ELECTRONIC DRINKOMETER AND RECORDER¹

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Although drinkometers are available on the market,² as well as circuit diagrams for contact recording,³ these circuits are designed to operate cumulative recorders or operations recorders. Although these recorders are useful for examining over-all rates of response, they fail to provide a record of the small local changes in the rate of response that are easy to analyze. Furthermore, in the experience of the author, an accurate record of the local changes in the rate of licking and of the distribution of the sustained periods of responding provide the information essential for determining the effects of the experimental variables on drinking behavior. For example, all of the temporal dimensions of the operant described by Gilbert (1958) can be determined from these. Collecting these data from a cumulative record is usually tedious and inaccurate, and frequently only approximations to the desired data are possible. For these reasons, the recorder described here was designed. It provides both a direct and continuous record of the rate of drinking permanently recorded on a recording microammeter. It also provides an output which when connected to an operations recorder indicates the sustained periods of drinking, ignoring pauses during the response period of any duration selected by the experimenter.

The recorder consists of five basic units connected together to provide the necessary outputs. An input circuit amplifies a small current (less than 1 microampere) which passes through the rat each time that it makes contact with the drinking tube. One of the input leads is connected to a metal floor (stainless steel rods have been found to be most satisfactory) of the chamber which contains the rat and the other lead into the fluid to which the rat has access. The output from this amplifier is used to trigger a monostable multivibrator (univibrator) which provides a pulse output of constant width and amplitude for each response made by the animal. These pulses are fed into an integrator which acts as an analogue device converting the series of pulses provided by the univibrator into a current which is directly proportional to the pulse rate. Thus, M_1 provides a visual indication of this current and hence the rate of response; and C_1 and R_1 determine the scale. The values indicated in the circuit diagram give a meter deflection of about 30 microamperes with an input rate of five responses per second. If higher rates of response are anticipated, the size of the capacitor C_1 should be reduced. This will provide a more linear relationship between rate and current. The variable resistor R_1 should be adjusted when the circuit is complete to give convenient readings on the meter. Within a limited range, its setting will determine the amount of current passing through the meter at a given rate of response.

The output of the univibrator is also fed into a second one-stage amplifier, the output of which controls a timer. The timer is designed to hold a relay open as long as the rate of response remains above a predetermined value. If the rate falls below this or stops altogether, the relay closes and remains closed until the next response occurs. This is achieved by allowing each pulse from the univibrator to discharge the capacitor C_2 , which then recharges through R_2 at the end of the pulse. As long as the pulse rate is high enough, the

¹The development of this apparatus was made possible by a grant to the author from the research committee of the school of Arts and Sciences at the American University of Beirut.

²Grason-Stadler Company.

³Cockrell, W. D. (ed.) *Industrial Electronics Handbook*. New York: McGraw-Hill, 1958.

Circuit diagram.*

capacitor cannot charge to a voltage high enough to fire the cold cathode tube (5823). However, if the rate of response falls sufficiently, C_2 charges up to the ignition voltage of the tube, the tube conducts, and the relay in the plate circuit closes. When responding is again resumed, a voltage drop appears at the plate of the cold cathode which extinguishes the tube and opens the relay. By appropriate selection of C_2 and R_2 , the relay will remain closed for any reasonable length of time following the termination of responding. With C_2 3 microfarads and R_2 approximately 0.7 megohm, the relay will delay opening for about 1 second.

A permanent record of the rate of response is obtained by the incorporation of a VTVM with a recording microammeter as M_2 . The input to the VTVM (X) is connected to the positive side of the meter (M_1) in the integrator circuit, and M_2 is a 0-200-microammeter recorder.⁴ Resistor R_3 is used to calibrate the recorder. This is accomplished by applying a 50-volt DC source to the input (X) and adjusting R_3 until the recorder reads full scale. The input (X) must be disconnected from M_1 when this operation is performed. Resistor R_4

*A 150k resistor should replace the wire connection in the VTVM cathode circuit between the common connection of the 150k and 220k resistors and the adjustable tap of R_4 .

⁴A relatively inexpensive recorder if this type is available from The Rust Industrial Co., Inc., 130 Silver St., Manchester, New Hampshire.

is a zero adjustment control, and it should be mounted on the chassis so that it is easily accessible because readjustment will be necessary from time to time.

In construction, precaution should be taken to eliminate AC pick up in the grids, especially in the input amplifier. Shielded grid wire used on all of the grid connections should eliminate this problem. In particular, the input leads connected to the drinking box and the drinking tube should be of two-conductor shielded microphone cable with the shielding grounded to the chassis. In addition, it may be necessary to insulate the drinking box from ground by mounting it on sponge rubber. Finally, in adjusting the drinking tube, it will be necessary to insure that after each lick the animal breaks contact with the tube before it makes contact again. If the animal maintains contact, with its nose, for example, the uni-vibrator will respond on only the first contact, but will not follow the subsequent contacts. This problem can be solved by mounting the tube behind a small hold which permits only tongue contact with the tube.

REFERENCE

Gilbert, T. F. Fundamental dimensional properties of the operant. *Psychol. Rev.*, 1958, **65**, 272-282.

Received Sept. 1, 1960.