EXPEDITIONARY OXIMETER "ELBRUS"

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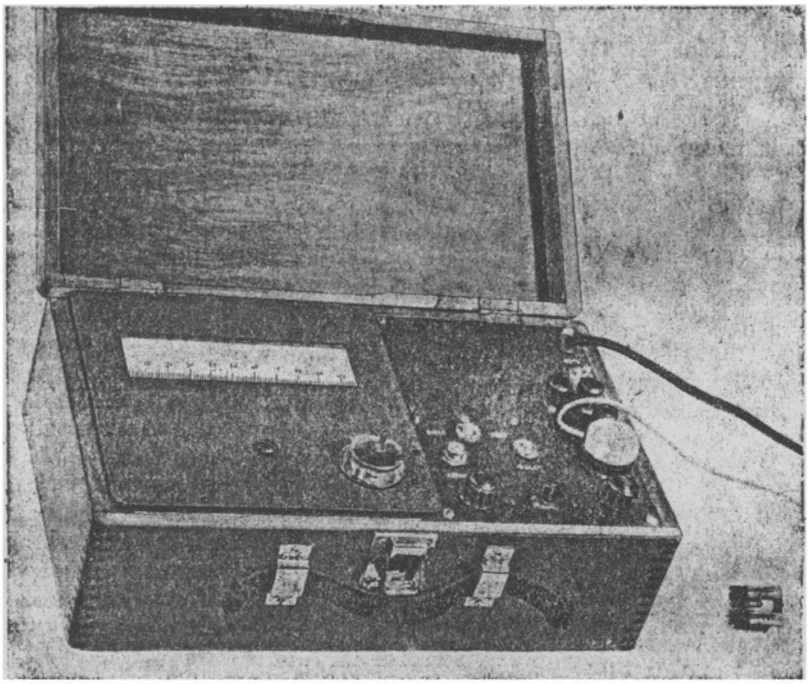
Oximeters (instruments that permit observation of changes in the saturation of the blood with oxygen) are constantly increasing in application in various fields of medicine and physiology.

The oximeter described below was designed in the laboratory directed by E. M. Kreps especially for the conditions of the Elbrus Expedition. This is how it received its name.

The nature of the expeditionary work determined the chief requisites of the apparatus: input from direct current sources, small consumption of electrical energy from the power sources, small dimensions and weight.



Expeditionary oximeter "Elbrus". On the right is the earpiece.

The operation of the oximeter is based on the general principle of a photoelectric oximeter. A special device (earpiece) with incandescent lamp and photocells is placed on the ear. Two different photocells, selenium and silver sulfide, are used in the earpiece of the oximeter "Elbrus". The selenium photocell, sensitive to the red region of the spectrum, reacts to changes in illumination that occur as a result of changes in the saturation of the blood with oxygen, since the adsorption of light by hemoglobin and oxyhemoglobin differs in the red region of the spectrum. The silver-sulfide element, sensitive to the infrared region of the spectrum, does not react to changes in the degree of saturation of the blood with oxygen, since in the infrared region the adsorption of light by hemoglobin and oxyhemoglobin is the same. This photocell serves to compensate for the changes in the optical properties of the translucent region that occur not as a result of the change of saturation of the blood with oxygen but are due to other factors, for example, to changes in the diameter of the vessels.

The differential photocurrent of both photocells is picked up by a portable mirror galvanometer with inner light.

Utilization of a silver-sulfide photocell, with its high sensitivity to infrared rays, permitted the use of a more rugged, and hence, less sensitive galvanometer.

The sensitivity of the galvanometer was 1 microampere on the scale; the length of the scale was 120 mm; the internal resistance was about 4,000 ohms.

The use of two photocells in the "earpiece" enabled us to work without filters.

The detection of the required spectral regions is assured by the favorable spectral characteristics of the ear coupled with the high sensitivity of the photocells. To reduce the size of the "earpiece" a special "flat" lamp is used. The "earpiece" and the galvanometer lamps may be used on direct current as well as on an alternating current line.

Using a source of direct current, a voltage of 6 V is needed for a 0.4 A current consumption. Input from an alternating current line is effected by means of a transformer with ferroresonance stabilization.

The general appearance of the oximeter "Elbrus" is shown in the illustration. The oximeter is mounted in a wooden carrying-case (340 x 200 x 130 mm) with a closed top. Its weight minus current sources is 5 kg. A galvanometer is located in the left half of the case and in the right half there is a control panel and a transformer for input from an alternating-current line. The transformer is attached to a separate panel and may easily be disconnected from the circuit. On departure on the expedition, the transformer may be removed from the case and left behind to reduce the weight of the unit.

The main and auxiliary controls, the terminals for input lines and socket to connect the earpiece cord with the circuit – are located on the control panel.

The considerable variations in the surrounding air temperature under expeditionary conditions may necessitate changing the degree of heating of the ear. For this purpose the filament of the "earpiece" lamp may be regulated by means of a rheostat, an axis of which is extended out to the control panel.

In order to use the complete scale of the apparatus and to allow changes in the range of calibration there is a special calibration potentiometer. The axis of the potentiometer is extended out to the control panel. The calibration potentiometer and the filament rheostat are auxiliary controls. They are used relatively infrequently, and therefore they do not have knobs and their axes are protected by removable caps.

Thus, the instrument is controlled by means of two potentiometers and a two-position switch.

The adjustment necessary to assure the "single-scale" functioning of the oximeter, i.e. calibration of the scale for ears with different optical densities, is carried out directly on the ear without preliminary adjustment of the "earpiece" by standard illumination.

Two samples of the described oximeter were successfully used in expeditions to Elbrus in 1953 and 1954 (Institute of Physiology of the Academy of Sciences of the USSR and Institute of Physiology of the Academy of Sciences of the Ukrainian SSR).

E. M. Kreps supervised the work on the instrument. The testing, calibration and the work with the instruments on the expeditions was carried out by V. N. Voitkevich. The galvanometer was constructed by N. V. Noskov.