WINK SWITCH ACTIVATION OF POWERED FLEXOR HINGE SPLINT

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INTRODUCTION

Medical literature is replete with articles on research and evaluation of both conventional and powered wheelchairs. A few articles deal with special controls for mechanized chairs. Fewer still concern the actuation of an externally powered flexor hinge splint, either independently powered or in series with the power for a wheelchair.

Data and experience are recorded primarily on the low-force, low-excursion joy-stick wheelchair controls which can be operated by a patient with some useful degree of hand function. Obviously, in patients without satisfactory hand function, a control device must be supplied which operates by means other than hand or arm movement. The operative mechanism, however, may exert direct control over the wheelchair or facilitate indirect control by activating an intermediary, such as a flexor hinge splint (Fig. 1).

Lipskin (1) reported an evaluation of six non-manual switches for motorized wheelchairs. These included chin control, tongue switch, pneumatic "puff and suck," sonic, shoulder elevator, and sight switch. Obviously, it would be much simpler to harness these to activate the flexion-extension of a powered flexor hinge splint than to effect the multi-faceted control of a powered wheelchair.

At Hot Springs Rehabilitation Center, we evaluated the NASA sight-switch as adapted to activate a battery-powered flexor hinge splint. This combination performed a two-fold function in that it directly controlled prehension and other hand activity at the target area, yet it indirectly afforded wheelchair control by allowing activation of a modified joy-stick (Fig. 2).

However, serious disadvantages were encountered as documented by Hassard et al. (2). Thus, the wink switch, an entirely different

FIGURE 1.—Sight-switch attached to powered wheelchair.

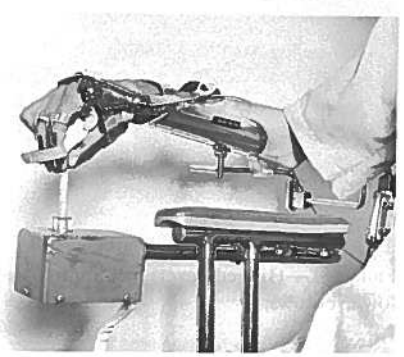

FIGURE 2.—Operator's arm in ball-bearing trough feeder with flexor hinge splint to operate manual control.

control, was devised which readily adapted to the dynamic splint. The switch is presently being researched for applicability to mechanized wheelchair control and to other electrical devices.

TYPES OF WHEELCHAIR FUNCTION

Wheelchair-ambulant patients were categorized on four functional levels:

1. Full-time conventional chair, with or without "quad pegs."
2. Part-time conventional chair with motorized chair as alternate or standby.
3. Full-time motorized chair with manual control.
4. Full-time motorized chair with non-manual control.

Non-manual controls were necessitated by the severity of involvement on the basis of pathologic etiology. These included high cervical spinal-cord injuries, severe arthridities, degeneration of central nervous system (particularly amyotrophic lateral sclerosis), and fractionated trials on normal individuals.

The wink switch was evaluated as an interchangeable entity rather than being tailor-made for each patient. The testing has proceeded over a period of 7 months.

DESCRIPTION OF WINK SWITCH

The "wink switch" consists of a heavy-duty eyeglass frame upon which are mounted two microswitches (Fig. 3). Each switch is actuated by a pivot-arm with a small flat pad on the end. The pad is adjusted to fit just below either eyebrow (Fig. 4). When the wearer contracts the orbicularis oculi muscle, or winks, he lowers an eyebrow and the padded arm-lever is pushed down. This closes the switch.

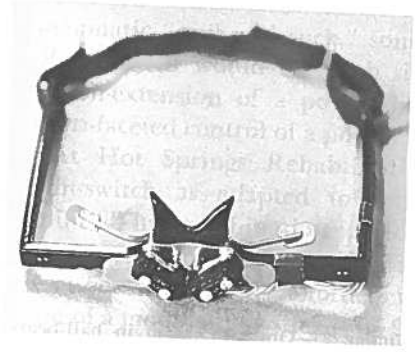

FIGURE 3.—Two microswitches mounted on baseball sunglasses frame.

FIGURE 4.—Hinged levers positioned below eyebrows.

Since it is essential that the actuating levers remain in a given position relative to the eyebrow, a sturdy, well-fitted eyeglass frame is necessary. We have used, most successfully, flip-up baseball sunglasses from which the lens section is removed. These are held on by an elastic band which encircles the head and provides a firm foundation for the switch mechanism (Fig. 5). The switches used are 115M107 miniature microswitches. Due to the mechanical advantage afforded by the lever, the switch can be actuated by approximately 10 grams of force.

A 12-v. d.c. motor is used to power the splint. An adjustable slip

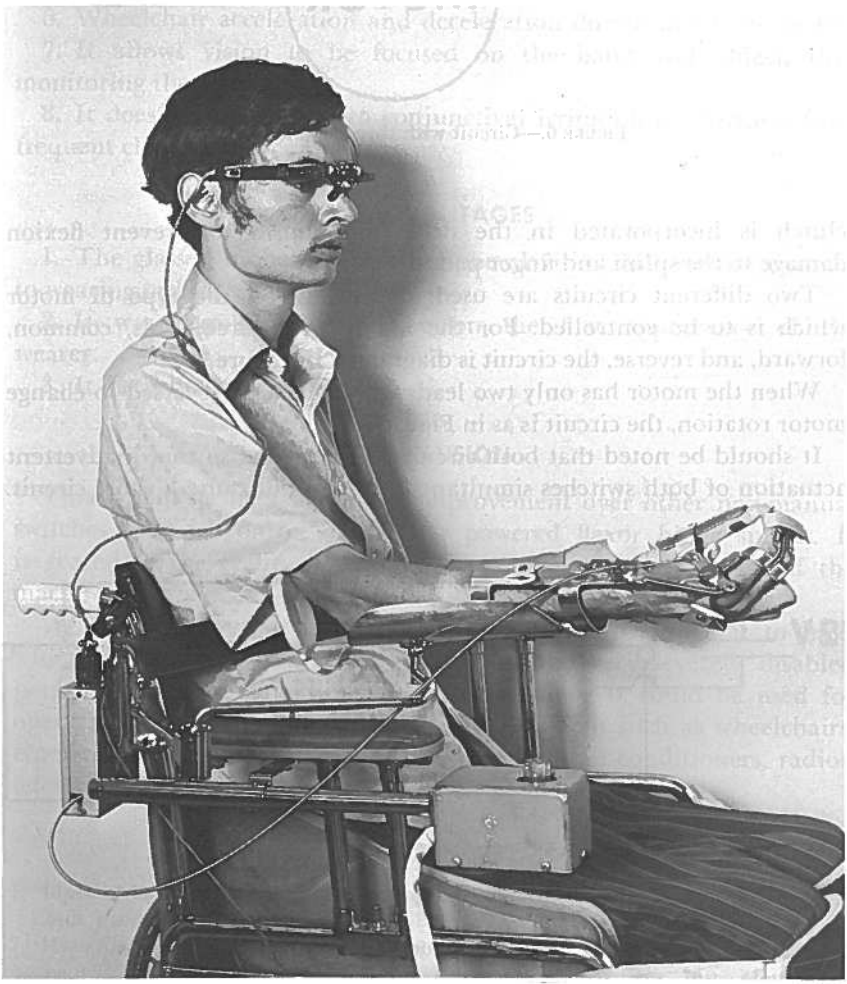

FIGURE 5.—Wink switch apparatus in place.

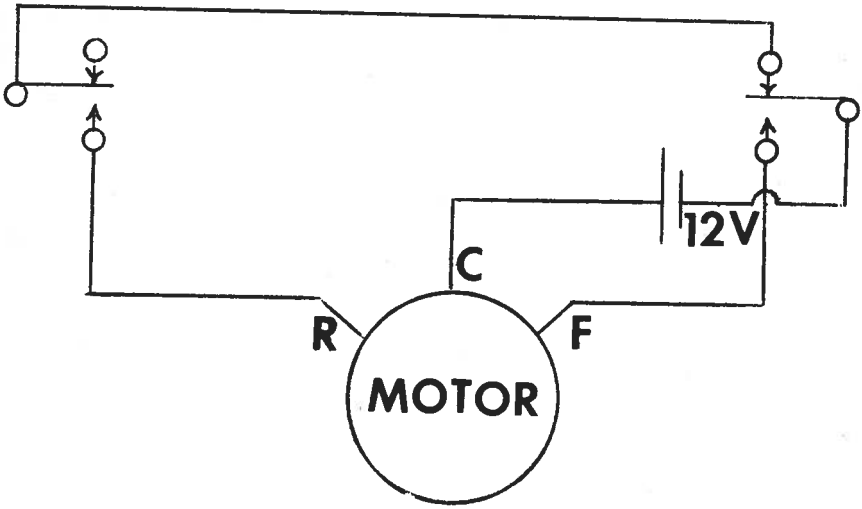

FIGURE 6.—Circuit with three-lead motor.

clutch is incorporated in the drive mechanism to prevent flexion damage to the splint and finger pads.

Two different circuits are used, depending on the type of motor which is to be controlled. For the motor with three leads, common, forward, and reverse, the circuit is diagramed in Figure 6.

When the motor has only two leads which must be reversed to change motor rotation, the circuit is as in Figure 7.

It should be noted that both circuits are designed so that inadvertent actuation of both switches simultaneously will not cause a short circuit.

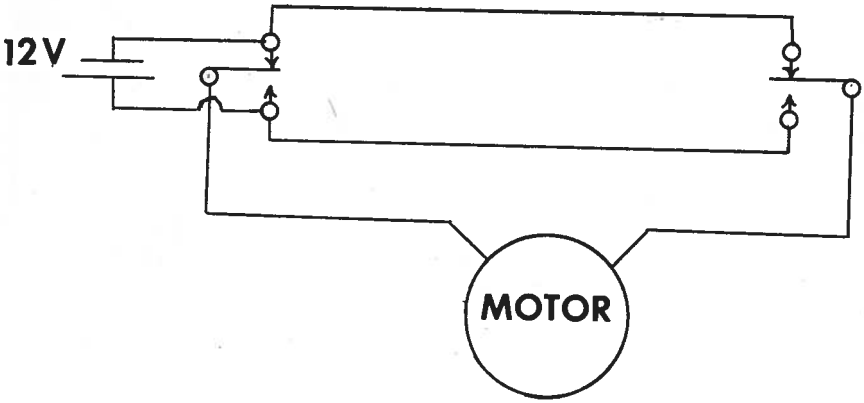

FIGURE 7.—Circuit with two-lead motor.

ADVANTAGES

1. It is always functional regardless of position of body or head and does not interfere with body position or movements.
2. It presents no complex electronic gadgetry. It is a small box $4 \times 5 \times 1\frac{1}{2}$ in., weighing $1\frac{1}{8}$ lb., and is readily mounted on wheelchair, chair, or at bedside.
3. It is easily donned and is not uncomfortable.
4. It is simple to learn and to control. It requires relatively few practices to attain proficiency in use. This seems the epitome of hand-eye coordination with alternate orbicularis contractions.
5. Floor obstacles, door jambs, and rough terrain do not cause intermittency of contact.
6. Wheelchair acceleration and deceleration do not affect the switch.
7. It allows vision to be focused on the hand and object, thus monitoring the activity.
8. It does not contribute to conjunctival irritation or dizziness from frequent changes of focus by the lens.

DISADVANTAGES

1. The glasses' frames affected peripheral vision in a similar manner to wearing ordinary spectacles.
2. It was cosmetically startling on the first appearance of the wearer.
3. It disturbed occipital hair-dos.

CONCLUSION

This system seems a significant improvement over other non-manual switches used to control electrically powered flexor hinge splints. It is geared to the realm of the man as compared to the realm of the machine.

We feel, however, that further investigation will prove it to have wider application as a control source for the very severely disabled person who has no functional use of his hands. It could be used for operating almost any kind of electrical equipment such as wheelchairs, typewriters, telephones, lights, nurse calls, fans, air-conditioners, radios, televisions, or bed positioners.

REFERENCES

1. Lipskin, R.: An Evaluation Program for Powered Wheelchair Control Systems. Bull. Prosthetics Res., BPR 10–14:121–129, Fall 1970.
2. Hassard, G. H., J. Conry, and S. Gephardt: Clinical Evaluation of NASA Sight-Switch Activation of Powered Flexor Hinge Splint. SW Res. Inst. Mon. Rep., Mar. 1972.