A self-contained garment to be worn by a user for control of functions by electrical or electronic means. The garment has a sensor and an electronic controller, the sensor detecting transient mechanical disturbances and causing the electronic controller to effect said control of functions by electrical or electronic means. In preferred embodiments, the self-contained electrical stimulation garment is intended for a user of reduced motor ability, the garment having a sensor and an electronic muscle stimulator, with the sensor detecting transient mechanical disturbances and causing an electronic muscle stimulator to effect muscle stimulation of the user through electrical connections associated therewith that are internal to said garment. Preferably, the garment has at least one accelerometer which detects the transient mechanical disturbances and activates the stimulator.

TITLE

GARMENT HAVING CONTROLLER THAT IS ACTIVATED BY MECHANICAL IMPACT

The present invention relates to a garment having a controller that is activated by a transient mechanical disturbance, and in particular to a self-contained electrical stimulation garment intended for use by a person of reduced motor ability.

Garments are known for applying controlled electrical stimulation to restore motor function for use by persons of reduced motor ability e.g. who are partially paralyzed people, for instance a person who is a quadriplegic, paraplegic or hemiplegic, or with hand or other tremors. In some instances, such garments are intended to be applied for pinch grip and hand opening functions, and in other instances the garments are intended to assist the person with walking.

The use of signals from switches or sensors to control functional electrical stimulation (FES) of paralyzed muscles is known. In particular, published PCT patent application WO95/10323 of A. Prochazka et al. discloses a non-invasive self-contained functional electrical stimulation garment, preferably in the form of a glove that may be donned in one piece by a user of reduced motor ability. That application also makes reference to known use of shoulder position sensors to control wrist extension via an implanted FES stimulator, shoulder sensors to control hand opening and pinch grip, a wrist position sensor used to control FES of leg muscles, and a multi component device in which wrist position sensors are used to stimulate FES evoked pinch-

grip. Several of such approaches utilize percutaneous wire electrodes or fully implanted FES stimulators i.e. invasion procedures are required.

A device for generating hand function having an S-type splint in disclosed in U.S. 5,330,516 of R.H. Nathan. Voice activation of an FES device to control hand function is described by R.H. Nathan et al in Arch. Phys. Med. Rehabil. 71: 415-421. A neuromuscular stimulation system is disclosed in U.S. 5,167,229 of P.H. Peckham et al. U.S. 4,558,704 and 4,580,569, both of J.S. Petrofsky, disclose systems for stimulating a grasping action by a paralyzed hand that particularly utilizes a sensor that transmits shoulder movement signals to a cuff worn on the forearm of the user. U.S. 4,650,492 of M. Barkhordar et al. discloses an artificial hand that has an actuator with a touch sensor. U.S. 5,643,332 of R.B. Stein discloses an assembly mountable on the leg of a user that utilizes a tilt sensor for measuring the angular position of the lower leg.

A self-contained garment that may be readily activated, especially by a person of limited motor ability, and which would be more user friendly than many of the garments currently available would be of benefit.

A self-contained garment that may be activated by transient mechanical disturbances has now been found, embodiments of which are readily usable by a person of reduced motor ability.

Accordingly, one aspect of the present invention provides a self-contained garment to be worn by a user for control of functions of an electronic device, said garment having a sensor and an electronic controller, said sensor being adapted to detect transient mechanical disturbances and said electronic controller being adapted

to effect control of functions of the electronic device on detection of said transient mechanical disturbances by the sensor.

Another aspect of the present invention provides a self-contained electrical stimulation garment for muscle stimulation of a user of reduced motor ability, said garment having a sensor and an electronic muscle stimulator, said sensor detecting transient mechanical disturbances and causing said electronic muscle stimulator to effect muscle stimulation of the user through electrical connections associated therewith that are internal to said garment, said electrical connections being adapted to make electrical contact with electrodes on said user.

In preferred embodiments of the garment of the invention, the garment has at least one accelerometer which detects such mechanical transients and activates the stimulator, and especially has three accelerometers arranged orthogonally.

In other preferred embodiments of the invention, the mechanical transients are of a magnitude that is above a predetermined level in order to effect activation of the stimulator.

In further embodiments of the present invention, the mechanical transients are applied by direct impact of the garment with an object.

In still further embodiments, the garment is activated by mechanical transients applied by direct impact of the user's body with an object and transmission of such transients through the user's body to the garment.

In other embodiments, the garment has means to adjust the response threshold of the electronic muscle stimulator.

In still further embodiments, the garment is in the form of a cuff or glove.

In further embodiments, the activation is in the form of off/on of the stimulator.

The present invention is illustrated by the embodiments shown in the drawings, in which:

Fig. 1 is a schematic representation of a cuff of the present invention on the arm of a user;

Fig. 2 is a schematic representation of a partially cut-away view of an electronic muscle stimulator on the cuff;

Fig. 3 is a schematic representation of application of a transient mechanical disturbance to the stimulator;

Fig. 4 is a schematic representation of effects of application of the transient mechanical disturbance of Fig. 3;

Fig. 5 is a schematic representation of an alternate method of applying a transient mechanical disturbance;

Fig. 6 is a schematic representation of another method of applying a transient mechanical disturbance.

Fig. 1 shows a garment in the form of a cuff, generally indicated by 1, having an electronic controller 2 located thereon. Cuff 1 is shown as located on the forearm 3 adjacent the wrist 4 of a user. Cuff 1 is made principally from the elastic material neoprene, preferably punched with small holes for breathability, although other materials could be used.

Electronic controller 2 may be in a variety of forms. For instance, electronic controller 2 could be in the form of a transmitter that emits infra red, radio or

other types of signals to a remote device adapted to receive such signals. The remote device would, in turn, respond to such signals by initiating or performing steps, functions or the like. For example, the electronic controller could be activated by transient mechanical disturbances, as described herein, and emit a signal to the remote device. Such a signal could effect ON/OFF of the remote device e.g. a television set, or could initiate the next step in a pre-determined procedure, or initiate some other function in the remote device.

The transient mechanical disturbances could be detected within electronic controller 2 by a device activated by transient mechanical disturbances, especially an accelerometer. Preferably, there are two accelerometers in a 2-axis cluster and most especially three accelerometers in a 3-axis cluster i.e. the accelerometers are oriented in different directions. It is understood that the three axes would be most preferably orthogonal to each other, as discussed below, i.e. at angles differing by 90°. The invention will be particularly described herein with reference to use of accelerometers.

While the garment of the invention may be used to initiate functions as described above with respect to a remote device, the present invention will be particularly described with reference to use of the garment in embodiments in which electronic controller 2 is an electronic muscle stimulator, and with the garments being particularly intended for use by persons of reduced motor ability. In such embodiments, the electronic muscle stimulator has electrical connections associated therewith (not shown) that are internal to the cuff.

Examples of such electrical connections are known. For example, adhesive FES electrodes and stainless mesh contact pads sewn between an inner surface of the cuff and an inner lining may be used, as disclosed in published PCT patent application WO95/10323 of A. Prochazka et al., published April 20, 1995. An example of such an electrode is a commercially available gel electrode exemplified by Conmed Corporation of Utica, New York, Type 650-2578.

Another electrode receptacle system consists of three major components viz. a grid, a receptacle and an electrode. Two halves of the electrode receptable are snapped together across the grid to provide a fixed but moveable receptacle for the electrode. The grid is fixed to the cuff, and positioned with respect to the user by means of, for example, a locator or shaped plate in the garment that conforms to the user e.g. a bony protrusion of the user. Such an electrode system is described in U.S. patent application No. 60/048215 of W. Gibson et al., filed 30 May 1997.

Other electrical connection systems could be used.

Fig. 2 shows cuff 1 having electronic muscle stimulator 12 thereon in partially cut-away form. Electronic muscle stimulator 12 has accelerometer 5 therein which, in the embodiment shown, is a cluster of three accelerometers arranged orthogonally. The accelerometers are arranged with orientations 6A, 6B and 6C that are at 90° to each other i.e. the orthogonal.

In operation with respect to muscle stimulation, the cuff, arm, hand or other suitable location is subjected to a mechanical jarring, and the resultant transient mechanical disturbance is transmitted to electronic muscle stimulator 12 and detected by the accelerometers.

The signals from the accelerometers are summed, and a threshold-detection circuit with electronic muscle stimulator 12 is urged to determine whether the resultant summed signal exceeds a pre-determined threshold level. If so, the electronic muscle stimulator generates signals to effect movement of muscles e.g. using techniques described in the aforementioned PCT application of A. Prochazka et al. In particular, the electronic muscle stimulator initiates a train of impulses to muscle under the electrodes, opening the hand. A second transient mechanical disturbance exceeding the pre-determined threshold level causes the impulses to cease i.e. the stimulation is turned off. In the summing of signals from the accelerometers, the signals should be rectified e.g. the signals should have full wave rectification. In addition, high pass filtering or other techniques may be used to improve the quality of the signal and/or accentuate differences between signals resulting from intentional jarring and from normal movements by the user.

Apparatus for generating electrical impulses and the setting of pre-determined threshold limits has been disclosed in the aforementioned application of A. Prochazka.

Fig. 3 shows one example of mechanical jarring i.e. generation of a transient mechanical disturbance. In Fig. 3, cuff 1 is located on the wrist of the right hand 6 of a user. The index finger 8 of the left hand 7 of the user is shown as flicking electronic muscle stimulator 12. Such flicking causes a transient mechanical disturbance which would be detected by the accelerometers 5. If the transient mechanical disturbance is sufficient to exceed the threshold-

detection limit, electronic muscle stimulator 12 emits the signals required for opening of the user's hand, as shown in Fig. 4 where thumb 9 and forefinger 10 have moved apart.

It is to be understood that the electronic stimulator used in the garment of the present invention would be intended to be activated by deliberate jarring or other transient mechanical disturbances, and not mere bumps or other mechanical transients that would occur during normal use i.e. wearing, of the garment. For this reason, the threshold detection limit may be appropriately set to discriminate between intended transient mechanical disturbances and transients occurring in normal use, and it is to be understood that provision of the threshold setting allows the stimulator to be so activated. This would reduce and preferably effectively eliminate accidental activation of the electronic stimulator.

An object may then be placed in the hand e.g. a can 11 is illustrated in Fig. 5. Placing of can 11 in hand 6 would cause a second transient mechanical disturbance that would be detected by the accelerometers of the sensor associated with electronic muscle stimulator 12, causing a change in stimulation that results in the hand closing about the can.

An alternative mechanical jarring is illustrated in Fig. 6, where can 11 is in hand 7 and is contacted with cuff 1. Such a mechanical jarring could be effected on the arm, hand or wrist, or elsewhere where it could be transmitted to and detected by the accelerometer.

It is understood that the transient mechanical disturbance could effect a passive response in the user e.g. by turning off the stimulus that effects the closing

of a hand of the user, or the transient mechanical disturbance could effect a positive response e.g. by active stimulation of muscles that cause closing of the hand.

The present invention provides an alternative and simple method for activation of electronic muscle stimulation, to permit a user to perform a variety of functions, especially opening and closing of the hand to grip object. The activation may be initiated by simple jarring, flicking or banging of the cuff, arm or hand, which may be particularly advantageous to persons of limited motor ability.

CLAIMS:

1. A self-contained garment to be worn by a user for control of functions of an electronic device, said garment having a sensor and an electronic controller, said sensor being adapted to detect transient mechanical disturbances and said electronic controller being adapted to effect control of functions of the electronic device on detection of said transient mechanical disturbances by the sensor.

2. The garment of Claim 1 in which the electronic device forms part of said garment.

3. The garment of Claim 1 in which the electronic device is remote from said garment, said electronic controller and said electronic device having means for communication therebetween.

4. The garment of any one of Claims 1-3 in which the transient mechanical disturbances are of a magnitude that is above a predetermined level in order to effect activation of the controller.

5. The garment of any one of Claims 1-4 in which the device is an electronic muscle stimulator.

6. The garment of any one of Claims 1-5 in which the device effects muscle stimulation of a user of reduced motor ability.

7. A self-contained electrical stimulation garment for muscle stimulation of a user of reduced motor

ability, said garment having a sensor and an electronic muscle stimulator, said sensor detecting transient mechanical disturbances and causing said electronic muscle stimulator to effect muscle stimulation of the user through electrical connections associated therewith that are internal to said garment, said electrical connections being adapted to make electrical contact with electrodes on said user.

8. The garment of claim 7 in which the transient mechanical disturbances detected by the sensor are of a magnitude that is above a predetermined level in order to effect activation of the stimulator.

9. The garment of any one of Claims 1-8 in which the sensor is adapted to detect transient mechanical disturbances applied to the garment.

10. The garment of any one of Claims 1-8 in which the sensor is adapted to detect transient mechanical disturbances that are applied to the user's body away from the sensor and transmitted to the sensor through the user's body.

11. The garment of any one of Claims 1-10 in which the garment has at least one accelerometer which detects such transient mechanical disturbances and activates the stimulator.

12. The garment of Claim 11 in which there are two accelerometers.

13. The garment of Claim 11 in which there are three accelerometers arranged orthogonally.

14. The garment of any one of Claims 1-13 in which the transient mechanical disturbances are applied by direct impact of the garment with an object.

15. The garment of any one of Claims 1-13 in which the garment is activated by transient mechanical disturbances applied by direct impact of the user's body with an object and transmission of such disturbances through the user's body to the garment.

16. The garment of any one of Claims 1-15 in which the garment has means to adjust the response threshold of the electronic controller or electronic muscle stimulator.

17. The garment of any one of Claims 1-16 in which the garment is in the form of a cuff or glove.

18. The garment of any one of Claims 1-17 in which the activation is in the form of off/on of the controller.

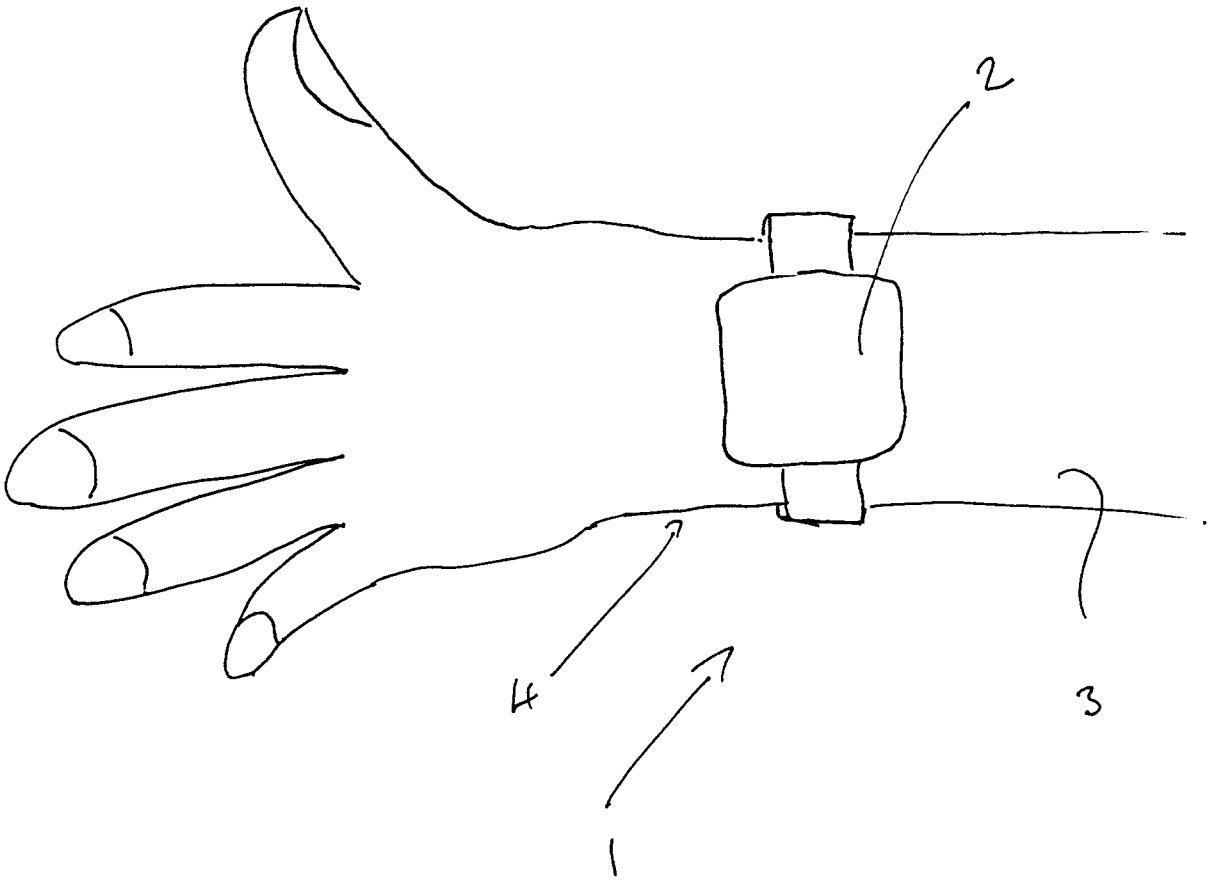


Fig. 1

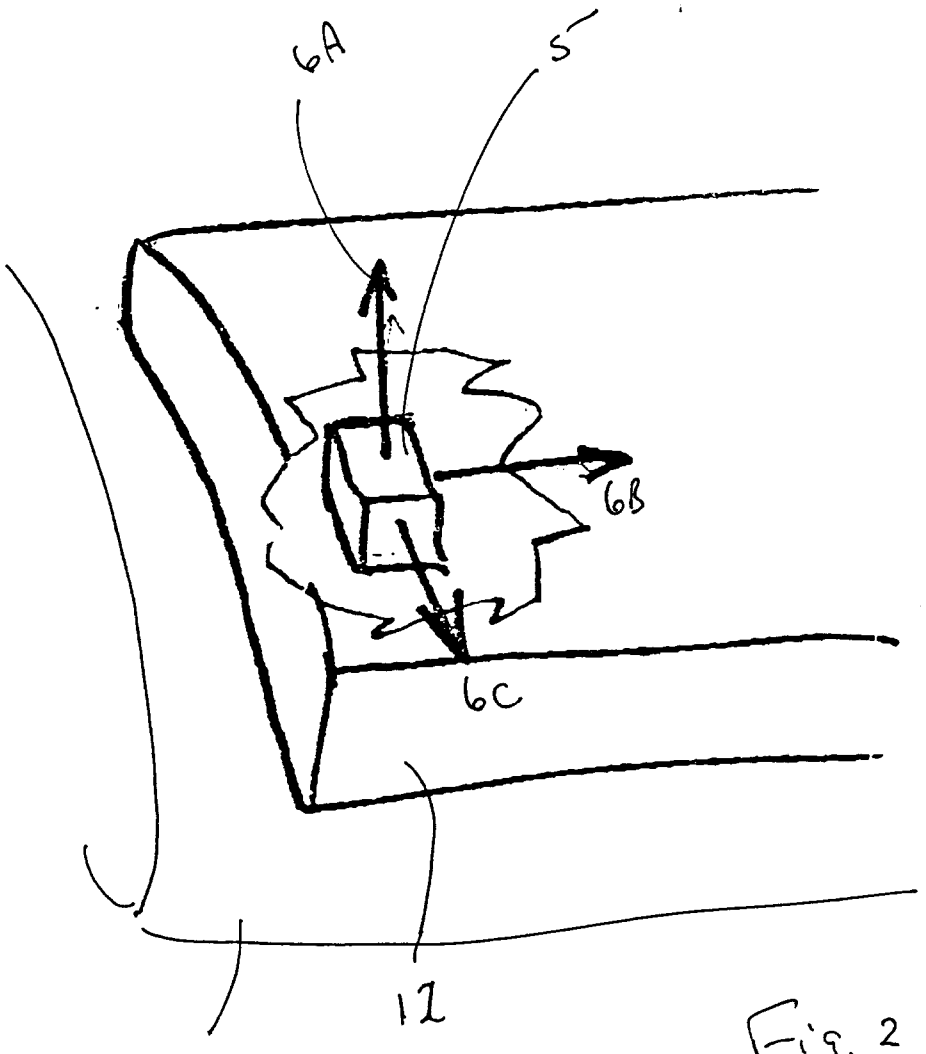


Fig. 2

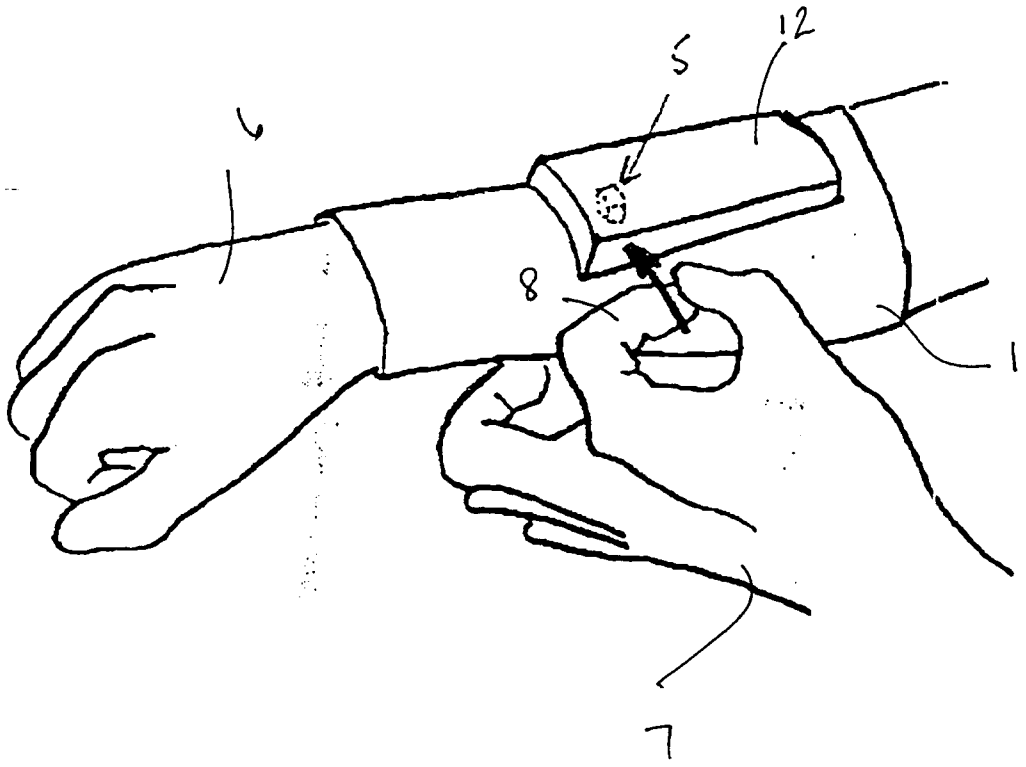


Fig. 3

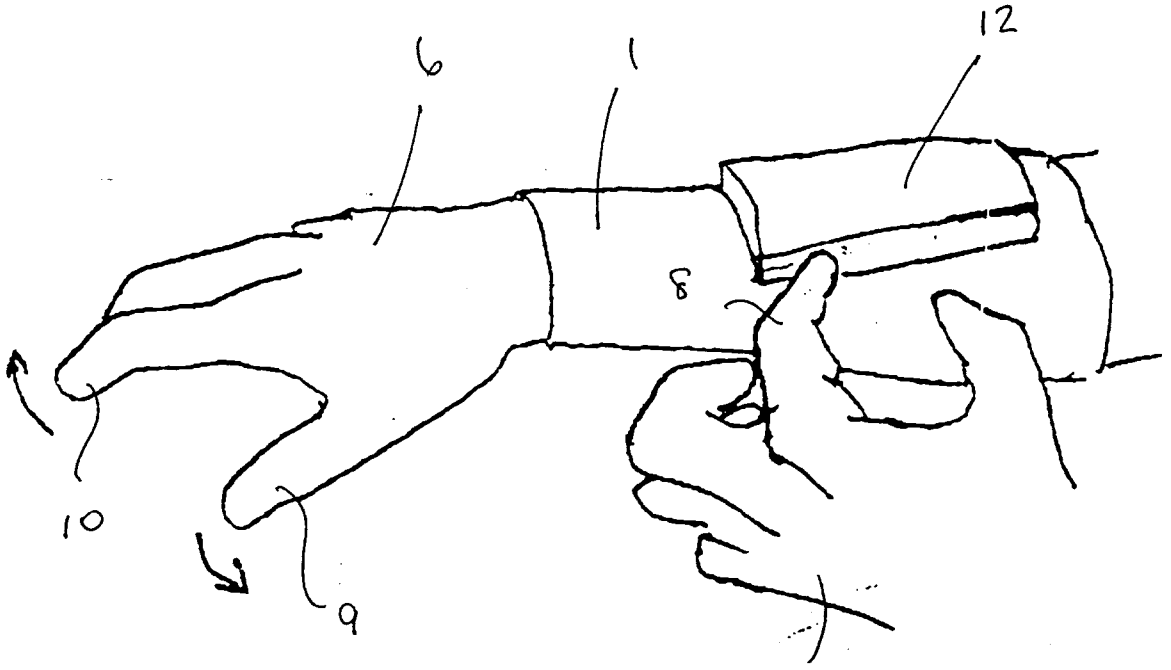


Fig. 4

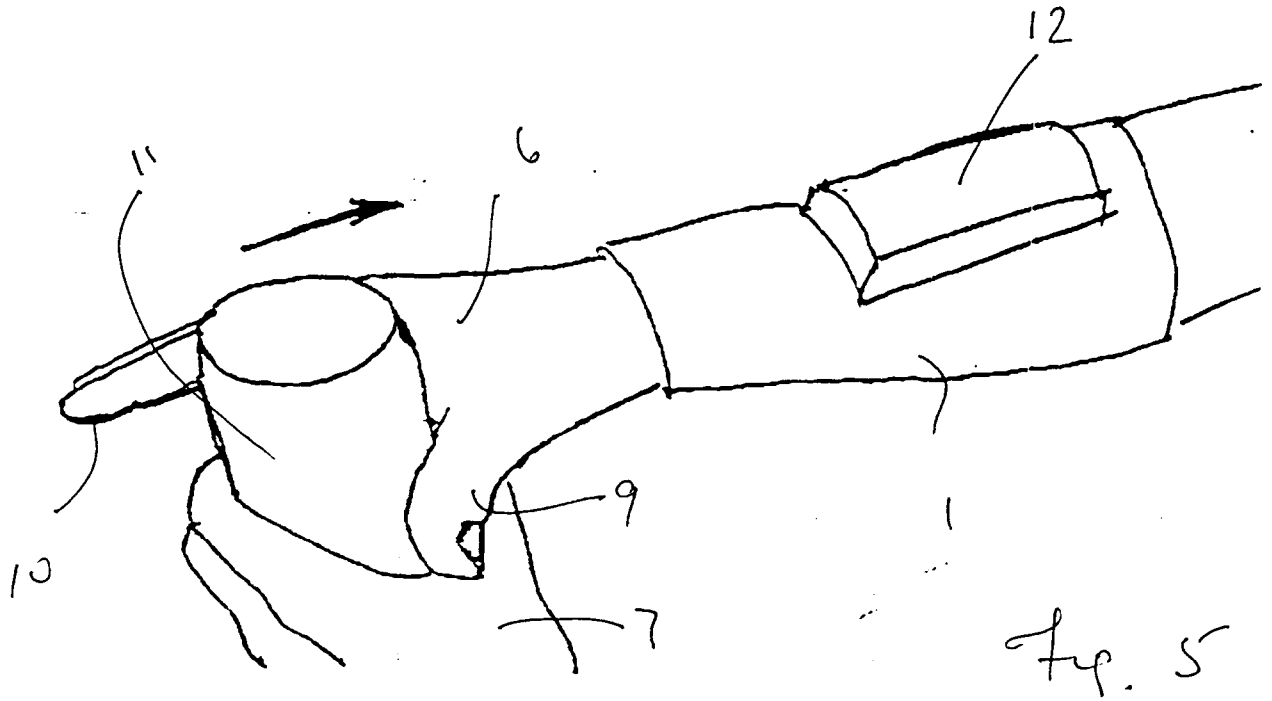


Fig. 5

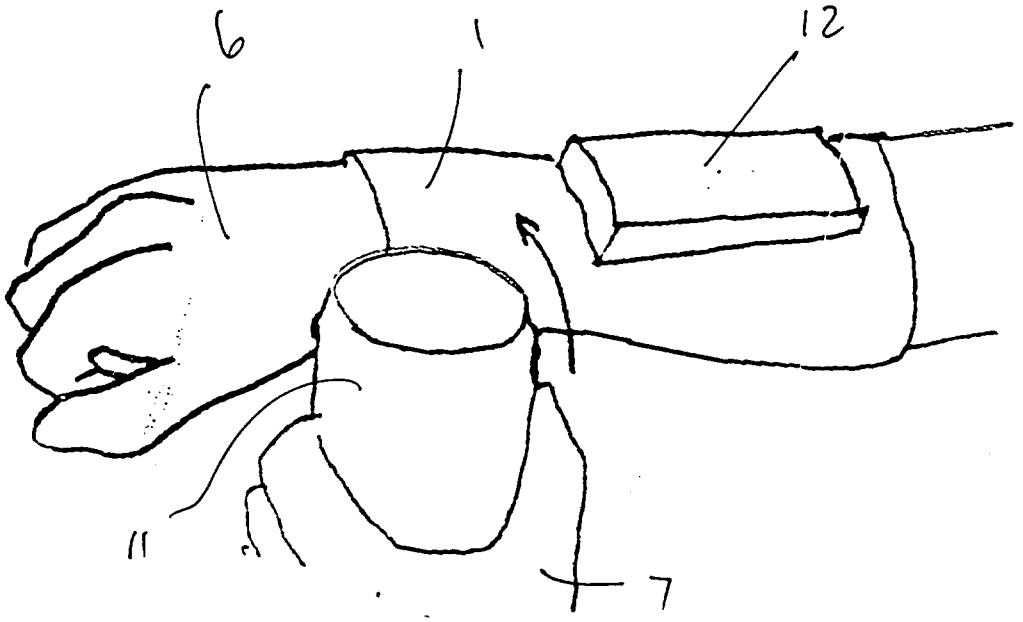
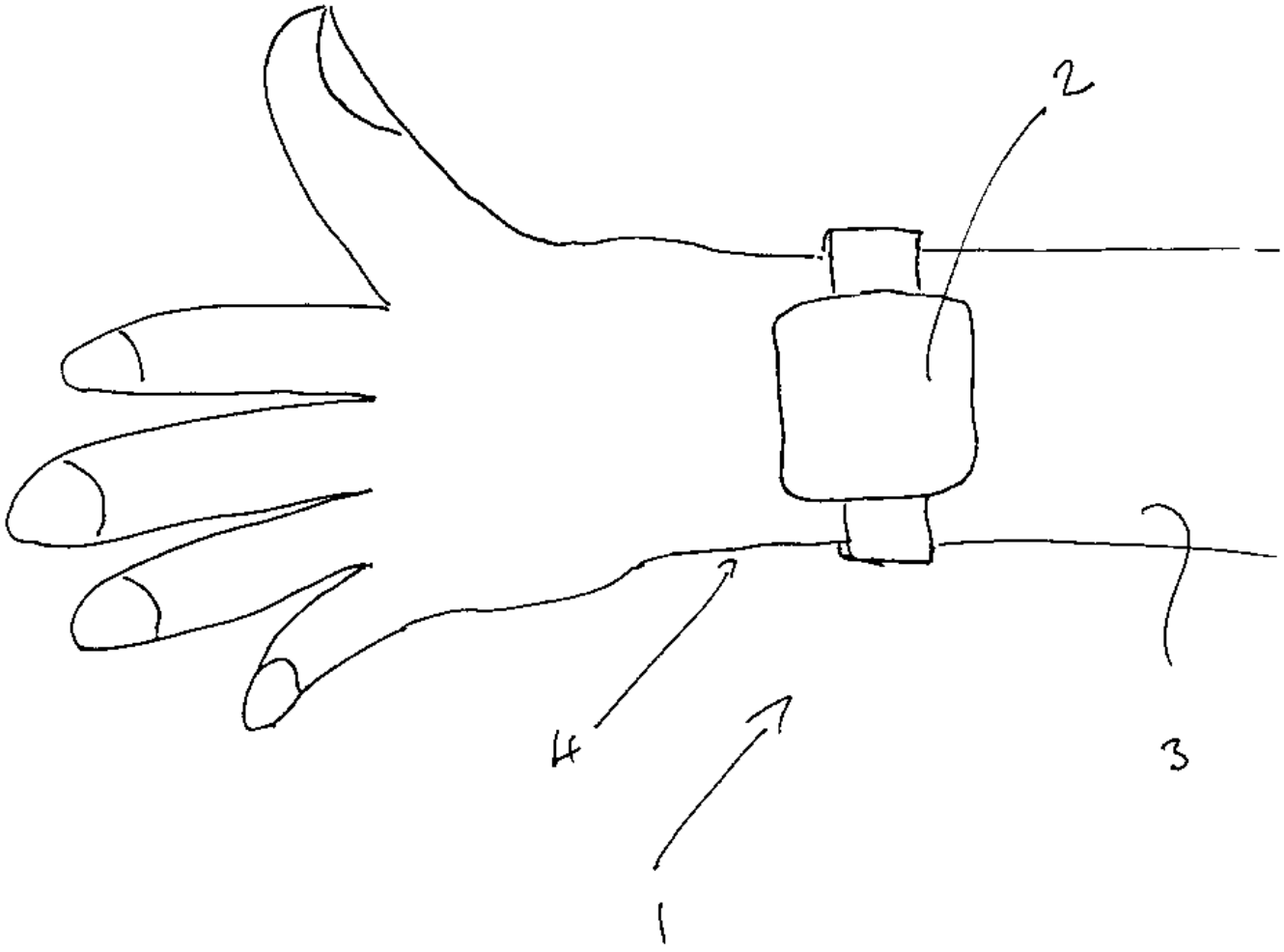


Fig. 6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