SIMULTANEOUS CHRONIC RECORDING OF THE TEMPERATURE OF THE SKIN, VISCERA, AND RECTUM

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Recently several articles have described the application of thermally sensitive semi-conductor elements for recording temperature in various parts of the body of an animal [1, 2, 3, 6-9].

We have developed an experimental method for the simultaneous recording from the skin, viscera and rectum in chronic preparations.

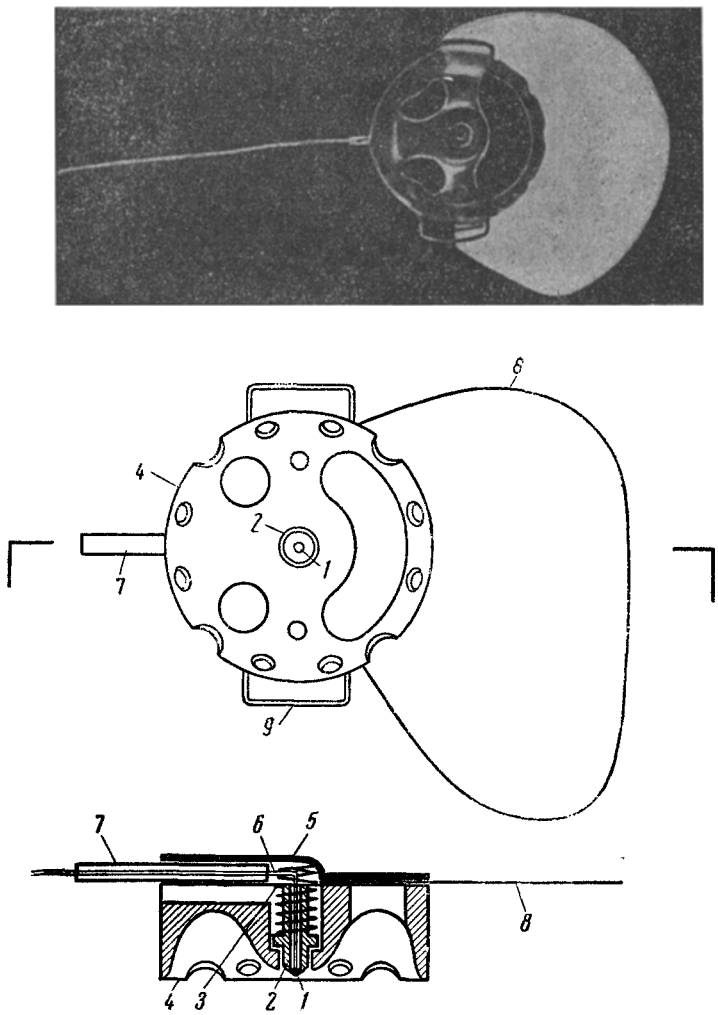

Fig. 1. Miniature thermistor for recording skin temperature. Above – external appearance of sensitive element with its cover; below – assembly diagram (explanation in text).

The method allows recording to be made at a distance from the animal of several tens of meters, over a considerable period. The recording portion of the apparatus consists of a modified pyrometric millivoltmeter which records simultaneously six temperature curves. The curves (thermograms) consist of dotted colored lines marked by the pointer of a galvanometer on a paper strip moving at 20, 40, or 60 mm per hour. The temperature scale ranges from 35 to 45°, and is marked in divisions of 0.1°.

The sensitive element consists of a miniature semi-conductor type MT-54 constructed by V. G. Karmanov [5]. These units have several advantages for temperature recording: 1) because of the high internal resistance of the thermistor, it is easy to arrange for remote measurement of temperature; 2) the high temperature co-efficient of the resistance enables a high accuracy to be maintained for a comparatively low sensitivity of the electrical measuring device; 3) the inertia is low (0.3 seconds in a constant fluid medium) and they are therefore very sensitive to temperature variation; 4) stability in operation; 5) the small dimensions (0.7 - 1 mm) enable it to be contained in a small space.

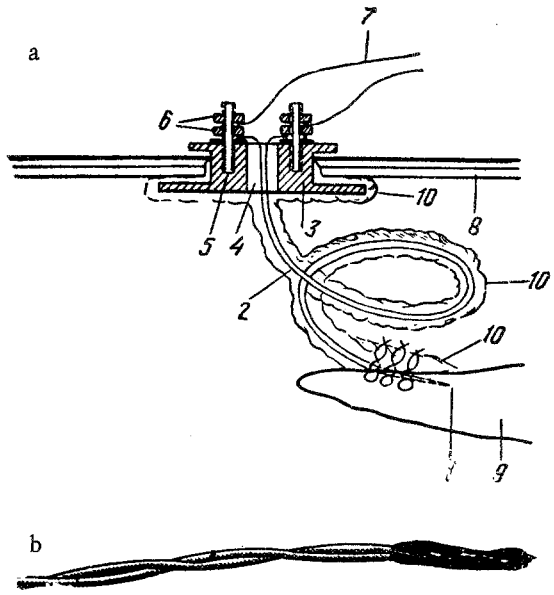

Fig. 2. (a) Diagram showing the attachment of the unit to a liver lobe; (b) external appearance of element.

Calculation of the circuit for the bridge and galvanometer, and the arrangement of the thermistors was carried out by N. V. Noskov according to the arrangement described by M. A. Kaganov [4]. The use of grouped transistors results in an error of 10° of the scale, corresponding to 0.15°C under the most unfavorable conditions. In our opinion such an error may be tolerated, because our problem concerns primarily the measurement of temperature changes in response to a particular stimulus. During operation, the indications of the thermistors are checked from time to time against a mercury thermometer.

The elements of the bridge circuit are mounted in the galvanometer box, and all the resistances are made of manganin wire. The voltage is controlled by a tube stabilizer. As a control, a constant resistance instead of a ther-

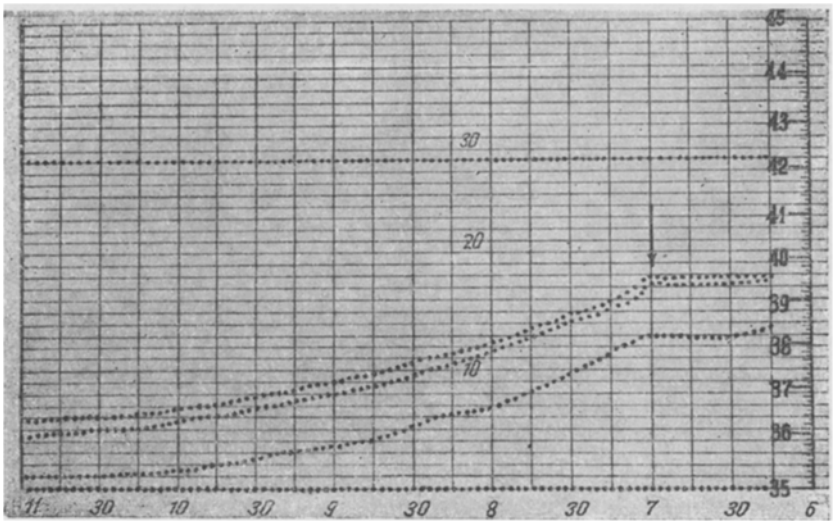

Fig. 3. Temperature changes in a rabbit induced by injecting 1.5 mg/kg of aminacin in a 0.25% solution. Curves, from above downwards: control of the stability of the supply to the bridge circuit; temperature of liver; rectal temperature; skin temperature; control line (35°). The arrow indicates the time at which aminacin was injected. Points are separated by two-minute intervals (read from right to left).

mistor is connected across one of the six pairs of terminals. Thus, during operation a record is obtained of the correct operation of the bridge circuit.

To record skin temperature (Fig. 1), the microthermistor (1) is mounted in a perspex tube (2) which is movable because of the spring placed upon it (3). The plate, to which the tube containing the sensitive element, and the spring are attached, has a base (4) containing a number of holes; a metallic cover (5) is attached by bolts to the plate. The leads from the sensitive element (6) pass from the plate into a rubber tube (7). So that the skin of the animal shall not cover the opening in the plate, a piece of photographic film (8) is attached to it. The plate with the thermistor is attached to the skin by a rubber band which is joined to the plate by clips (9). To record rectal temperatures in large animals, the unit is mounted in a thin copper container which is attached to the plastic cover measuring 100 by 5 mm.

To record rectal temperature in rabbits in their natural position, but restricted in movement, to the wires from the sensitive element, two thin steel leads are attached, which together with the unit are covered with a layer of material which insulates and fixes the cover of the leads. The elastic tube so formed measuring 60 mm in length and 3 mm in diameter is introduced into the rectum and fixed by a bandage to the base of the tail. When the unit is fixed in this way it remains highly sensitive to temperature variations, and its introduction and fixation at a definite distance from the sphincter does not interfere with normal defecation.

To record the temperature of internal organs (Fig. 2), the miniature thermistor is connected to a multiway cable surrounded by a polyethylene or chlorvinyl insulator. The nichrome lead from the thermistor is silver-soldered to the multiway cable. The junction and the nichrome leads are covered with a layer of a 25% solution of perchlorvinyl resin in xylol, and the same subtance also covers the ends of the polychlorvinyl insulation of the multiway cable.

After the perchlorvinyl resin has dried, a thin layer of varnish is applied.

When applying the insulating materials, it is necessary to ensure that the sensitive element itself is not touched. This arrangement of the thermistor for recording visceral temperatures reliably protects the leads from oxidation by tissue fluid, and it will operate reliably for several months. The element itself (1) is inserted into the tissue of an organ (9) and the leads (2) are fixed to the surface of the organ by two or three stitches. From the abdominal cavity, the leads are taken out through a perspex canula (3) having a rubber bung (4). Terminals (5) with nuts (6) connect the lead from the thermistor (2) with the leads (7) which are taken to terminals on the recording instrument. The canula is either sewn directly into the opening made at operation, or, better, inserted into a specially made aperture in the abdominal wall (8). The portion of the canula which is inside the abdominal cavity, and the leads from the organ (9) to the canula (3) are covered with omentum (10).

The method makes it possible to study disturbances of regulation caused by ionizing radiation, heat and cold stimuli, drugs (Fig. 3) and other agents.

SUMMARY

Miniature thermistors were used for simultaneous automatic remote recording of temperature from various parts of the body of animals. Diagrams showing the assembly of the transducer are given, and the arrangements are described for recording the temperature of the skin, internal organs, and rectum.

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