AN APPARATUS FOR THE GRAPHIC REGISTRATION OF SECRETION

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The methods of recording secretion at present in use [1-5] possess a number of drawbacks. Lockett's drop counter [6] has certain advantages, but it cannot be used to obtain a graph of secretion. The new model apparatus which we suggest is comparatively simple to construct, cheap, and reliable in operation.

Direct help with the development and construction of the apparatus and technical advice were given by S. S. Berkos of the All-Union Institute of Prospecting Methods and Techniques, USSR Ministry of Geology and Conservation of Mineral Resources, Leningrad.

The model to be described has been adapted and tested for recording the secretion of the isolated gastric pouch, the pancreas, and the secretion of bile in dogs, but in principle it can be used to record any secretory processes.

The apparatus consists of three principal parts: a conical detector, an automation unit, and an electromagnetic recorder unit. It is powered by the 127 or 220 V AC mains supply, frequency 50 cps. The mean power consumption is 40 W. The permissible main voltage fluctuations are from +5 to −10%. The dimensions of the apparatus are 170 × 240 × 150 mm and its weight is about 3 kg.

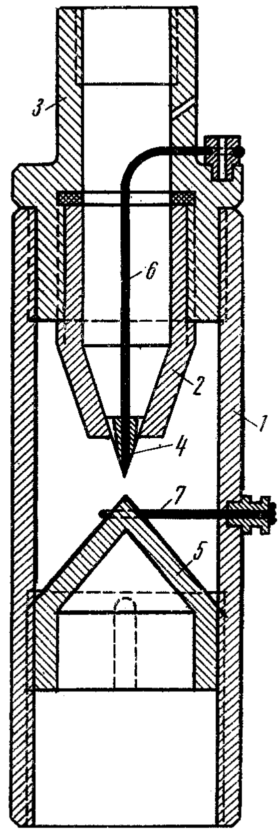

Fig. 1. Diagram of detector of secretion recorder. 1) Body, 2) receiver of secretion; 3) connecting sleeve; 4) forming cone; 5) receiving cone; 6) platinum electrode; 7) platinum ring electrode.

The detector (Fig. 1) consists of a receiver for the secretion, and because of its conical construction it forms it into drops. All the parts of the detector are made from organic glass and can be screwed together.

The detector is attached by means of a sleeve (3) to the fistula tube of the organ under investigation and to the receiver for the secretion. The body of the detector (1) is used for mounting all the other parts. At the opposite end of the body is the receiving cone (5), with outlet channels. The receiver for secretion (2) terminates in a truncated cone with an opening at the apex into which is inserted the forming cone (4), with two outflow channels on its surface.

Because of the screw-assembly of the receiving cone and the body of the detector, the distance between the apices of the two cones can be changed. Secretion flows from the receiver along the outflow channels of the forming cone, producing a drop at its apex. When the drop reaches a certain size it touches the apex of the receiving cone and flows over its surface into a tube attached beneath the detector. If its specific gravity is constant, the size of the drop is independent of the rate of movement of the investigated secretion (see table), but is determined by the distance between the apices of the cones of the detector (with a larger distance a drop of larger volume is necessary; see table). The maximal distance between the cones at which closure of the contacts of the

Effect of Various Factors on Size of the Drop

Characteristic fluid	Volume of drop (in ml)	Rate of flow (ml/min)	Volume of drop (in ml)	Distance between apices of cones, ml	Volume of drop (in ml)
Water	0.034	0.037	0.030	3	0.021
Gastric juice	0.030	0.37	0.030	5	0.032

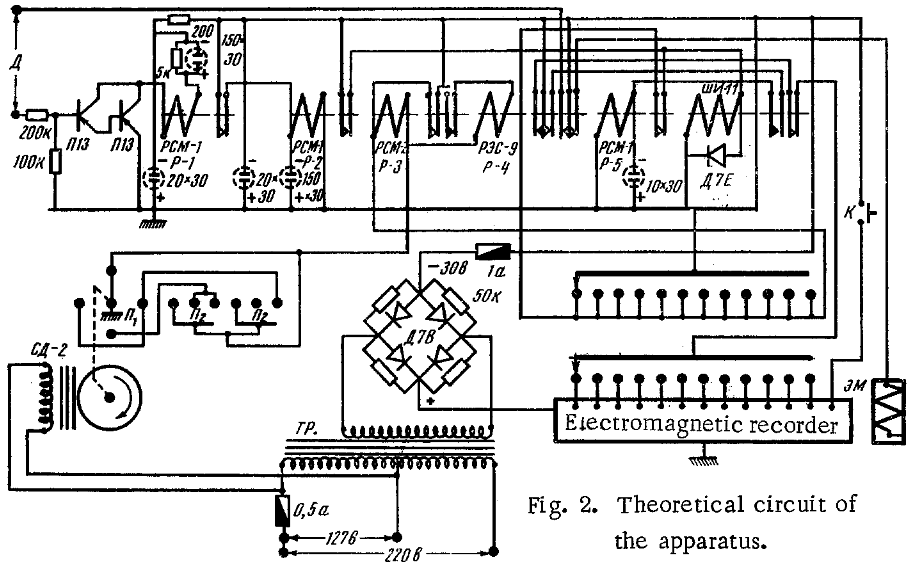

Fig. 2. Theoretical circuit of the apparatus.

Some of the following Russian abbreviations may be found in the figure: Л = tube, Д = diode, Тр = transformer, Др or др = choke, Вк = switch, в = V, М = MΩ, к = kΩ, мк = μF or μH, п = pF or pH, and н = nF or nH.

detector still takes place is limited by the volume of the complete drop. With shorter distances the drop touches the receiving cone and flows over it before it reaches the full volume.

At the apex of the forming cone is mounted a platinum wire electrode (6) with a lead to a contact terminal. The second platinum ring electrode (7) surrounds the apex of the receiving cone and is connected to the second contact terminal. As soon as the drop flowing from the forming cone touches the apex of the receiving cone, the contacts are closed and an electrical impulse is formed at the input. The conical construction ensures the constant duration of the input impulse, and this determines the accuracy of operation of the automation unit. Furthermore, as a result of the conical construction, an impulse of short duration is formed, which is very important for minimizing electrolysis in the drop. For the same purpose conditions were provided to ensure the formation of an impulse of the lowest possible strength; when contact is made between the electrodes of the detector a current of 0.01 A flows through the drop, and this produces only very slight electrolysis. Because of the low strength of the impulse an amplifier is provided in the automation unit.

The automation unit (Fig. 2) consists of a cascade amplifier on P-13 transistors (input unit) and a relay circuit with a step scanner. The apparatus is powered through a power transformer, lowering the voltage to 30 V. The rectifier is assembled on D7V diodes using a bridge circuit. A pulsed current with a strength of 1 A passing through the recorder ensures the accuracy and reliability of its work.

The recorder consists of a series of 13 electromagnets, arranged in one row and enclosed in a steel ring. The steel ring provides for the concentration of magnetic flux. The electromagnets of the recorder (12) are used for counting the drops, but one of them records stimulation. The electromagnetic unit is secured in a vertical position on a stand close to the extender of the kymograph.

With every closure of the circuit through the electrodes of the detector by the drops, the electromagnets operate consecutively, starting with the lowest.

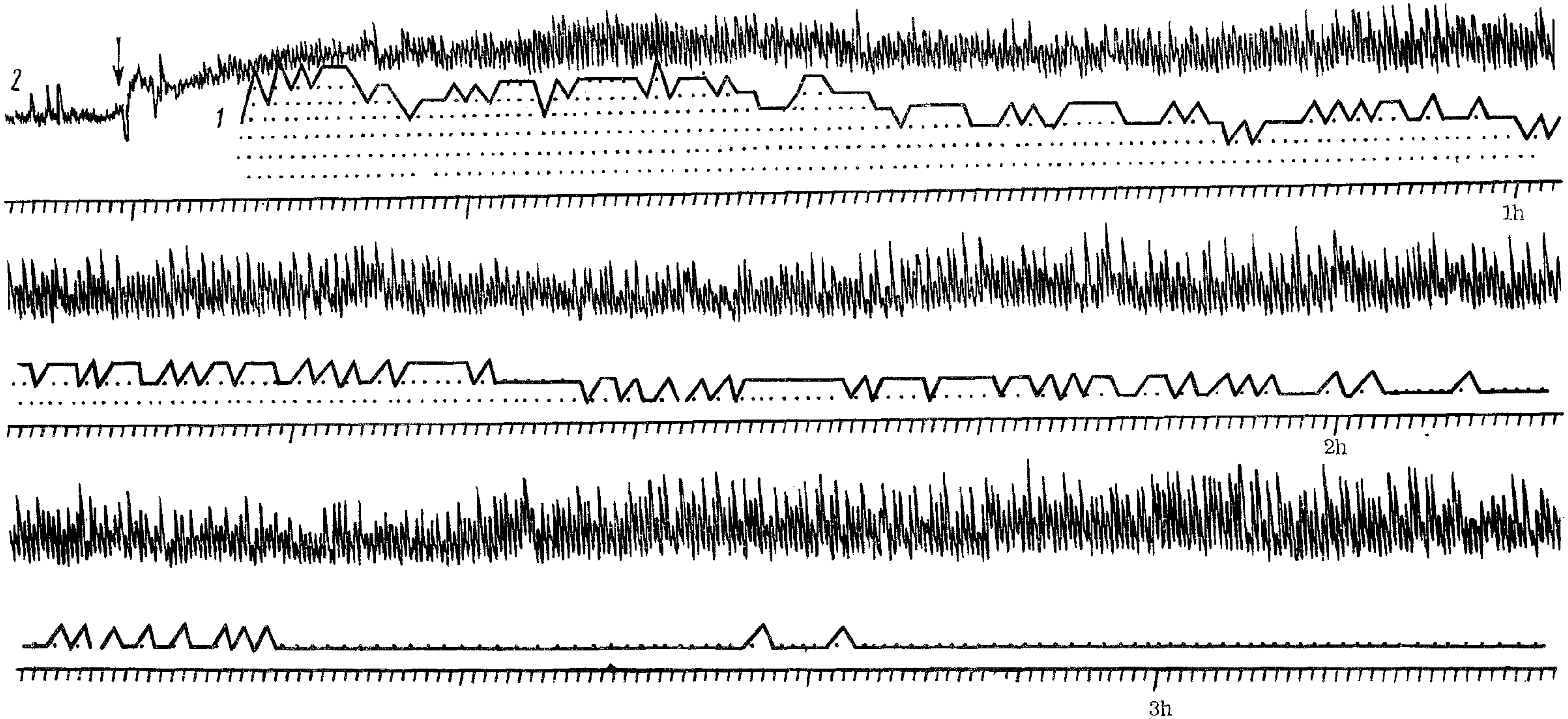

Fig. 3. Contractions of the stomach (1) and secretion of the lesser curvature of the isolated gastric pouch (2) in response to 100 g meat. Time marker 30 sec. The arrow indicates the time of feeding.

The resolving power of the apparatus is determined by the parameters of the automation unit and in this particular model it is 100 drops per minute. By means of this apparatus continuous recordings can be made of secretion for many hours. The curve consists of a differential, discrete tracing of the processes of secretion in time. From it the rate of secretion at any given moment and the volume of fluid secreted during any given period of time can be determined. Analysis of the curve must take into account the volume of the drop. If the distance between the cones of the detector is constant, the volume of the drop is dependent on the density of the secretion, which may vary in the course of the process of its production, and appropriate adjustments must be made in the calculations.

By means of this apparatus a graphic record can be obtained of the dynamics of the secretory process. It is reliable in operation, compact, and small in size. The maximal amplitude of the curve is 120 mm. A parallel recording can be made on the same kymograph paper of the motor activity of the stomach, a convenient feature when the characteristics of these two functions of the stomach are being compared. The accurate calibration of the curve is limited by the factor of density of the juice.

When the volume of a secretion containing flakes of mucus is being recorded, some form of filter must be placed inside the detector in order to protect the electrodes from becoming clogged with mucus. The apparatus is not put out of order if the electrodes are closed for a long time.

A specimen tracing of the secretion from an isolated Pavlov gastric pouch is shown in Fig. 3. The movements of the stomach were recorded at the same time by a balloon—manometric method. The dynamics of the secretory process can be seen clearly. The apparatus provides a detailed record of the characteristics of the secretory process and facilitates its analysis considerably.

SUMMARY

An apparatus has been designed for the prolonged graphic registration of digestive gland secretion in chronic experiments on animals.

Its resolving power is determined by the automation unit parameters and in the present model is equal to 100 drops per minute.

The curve represents a differential discrete recording of the secretion process in time. It can be used to determine the rate of secretion at any given moment and the amount of juice secreted per unit of time. It is interpreted in accordance with the volume of drops formed by means of a conical dropper. Accurate calibration of the apparatus is limited by the factor of the variable density of digestive secretions.

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