AN AUTOMATIC TRANSMITTER OF CONDITIONED AND UNCONDITIONED STIMULI FOR DEVELOPING CONDITIONED REFLEXES IN SMALL ANIMALS

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The process of developing conditioned reflexes in small laboratory animals (mice, rats and others) because of their biologic peculiarities encounters many practical difficulties.

Our method of approach employing the moving food method proposed by L. I. Kotlyarev in 1947-1948 [1], with the additional pneumatic record as proposed by L. Yu. Izergina and V. K. Fadeev (1949), has shown that, in order to develop rapidly conditioned reflexes in rats, one must maintain a very strict continuity in the giving of the stimuli both as to the timing and their order.

To observe these rules is somewhat difficult as it is necessary simultaneously to observe the animal's behavior and open and close switches producing on the second the conditioning and unconditioned food stimuli besides noting the character and kind of recording.

To obtain maximal objectivity in the conduct and recording of the experiment, it is necessary to automatize the entire process after having developed a stereotype. With this in view, we propose some automatic recorders and stimuli which will make the work of the experimenter simpler.

The existing apparatus for developing reflexes automatically is either difficult to make (E. A. Ganike, 1935; V. K. Fedorov, 1951) or includes only the recording of the experiment (L. I. Kotlyarev, 1951). Taking into account the merits of automatization and recording of an experiment, we developed and made an automatic instrument the nature of which is shown in Fig. 1.

The automatic transmitter acts on the principle of periodically opening and closing the electric circuit of a synchronized motor thus assuring adequate delivery of electric impulses on time.

Using the ordinary motor with two revolutions per 1 minute and employing a six gear 1:4 ratio we were able to make the drum revolve with a speed of 1 revolution in 2 minutes.

On the drum are 3 discs, each of which has 2 interacting plates, these permitting a change in the width of the teeth or distance between them.

Periodic electric impulses reach the step finder unit ATS (From a dial telephone) – see Fig. 2, with which is associated the transmission of the conditioned and unconditioned stimuli.

The step finder ATS has three movable commutator bars each of which corresponds to 12 immovable commutator bars; the first may simultaneously be relayed from one of the immovable commutators to others in conformity with the transmission of electric impulses to the coil of the step finder; moving bar I switches in the conditioned stimulus, bar II – unconditioned stimulus, while bar III alternately switches in 2 simple relays which assure the recording of the conditioned stimulus and the subsequent introduction of the conditioned stimuli into the stereotype of the experiment.

The first disc has 2 teeth and with 1 rotation of the drum the electric circuit to the step finder is closed twice as the moving commutator bar closes twice on the succeeding immovable bars.

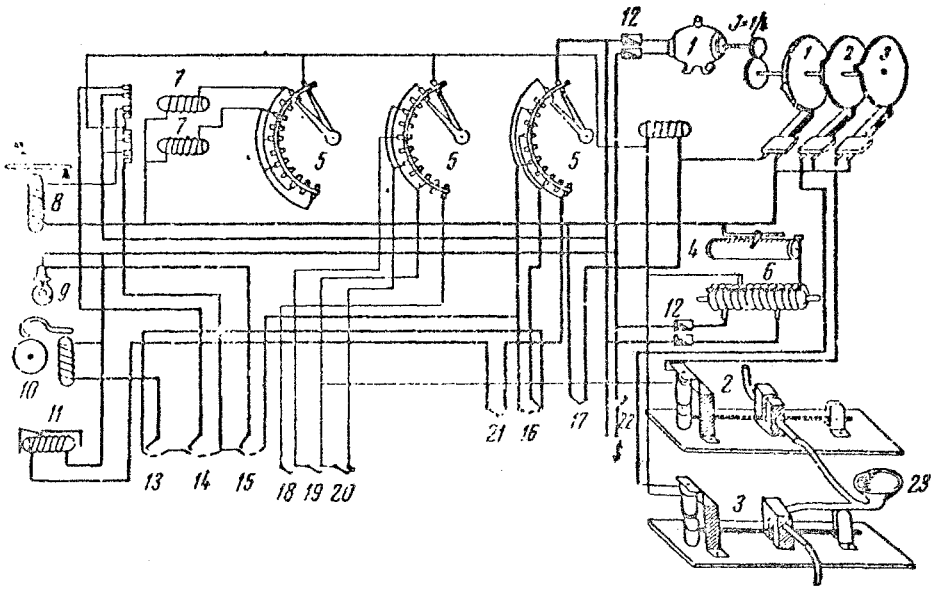

Fig. 1. Diagram of automatic producer of conditioned and unconditioned stimuli for producing conditioned reflexes in small animals.
1) motor 1270 2 turns/minute; 2) electromagnetic presentation of milk to the feeder; 3) electromagnetic release of milk from feeder; 4) sliding rheostat; 5) step finder unit ATS; 6) selenium regulator; 7) relay; 8) recorder of the conditioned stimulus; 9) electric lamp; 10) electric bell; 11) buzzer; 12) safety device; 13, 14, 15, 16) two-contact commutator; 17) electric button; 18, 19, 20) disconnecting switches; 21, 22, 23) feed container.

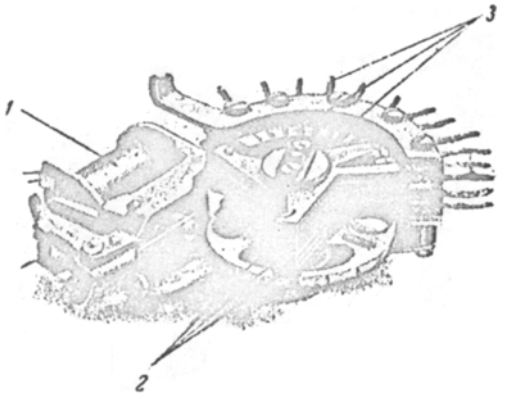

Fig. 2. Step finder ATS.
1) coil; 2) movable commutator bars; 3) immovable commutator bars.

The first time the circuit closes on the conditioned stimulator and its recording device as well as switching in the electromagnet to the feeder thus assuring the delivery of the unconditioned stimulus; finally the electric circuit is closed by the disc the width of whose teeth regulates the amount of the food stimulus; and its removal upon the giving of the conditioned stimulus being dependent on the angle between the first tooth in disc 1 and the tooth in disc 3.

In case of a negative conditioned stimulus, the electromagnet giving the unconditioned stimulus is not switched into the feeder.

The second impulse excludes the various instruments as the moving commutator bars switch into the succeeding immovable bars which are outside the electric circuit.

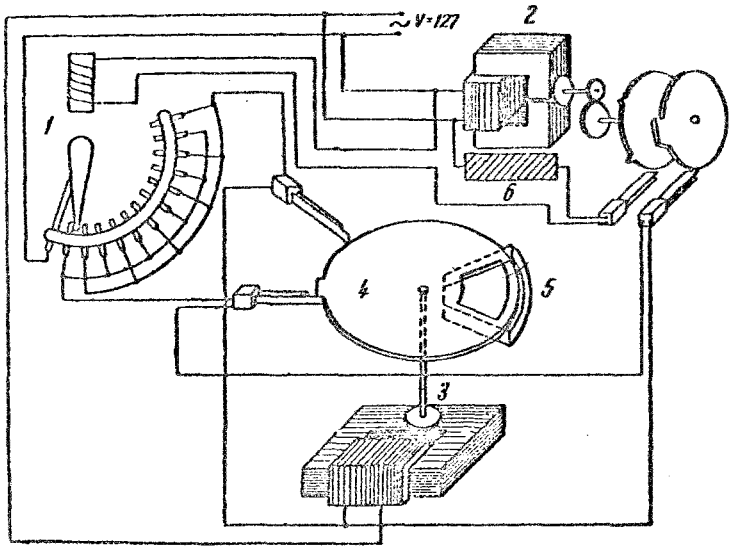

Fig. 3. Diagram of the principle of the electric feeder.
1) step finder unit ATS; 2) motor assuring delivery of impulses; 3) motor assuring working of feeder; 4) disc opening and closing feeder; 5) feeder.

From the relay commutator we can obtain conditioned stimuli in the needed sequence. We used the stereotype light-bell-buzzer (differentiating to the bell), corresponding to this, the immovable bars were set to light-bell-buzzer-light-bell-buzzer but, it is possible to get a stereotype having two, three, four or six signals.

For feeding, the diagram shows a direct current introduced with a selenium rectifier while the needed strength is assured by a constant resistance which is determined empirically.

Re-enforcement of the conditioned stimuli (in our case milk) is also done automatically with the aid of two electromagnets which automatically open or close the tubes bringing the milk to or taking it away from the feeder in correspondence with the appropriate conditioning signals.

The tube bringing the milk is always clamped and milk can flow by gravity into the feeder only when the electromagnet switches in, this being done by simultaneous closing of circuit to moving commutator bar II and disc 3.

The hose leading away from the feeder is clamped during the re-enforcement period, thus permitting the milk to stay in the feeder, this being accomplished by the other electromagnet which is thrown into the circuit through disc 2. This transmitter permits electric or pneumatic feeding thus permitting use of either food stimulus. The principle is given for electric feeding stimulus in Fig. 3.

For subsequent alterations of the stereotype, for changing the reflexes and for introducing the step finder into the base conditions there is shown a switch-board which contains 4 commutators, 5 current breakers and 1 button (see diagram).

Use of the switch-board permits any combination of three signals.

Actual use of this automatic transmitter has shown that it aids greatly in the task of developing conditioned reflexes. The usual city current activates it thus obviating the need for a steady source of direct curre

and its standard details are quite simple: motor, step finder ATS and selenium rectifier. This automatic transmitter assures a correct continuity and sequence of signals at the predesignated time intervals. The transmitter permits the setting up of a stereotype composed of several signals and guarantees errorless re-enforcement.

SUMMARY

We developed an apparatus which will permit automatic transmission of conditioned and unconditioned stimuli for the development of conditioned reflexes in small animals. The step-finder, the synchronous motor, the switch board and all the numerous details are well-illustrated.

This transmitter facilitates laboratory investigations and permits a very objective and precise approach to the animals. It may be connected either to electric or pneumatic feeding devices and may be used in standard conditioned reflex boxes.