AN INSTRUMENT FOR DIRECT NERVE STIMULATION

JAMES G. GOLSETH, M.D.,† AND JAMES A. FIZZELL, B.S.

Department of Nervous and Mental Diseases, Northwestern University Medical School, Chicago, Illinois

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Experience with a number of existing nerve stimulators which were provided with means to measure only their output voltage revealed that in some instances false impressions were obtained relative to the functional integrity of the nerves being tested. Since there was no provision for measuring the actual current that was passing out of the stimulator, one could not ascertain what current, if any, was passing through the tissue and could not be sure that the electrodes were in suitable operating condition. It was discovered that some of the contemporary electrodes developed conducting paths through themselves as a result of the retention of electrolytes from the sterilization process and that this fact could not be detected except by some additional testing procedure. Occasionally, these conducting paths by-passed so much of the current that normal muscle in the operative field could not be made to contract even when the voltmeter was set to its maximum value.

As a result of this experience, we have devised a small portable instrument with appropriate electrodes for direct nerve stimulation which overcame the above-mentioned difficulties. In addition to the features usually found in stimulators of this nature, this instrument has the

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† Now at The Los Angeles County General Hospital, Los Angeles 33, and the University of Southern California Medical School, Los Angeles, California.
following attributes: (1) means for measuring the stimulating current (as opposed to voltage); (2) provision for obtaining either 60 cycle alternating current or direct current (galvanic current); (3) reliable electrodes, unaltered by the sterilization process and easily re-conditioned.

Fig. 1 shows the front view of this nerve stimulator with the electrodes connected to the output terminals. The milliammeter scale contains only one arc because a specially designed circuit enables it to measure accurately both alternating current and direct current on that one arc. The line switch and fuse are located below the milliammeter.

![Fig. 1. Front view of nerve stimulator.](attachment:image)

At the left of the milliammeter there is a knob and a toggle switch. This toggle switch enables the operator to select either alternating or direct current for use in stimulating a nerve. The magnitude of the stimulating current is controlled by turning the aforementioned knob.

The complete stimulator, which measures $9'' \times 9'' \times 7''$ and weighs $7\frac{1}{2}$ pounds, has a compartment in the rear which holds the line cord and electrodes when they are not in use.

A schematic wiring diagram is shown in Fig. 2, and the essential components are listed. The transformer is a standard filament transformer having a secondary voltage of 6.3 volts. It was designed to withstand indefinitely the application of twice-rated voltage plus 1000 volts between the primary terminals and all other metal parts of the structure. This was believed to provide adequate isolation from the line. The four-pole, double-throw switch, which selects either alternating current or direct current, is a conventional toggle switch of the so-called anti-capacity type.

The secondary voltage from the transformer is rectified by means of a full-wave rectifier and filtered with a large electrolytic condenser to provide a ripple-free source of approximately
8 volts d.c. It is seen that one half of the toggle switch is arranged to connect the potentiometer either to the output of the rectifier or directly to the output of the transformer. The other half of the toggle switch is arranged to send direct current through the milliammeter or to send alternating current through the instrument rectifier. The output from the instrument rectifier is passed through the milliammeter in the conventional manner. These provisions make it unnecessary for the operator to concern himself with the choice of an appropriate meter range.

Acting on the theory that the electrodes would need to be reconditioned occasionally, we sought to make them as easily constructed as possible. The detailed routine for preparing complete new leads and electrodes reveals their simplicity: Obtain a length (approximately 8 feet) of Belden No. 18 Tandem 2-conductor lampcord. Separate the two conductors for about 4 inches at one end and remove 1" of insulation from each conductor. Then attach a solderless cord tip to each conductor.

Remove about 1" of insulation from each conductor at the other end of the cord but do not split the cord. Take each conductor separately and twist the strands of each conductor snugly together. Now solder or "tin" each conductor neatly along its exposed 1" length, using a resin flux-no acid. When this has been done, cut the exposed conductors so that only 1" of metal projects and, using crocus cloth or very fine emery paper, carefully round and smooth the ends of the conductors so that no sharp edges or points are left.

Obtain a 4" length of some fairly stiff tubing made of a non-conducting material such as rubber, neoprene, bakelite, or black fibre. The inside diameter of the tubing should be approximately 1" or 6 mm. Slide this length of tubing on the tinned end of the cord so that the bare tips of wire project 1" outside the tubing. In case the tubing is slightly too large to make a very snug fit on the cord, wrap the cord with a small rubber band so as to increase its outside diameter a sufficient amount.
The only precaution to be observed while using the stimulator is to make certain that the pointer on the milliammeter reads zero at all times excepting when the electrodes are applied to the nerve. Failure of the pointer to return promptly to zero upon removal of the electrodes from the nerve indicates the presence of a conducting path between the electrode tips. Such a path results when a drop of saline solution or blood becomes lodged between the tips. By wiping away the electrolyte with a piece of sterile gauze, one can immediately restore the electrodes to suitable operating condition.

AN OXYGEN CONVEYER: A TOY BALLOON

ALFRED W. ADSON, M.D.
Section on Neurosurgery, Mayo Clinic, Rochester, Minnesota

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Experience at the Mayo Clinic confirms the experience of others that the unpleasant symptoms that follow encephalography, ventriculography or myelography are of shorter duration when oxygen is used instead of air as the contrast medium. Knowledge of this fact and a desire to avoid setting up cumbersome apparatus or moving gas tanks from room to room prompted me to employ the procedure herein described for conveying oxygen.

The materials required for constructing the device are 6 feet (182.9 cm.) of rubber tubing, a glass tube, 3 inches (7.6 cm.) long, filled with absorbent cotton to serve as a filter, six stopcocks and a dozen or two toy balloons. One end of the stopcock is such that it will admit the

Fig. 1. Filling a balloon with oxygen.