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A BATTERY-ALARM SYSTEM FOR PHRENIC NERVE STIMULATORS

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ABSTRACT. A simple alarm circuitry for unilateral diaphragm pacer transmitters has been constructed. The system, which is attached to the 9 V battery powered transmitter, will trigger an alarm sound when the battery voltage decreases to 8 V. The system may diminish or abolish the need for special supervision of patients with phrenic nerve stimulators.

Key words: Battery alarm system, diaphragm pacer, phrenic nerve stimulation

Electrostimulation of the phrenic nerves (diaphragm pacing) for ventilatory support is now an established method in patients with respiratory insufficiency due to high cervical cord lesions and central alveolar hypoventilation (2, 3, 4). The diaphragm pacer system (Avery Laboratories, Farmingdale, New York) consists of 4 parts: A battery powered radiofrequency transmitter, an external coil or antenna, a radiofrequency receiver and neural platinum electrodes. The transmitter generates a coded radiosignal which, in turn, induces the implanted receiver to deliver the desired trains of electrical pulses to the phrenic nerve. Two types of transmitters are currently available—a small unilateral model (S202) and a larger bilateral unit (S242). The unilateral model has the advantage of being small and portable (size 73×25×140 mm, weight 0.3 kg). Power is provided by a 9 V battery which for safety reasons must be changed every 24 hours. The bilateral model has the advantage of containing rechargable 6 V batteries that will operate the transmitter for one week. The disadvantage is the size (205×205×130 mm) and weight (3.5 kg) of the unit. The bilateral model also contains a voltmeter which will indicate the terminal voltage of the battery whereas the unilateral model has no battery control system. Death has occurred in a patient with diaphragm pacers because of battery failure (1). To overcome this problem, we have constructed a simple battery-alarm device attached to the unilateral transmitter model S202 (Fig. 1).

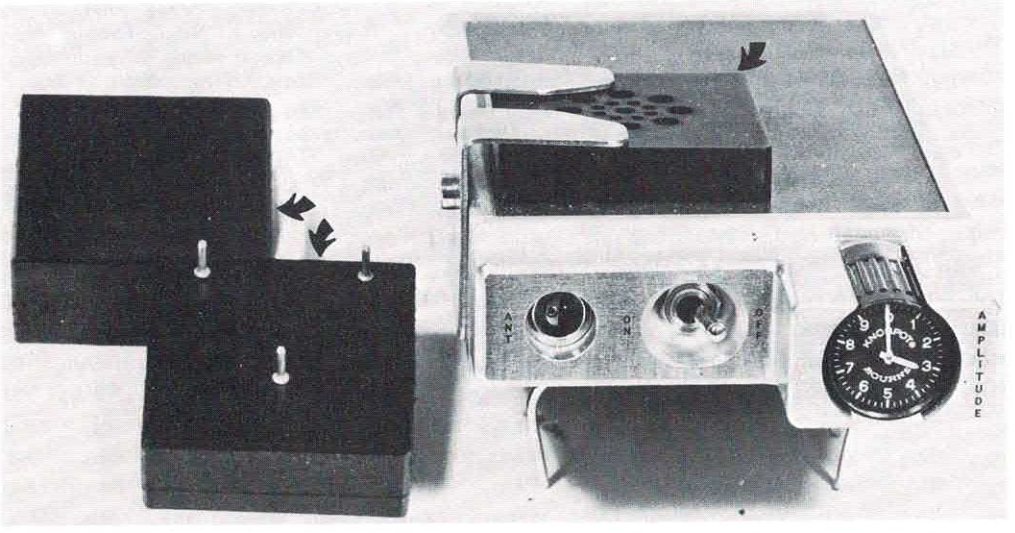

Fig. 1. Transmitter S202 for diaphragm pacing with the alarm circuit attached to its wall (single arrow) and the remote alarm system (double arrows).

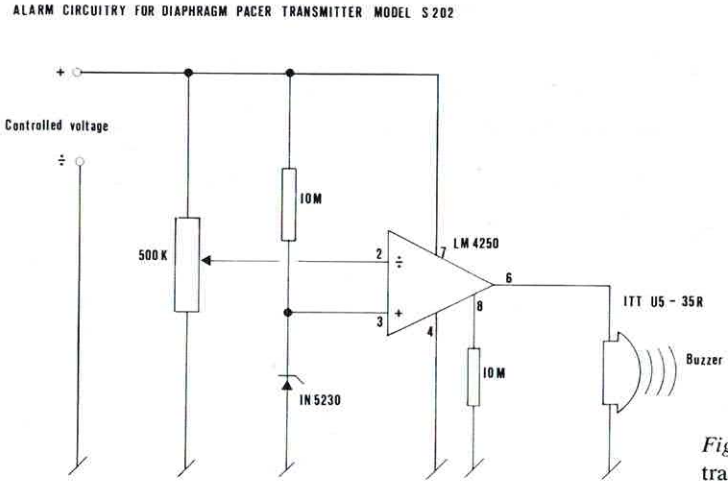

Fig. 2. Alarm circuitry for diaphragm pacer transmitter model S202.

TECHNICAL DESCRIPTION

In the alarm circuitry the balanced input 2–3 of an operational amplifier is used (Fig. 2). The voltage of input 3 is approximately constant with a zener diode. The voltage of input 2 can be varied from 0 V to full battery voltage (9 V), and with the aid of a screwdriver the alarm voltage can be set at any desired level. Alarm voltage is the level of battery voltage that initiates the alarm sound (buzzer). The battery alarm can be set at any voltage from 5 V to 9 V.

The transmitter has an average consumption of 5 mA. When the alarm is on the consumption will increase about 60%. The battery will keep the transmitter and the alarm going for at least 30 min with suf-ficient effect, but at 8 V battery voltage the stimulation effect is reduced by 20%.

Specifications

Power consumption: under controlled voltage: 30 μA with alarm on: 3 mA. Control range: 8–25 V. Adjusted alarm voltage: 8 V. Alarm range: 8→5 V. Alarm (constant buzzing sound): 2 kHz.

The alarm circuit is attached to the outside wall of the transmitter through 3 contact holes and one metal shield with a screw (Fig. 1). An extension cable makes it possible to hear the alarm sound in a place distant from the patient's room.

The described alarm system has been successfully applied to several patients with diaphragm pacers in our unit 2. Thanks to this simple and inexpensive alarm device, patients dependent on phrenic nerve stimulators for ventilatory assistance now can spend more time outside the hospital without the special attendance previously necessitated for safety reasons.

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