A SENSITIVE ELECTRONIC DRINKOMETER

J. ANTHONY DEUTSCH

NEW YORK UNIVERSITY

This paper describes a device of simple design which allows rates of drinking in animals to be measured while passing the minimum of current through the subject. The drinkometer employs a gas filled tetrode (2D21) and a standard relay.

The device shown here consists of a 2D21 thyatron with a conventional relay in series with the anode. The thyatron is a gas filled tube. Once its grid has gone sufficiently positive to initiate conduction, such conduction will then persist independently of any further state of the grid. The only way to stop conduction is to lower the voltage between the cathode and the plate of the thyatron. Only after conduction has been stopped can conduction then be held off by the grid when voltage is reapplied between the plate and the cathode. To render the flow of current across the thyatron controllable by the grid, by fast repeated lowering of potential across the thyatron, a capacitor (with a limiting resistor in series) is connected in parallel to the

thyatron. When current flows through such an arrangement, the voltage across the thyatron is initially low and it will not conduct until a certain voltage (depending on the voltage of the grid) is reached. This is because the impedance of the capacitor is initially very low, and so the voltage across it is also low. As the impedance of the capacitor rises as it charges, the voltage across the capacitor, and so the thyatron, rises to the point at which the thyatron begins to conduct. As soon as it conducts, the capacitor discharges through it, thus reducing the voltage across the thyatron again to the point where the thyatron can conduct; and the cycle begins anew. This arrangement is a thyatron relaxation oscillator. However, if during this cycle the grid is brought sufficiently negative with respect to the cathode, the grid will prevent the thyatron from conducting in spite of the development across the thyatron of a voltage sufficient for this when the grid was positive. If the frequency of oscillation is high

SENSITIVE DRINKOMETER

with respect to the changes controlling the potential on the grid, the appearance and disappearance at the plate of oscillations will mirror with good accuracy the temporal distribution of the changes controlling the grid. Licking rates are in the region of 10 laps per sec; the rate of oscillation of the present device varies from five kilocycles to three kilocycles per sec. This high frequency eliminates relay chatter.

In the present device when the grid is positive to the cathode, oscillation occurs and so current flows through the relay, closing it. It is a convenient property of the thyatron that its grid, when left floating, will bias itself off positive to the cathode and so initiate conduction, permitting the circuit to oscillate. As the grid is connected to the water nozzle, which is insulated from ground, the potential on the grid is positive, allowing oscillation to occur, when the rat's tongue is not touching the water nozzle. The grid is attached to the cathode (kept about 8 v above ground) through a 60 megohm resistor, and to the water nozzle through a 20 megohm resistor. As soon as the rat, standing in a grounded cage, touches the water nozzle, the 20 megohm resistor attached to the grid at one end and the nozzle at the other, is effectively grounded, bringing down the potential at the grid approximately 6 v negative with respect to the cathode. This prevents further oscillation while the rat's tongue is in contact with the water nozzle. As soon as the rat's tongue loses

contact, the grid biases itself off positive to the cathode once more, and oscillation resumes.

The current passing through the animal when it touches the drinking tube can be calculated by dividing the voltage at the cathode (say 8 v) by the resistance in series with it (80 megohms). This makes the current drawn by the animal less than 0.1 of a microampere. The model will work even when lower values of current are desired. It has been possible to halve the value of current drawn by the animal by doubling the value of resistance between the cathode, grid and animal. Adjustments of the sensitivity are made by altering the voltage at which the cathode is kept by setting the potentiometer which forms the bleeder circuit. In spite of extreme sensitivity of the circuit it is found to be robust and reliable in practice. The device can also be used as a sensitive touch relay. If there is a long connecting lead between the drinking nozzle and the device this should be shielded and the shield grounded. If the relay chatters or remains open after the apparatus is set up this is probably due either to a faulty or inadequate grounding of the device, or to inadequate insulation from ground of the water container. The last is very important. It is possible to detect with the instrument whether a person touching the input lead is wearing rubber or leather soles. The insulation of leather soles is not sufficient to prevent grounding of the grid.