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A Drug Dispenser to Measure Individual Drinking in Rat Colonies

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COAMBS, R. B., B. K. ALEXANDER, C. M. DAVIS, P. F. HADAWAY AND W. R. TRESSEL. *A drug dispenser to measure individual drinking in rat colonies.* PHARMAC. BIOCHEM. BEHAV. 13(4) 593–595, 1980.—This article describes an automated device which substantially facilitates the measurement of oral drug consumption by individual rats housed in a colony with a common drinking source. To drink, each animal enters a Plexiglas runway, triggering a video system which records the rat's identifying dye mark, and its consumption of each of two liquids. Rats learn to operate the device easily and rapidly. Data for 24 hours can be collected on a one-hour videotape.

Drug self-administration Colony housed rats Apparatus

TO enable studies of the effects of colony housing on drug self-administration in rats, a system was designed to record the volume of each of two liquids consumed by each animal. Using this device, we have shown that significant differences in morphine self-administration exist between the sexes in a colony, and between colony housed and individually caged rats [[1,2].

The apparatus functions as follows: Each rat has a hair dye mark on the back for identification. To obtain liquid, it passes through a hole in the enclosure wall and enters a Plexiglas runway just large enough for a single rat (H, 4.7 cm; W, 5.8 cm; L, 24 cm). The animal's entry breaks a light beam and triggers a videotape recorder (VTR), which remains on for five seconds. A fixed overhead video camera records the rat and the display on two digital counters.

Fluids are available in two small pools at the end of the runway. The rat breaks a light beam by drinking the contents of a pool, after which it withdraws its snout. This reconnects the light beam, triggering a solenoid-activated dispenser to release a measured drop of liquid. Rats quickly learn this, and operate the dispenser at a steady rate. Each drop release is recorded on one of the digital counters. After the rat's departure, the next entrance of an animal triggers the VTR, producing a recording of the amount the first rat drank, and the identity of the incoming animal. Because each entry requires approximately 5 sec of recording time, 24 hours of normal drinking by 16 rats can be condensed onto a one hour videotape.

The apparatus consists of three interlocking systems. The first is a video system, with a video camera (Sony AVC-3400) mounted directly above the Plexiglas runway, a 150 W floodlight, and a VTR (Sony AV-3650). The VTR is connected to the video triggering device (Fig. 2), which is comprised of a photocell, a relay, and an adjustable timer. The relay energizes the VTR and floodlamp when the photocell's

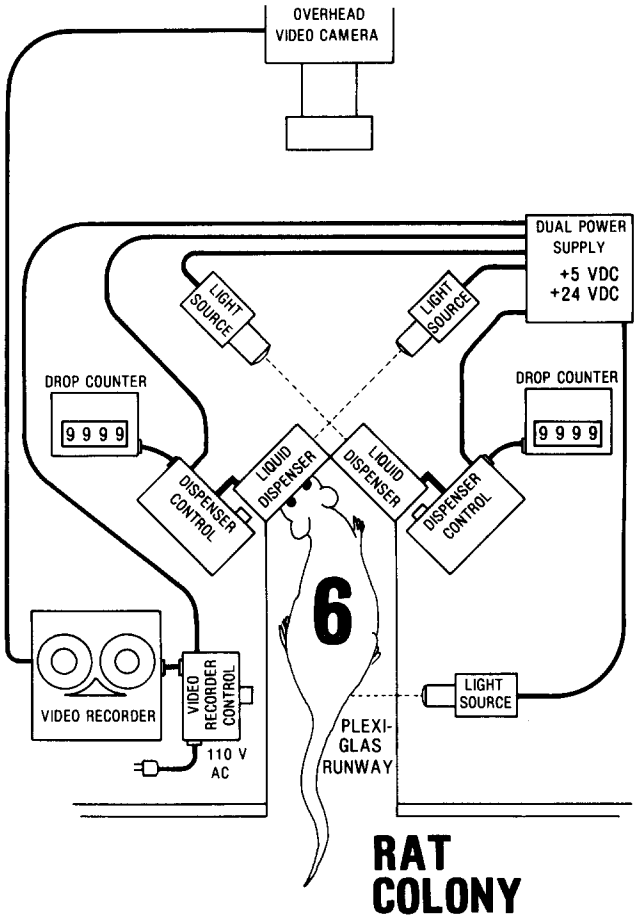

FIG. 1. Overhead view of the apparatus. Two additional non-resetting counters (not shown) cumulate daily totals.

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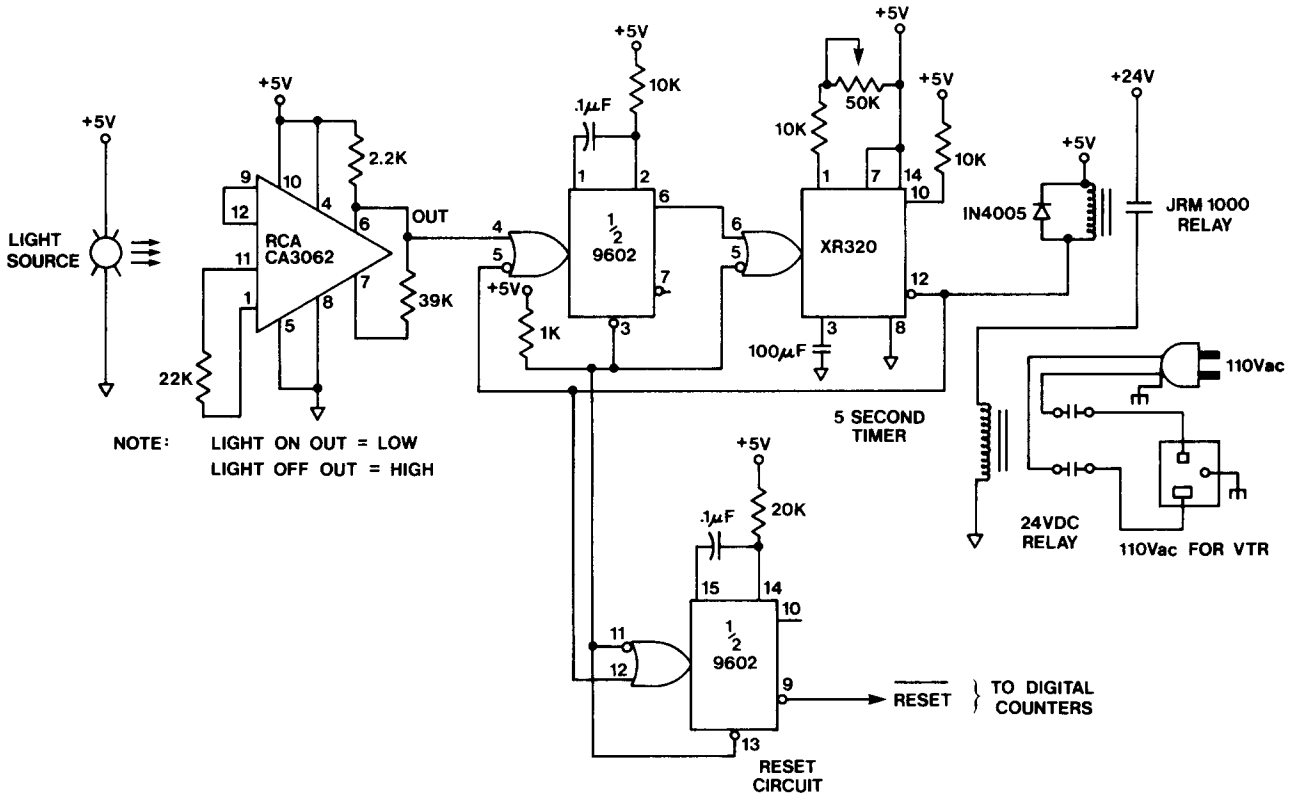

FIG. 2. Circuit diagram of the video recorder control. Components labelled "9602", "JRM 1000", and "XR 320", are manufactured by Fairchild Semiconductor Ltd., Potter and Bromfield Ltd., and EXAR Products Ltd., respectively.

light source is broken by an incoming rat. The adjustable timer determines the period that the VTR remains energized (3–9 sec). The counters are reset when the VTR shuts off, so that each rat begins drinking from zero. After an entering rat triggers the VTR, 2–15 sec are required to approach and activate the liquid dispensers. Occasionally, one drop is dispensed prior to the reset pulse, but this can be rectified, since it is evident on the videotape.

The second system dispenses liquids, using a modified Lafayette Instruments Liquid Dispenser (cat. No. 80201). It consists of a graduated cylinder with a hole at the bottom in which a solenoid-controlled plug rests. The redesigned liquid

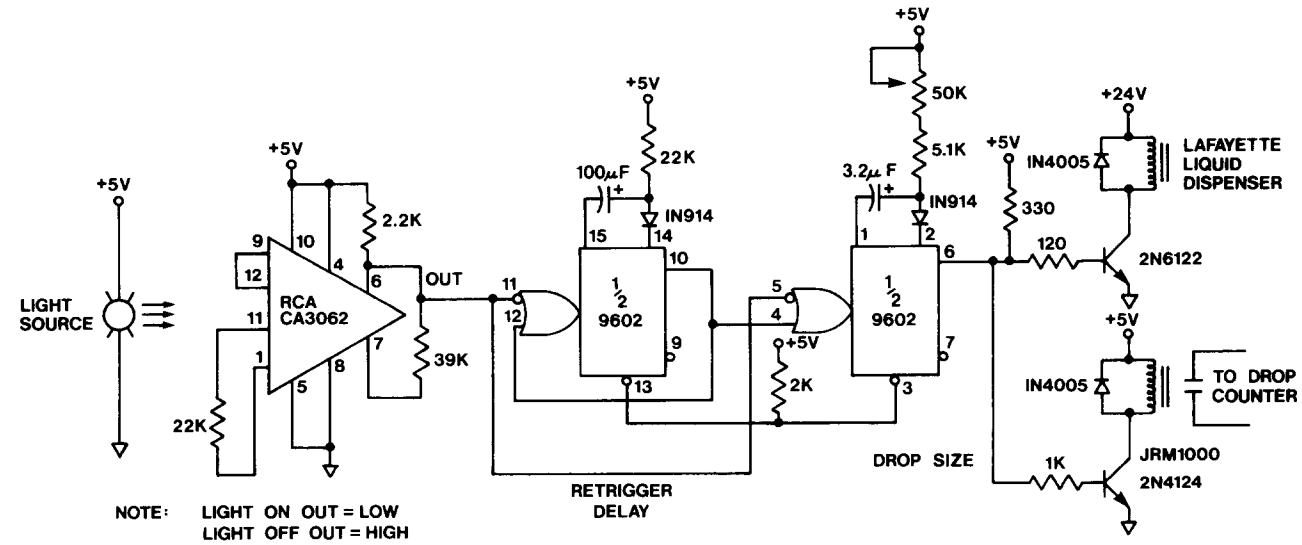

FIG. 3. Circuit diagram of the liquid dispenser control.

dispenser control electronics (Fig. 3) energize the solenoid when a rat withdraws its snout from the drinking pool, releasing another drop. A potentiometer determines drop size by regulating the duration that the dispenser solenoid is energized.

In order to increase the amount of liquid reservoir capacity of the dispenser, the graduated cylinder is fitted with a brass nipple, to which a length of Tygon tubing is connected, leading to a 2 l liquid reservoir. Total daily fluid consumption is determined by weighing the reservoirs.

Four counters are used; each liquid dispenser activates one which resets, for the video display, and another, which cumulates daily totals. Drop size can be derived from daily totals by dividing the weight consumed by the total number of drops dispensed. The resetting counters eliminate the tedium of obtaining each rat's total from the cumulative counters by subtracting the readout at the time of a rat's entry from the succeeding entry readout. Suitable counters are available from Metermaster (R. H. Nichols, Downsview, Ont., Model PC-4).

Sometimes the drinking pools are spilled slightly (especially when unpalatable solutions are used). The third system collects this waste, thereby permitting a loss correction calculation. An 18 ga square ended syringe needle is affixed (epoxy glue) to the edge of each drinking pool, and connected via Tygon tubing to collection bottles. In order to evacuate the liquid, the bottles are maintained at mild negative pressure by an air suction pump (Phipps and Bird, Richmond, VA, Small Animal Respirator, Cat. No. 7088–600). The correction presupposes that each rat wastes fluid in proportion to the amount it consumes, and is performed by attributing daily waste to each animal according to its fraction of the colony's total daily consumption. The possible error that this presupposition permits is small, since waste is normally less than 10% of total fluid dispensed. This compares favorably to experiments using gravity feed water bottles, which allow no estimate of the possible waste accompanying drinking.

Detailed instructions for construction are available from the first author.

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