OBJECTIVE RECORDING OF RESPONSES TO VESTIBULAR STIMULATION

V. E. Busygin and Yu. G. Grigor'ev

Scientific Director – Active Member AMN SSSR A. V. Lebedinskii
(Presented by Active Member AMN SSSR A. V. Lebedinskii)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 54, No. 7, pp. 102-104, July, 1962
Original article submitted June 26, 1961

We have developed and perfected various methods for recording vestibulo-somatic and vestibulo-autonomic reflexes. They have been tested in systematic work in both acute and chronic experiments on rabbits and dogs.

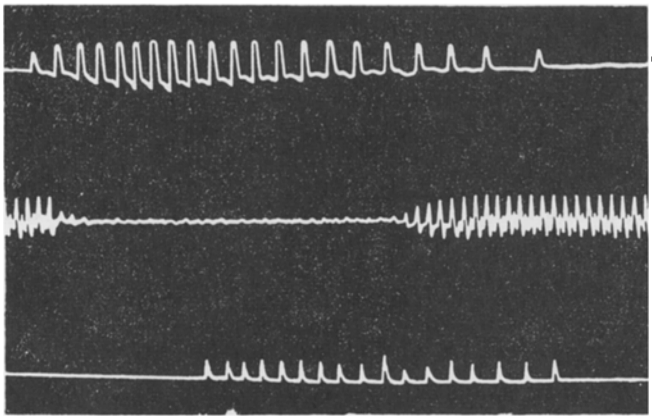

Fig. 1. Recording of various responses in rabbits by means of the methods described. a) Pressure in sleeves; b) sphygmogram during the measurement of arterial pressure; c) retino-corneal nystagmus potential.

For the preliminary experiments to determine the effect of angular accelerations, we developed a device for rotating the animals. It consisted of a fixed base in which a shaft revolved, ten sliding contacts to pick up potentials, and two replaceable stands to which the rabbit or dog was fixed. Provision was made to supply air under the necessary pressure through a shaft rotating in an air-tight sleeve, so that arterial pressure could be measured during rotation. The device was also equipped with a contactless electromagnetic marker to record the number of turns. During the rotation, simultaneous recordings were made of nystagmus, the ECG, respiration, pulse, and arterial pressure.

At present these quantities are recorded by means of a new (VU-2) device, which enables steady accurate positive or negative accelerations from 0.01 to $60°/sec^2$ to be obtained, and provides for angular velocities up to 180°/sec, and for the rotation to be stopped within 0.1 sec. Provision is also made for inclining the animal in the saggital or frontal plane during the rotation (the action of Coriolis force).

Recording of the potential developed between retina and cornea to indicate the nystagmus of rabbits was carried out in a chronic experiment by implantation of electrodes into the bone of the orbit. The electrodes, which were found satisfactory, were made from stainless steel studs or screws mounted in a threaded plastic case. For the acute experiment we used needle electrodes, which were inserted into the bone of the orbit before recording. The nystagmus was recorded by means of the electrodes just described, and the potentials were then amplified, and are shown in Fig. 1c.

Arterial pressure was recorded in rabbits and dogs by a bloodless method from the carotid artery, which was brought out on to a fragment of skin. As usual, the proximal end of the fragment was compressed with a pneumatic cuff, and the distal end used to record the sphygmogram (Fig. 1b). At the same time, a record was made of the pressure in the sleeve, and took the form of periodic pulses increasing by intervals of 10 mm of mercury (Fig. 1a). From the sphygmogram and the pressure marker, the maximum arterial pressure was determined. The maximum blood pressure was taken as equal to that of the pressure marker at which the first noticeable pulse could be seen in the sphygmogram.

A new design of pneumatic cuff, and a new pulse manometer for recording pressure, will be of interest to experimenters.

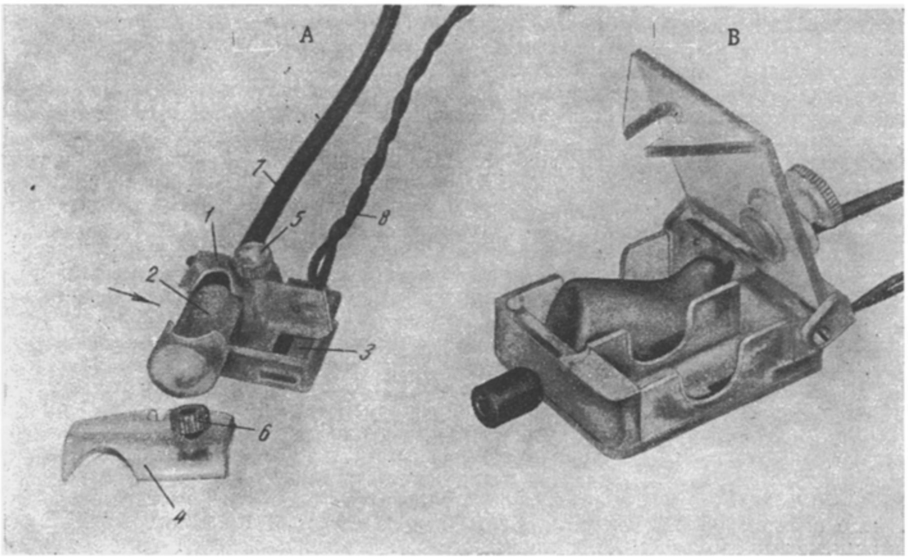

Fig. 2. New construction of pneumatic cuff. A) For rabbits; B) for dogs. Explanation in text.

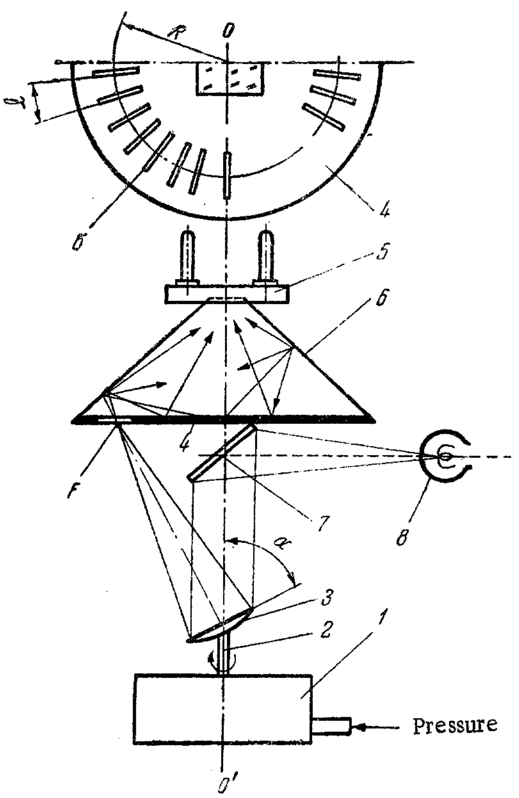

Fig. 3. Diagram of the pulsed photoelectric manometer. Explanation in text.

The cuff, whose body is made from perspex, is of small size and weight. As can be seen from Fig. 2, in the body of the cuff (1) besides the rubber bag (2) which compresses the artery, there is a piezoelement (3) which serves to record the pulse.

To accommodate the skin fragment, in the body of the sleeve there is a corresponding groove (indicated in the diagram by an arrow); when the skin fragment has been placed within it, it is protected by a cover (4) which is retained in position by the screw (5). Screw (6) placed on the cover serves to provide the necessary pressure between the artery and the piezoelement, and makes it possible to obtain a clear recording of pulse oscillations. The air in the sleeve is supplied through a rubber tube (7). The lead (8) connects the piezoelement to the amplifier of a recording device.

As long experience has shown, the design of the sleeve makes for reliable connection, great convenience in operation, and consistency of measurement. It makes it possible to obtain complete compression and a definite recording of the first pulse oscillation.

The pulsed photoelectric manometer consists of a normal spring manometer working together with the photoelectric device illustrated in Fig. 3. As can be seen from the diagram, on the manometer 1 and rotatable about an axis 2 and inclined at an angle α, there is fixed a small light spherical mirror 3. When the latter rotates about axis 2 it moves the light beam F in the plane of the diaphragm 4 along the arc of a circle radius R. The diaphragm contains slit apertures b running radially out from its center. The angle γ between the apertures in the diaphragm corresponds to an angular rotation of the mirror brought about by a pressure change of 10 mm Hg. The first aperture in the diaphragm corresponds to a pressure of 40 mm and the last to one of 200 mm Hg. The light beam from the lamp 8 reflected from the plain mirror 7 and the spherical mirror 3 is focused by the latter in the plane of the diaphragm 4 as a light spot F. As the light spot moves across the slit apertures of the diaphragm, through the action of the light-collecting cone 6, it periodically illuminates the photoelement 5. Current pulses developed in it are taken to the amplifier of an oscillograph.

The advantage of this manometer is that it contains no rubbing or mercury contacts which require considerable attention, cleaning, and regulation, and give variable results.

Respiration was recorded from changes in the circumference of the thorax. For this purpose we used elastic rheostats [1], from which a clearly marked respiration curve was obtained.

At present we are arranging to collect blood at a distance from the animals during their rotation, using the method we have developed [3].

The methods and apparatus described above are recommended for wide-scale laboratory use.

SUMMARY

A description is given of methods of objectively recording vestibulo-somatic and vestibulo-autonomic reflexes in experimental animals. An explanation is given of how to use these methods when vestibular stimulation is induced by rotation.

LITERATURE CITED

1. V. E. Busygin, Byull. éksper. biol., No. 6, 71 (1955).
2. V. E. Busygin, Byull. izobretenii, No. 3 (1956); Patents Nos. 93291 and 102714.
3. V. E. Busygin and Yu. G. Grigor'ev, Med. radiol., No. 1, 22 (1958).

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. ***Some or all of this periodical literature may well be available in English translation.*** **A complete list of the cover-to-cover English translations appears at the back of this issue.**