AN EASILY-CONSTRUCTED CABLE SWIVEL DEVICE FOR BRAIN STIMULATION EXPERIMENTS

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Electrophysiological research involving stimulation of unrestrained animals is often plagued by twisted leads. Commercially available slip ring assemblies (*e.g.*, Lehigh Valley Electronics), are relatively expensive and unsuitable for small animals. For multiple conductor recording, a coupler employing mercury baths has been described (Sutton and Miller, 1963) and is available commercially (Laboratory Concepts, Inc., 267 W. 256 St., N.Y.). The device described here is suitable for brain stimulation work where only two conductors are required. It is similar in principle to that described by Simpson and Valenstein (1962), but is simpler to construct and incorporates the swivel with a balancing arm.

The only specialized items needed are two good-quality all-metallic ball bearing assemblies (10 for \$1.00 from Edmund Scientific Co., Barrington, N. J.; precision bearings available at \$1.00 each from PIC Design Corp., 477 Atlantic Ave., East Rockaway, N. Y.). The operating principle is simple: the outer rings of both assemblies are mounted firmly while the inner rings, to which the electrode wires are attached, turn freely. Current is passed from

the terminals on the outer rings through the ball bearings to the inner rings.

The ball bearing assemblies should have an outside diameter of about $\frac{3}{4}$ in. and an inside diameter of about $\frac{1}{4}$ in. The outer ring of assembly 1 is tightly secured to a piece of Plexiglas (through which a hole has been cut to allow access to the inner ring of the assembly) by an ordinary metal socket wafer. The inside flanges of the wafer are crimped to the outer edge of the ball bearing assembly (mechanical connections are necessary since it is difficult to solder a satisfactory connection without applying intense heat which may interfere with smooth action of the bearing). One of the screws securing the wafer can then be used as a terminal.

A thin strip of metal is then crimped around the outside of ball bearing assembly 2 and mounted to the Plexiglas, the mounting screw being used as a terminal (see Fig. 1). A machine screw is passed through the center of both assemblies making sure that the assemblies are insulated from each other by sleeving and insulating washers. A terminal lug secured to the bottom of the inner ring

Fig. 1. Cross section of the swivel mechanism. (1) ball bearing assembly 1; (2) ball bearing assembly 2; (3) center screw; (4) terminal lug; (5) metal wafer; (6) nut; (7) insulating washer; (8) insulating sleeving; (9) spacer; (10) metal crimped around bearing and fixed to Plexiglas; (11) Plexiglas mounting plate.

of assembly 1 is used for one lead, and a lug connected to the center screw for the other. A torque of less than 1 g will cause the inner ball bearing rings to rotate freely. Ordinary electrode cord (Plastic Products Co., Roanoke, Va.) has enough tension to turn the swivel as the animal turns.

The ball bearings should be brushed with contact cleaner to assure good continuity. In the present device, resistance in either channel during rotation ranged from 0 to 15 ohms, a negligible amount in stimulating circuits employing a large series resistance. The mechanical action of the bearings would probably create appreciable electrical noise in

the microvolt range if used for EEG recordings.

The swivel is mounted on a piece of $\frac{1}{8}$ in. Plexiglas about 3 in. square. This piece is in turn attached to a similar piece (see Fig. 2) that swings freely from one end of a balancing rod, thus maintaining a horizontal position. An adjustable counter-balance at the other end of the balancing rod will cause the swivel assembly to rise when the animal stretches toward the chamber ceiling, thus preventing it from biting the leads or "hanging" itself in looped wire. A short length of rubber band attached across a shallow loop in the cord as shown helps to stop sudden movements.

This device has been used successfully with rats for long sessions of repeated stimulation (Johnson, 1965). With positive brain stimulation as a reinforcer, rats have been given over 1000 trials per hour in a visual pattern discrimination problem.

Fig. 2. Swivel device mounted on balancing arm.

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