A Rack and Pinion Cable Drive for Orthoses

by

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We required an all-around reliable cable drive mechanism suitable for driving orthoses such as the Highland View Hospital flexor hinge hand splint and the Ampersand Powered Elbow Unit. The latter device provides elbow flexion assistance for patients with paralyzed elbows, especially if elbow stiffness is present.

Certain important features were required; the design shown in Fig. 1 has been adapted for use by several of our patients, as well as some patients in other cities. The requirements which have been met are:

1. Rapid and easy servicing of the motor and the cable attachment.
2. Freedom from cable problems such as the detachment or unraveling which occurs in reel windings.
3. Ease of removal and installation of longer or shorter cables.
4. Ability to use two racks, side by side, to drive two cables at once, in the same or different directions, by attaching them at the same or at opposite ends of the racks.
5. Length of cable travel to be varied by inserting a spacer at one end of the groove in which the rack slides.

All of these requirements have

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been adequately provided in this device. Some of the details include the housing, machined from aluminum, two sets of set screws in the rack to securely anchor the cable, a taper pin driven through the gear hub and motor shaft to prevent slipping, and another set screw to anchor the cable housing where it enters the box.

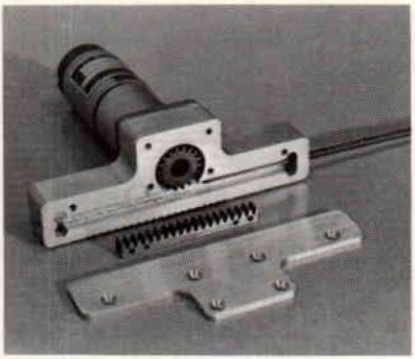
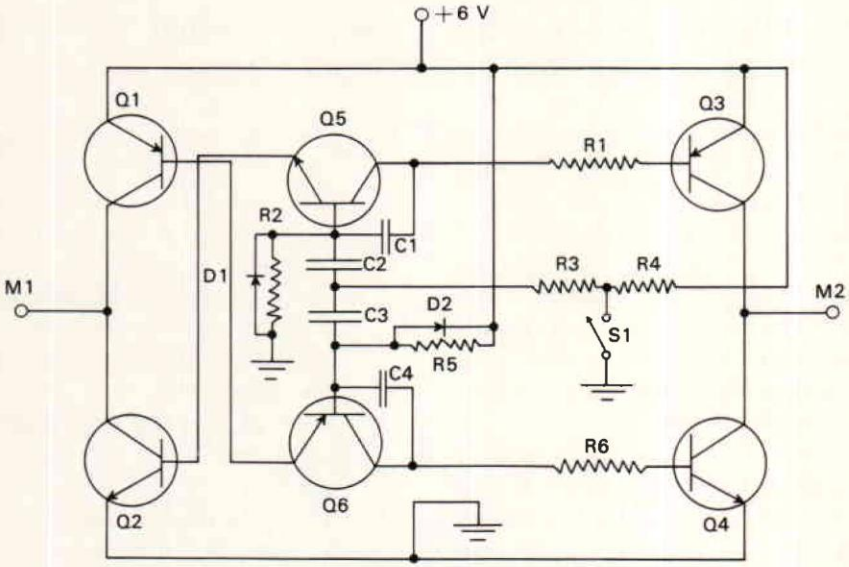


FIGURE 1.

We use a Globe 12 volt DC motor, No. 319A112-3, with 100:1 reduction gears, a speed of 90–110 R.P.M., and a torque of 77 ounce inches. The spur gear has a pitch diameter of .750", and a 24–14 ½ pitch. The rack is of steel, ¼" square, 24 pitch. For driving a flexor hinge hand splint, the unit provides a cable travel of 2⅛".

Since our devices are used mainly by patients in wheel chairs, the motor, gear box, and



Q1, Q3, 2N376A
Q2, Q4, 2N3055
Q5, 2N5183
Q6, 2N3638

R1, R6, 68 ohm 2 watt
R2, R4, R5, 1000 ohm ½ watt
R3 330 ohm ½ watt
D1, D2, 1N456A
C1, C4, 0.1 mfd
C2, C3, 500 mfd 15 volt
M1, M2, 12 volt d-c motor

POWERED ELBOW CONTROL
TMC-61-C 4-25-68

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FIG. 2

FIGURE 2.

the control device, such as our myoelectric control, are mounted behind the chair (1).

The Ampersand Powered Elbow Unit, also developed at Highland View Hospital, Department of Physical Medicine and Rehabilitation, was designed to enable quadriplegics with elbow contractures to feed themselves.

A motor with the above described rack and pinion drive is used to bring the hand splint close to the patient's mouth. Using a flexor hinge hand splint and a BFO, the patient can actively flex the arm by tilting a mercury switch attached to the radial side of the trough. When the hand is raised, by dropping the shoulder, the switch turns on and the motor driven cable pulls the hand towards the mouth. By lowering the hand the motor is reversed and the cable is extended, allowing the elbow to extend with gravity. A solid-state control circuit turns the motor clockwise when the switch closes, and counter-clockwise when the switch opens. Current is automatically cut off after the cable pulls all the way in or after it reaches the other position. This circuit is shown in Fig. 2.

The powered elbow control requires a longer cable travel than the hand splint. Our unit provides a travel of 2⅞" which is enough to permit the hand to move from the mouth to the front edge of the lapboard.

Power for the motor or motors is supplied either from the batteries of an electric wheel chair or from a Gould 12 volt nickel cadmium battery which can be recharged overnight.

Since November 1966, we have equipped thirteen people with rack and pinion cable drives, and five with powered elbow devices. All of these have been in constant use without major problems.

Blueprints of the motor housing and gear box shown in Fig. 1 are available without charge on request, and further information may be obtained from the authors.

REFERENCE

1. Trombly, Catherine A., Prentke, Edwin M. and Long, Charles, II: *Myo-Electrically Controlled Electric Torque Motor for the Flexor Hinge Hand Splint.* **Orthop. and Pros. Appl. J. 21:** 39-43, 1967.