

# BRIEF COMMUNICATION

## A Simple Method for Studying Operant Wheel Running in Rats<sup>1</sup>

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PORTERFIELD, A. L., J. J. STERN AND W. B. VALADE JR. *A simple method for studying operant wheel running in rats.* *PHYSIOL. BEHAV.* **12**(6) 1083–1085, 1974. — The present report describes an operant running device for rats. The apparatus makes use of an activity wheel driven by a small electric motor. The motor is started by a bar press; once activated, the wheel turns for 3–30 sec. depending on the setting of a timing device. The system is well suited to long term studies of activity patterns.

Activity patterns      Operant running      Wheel running

HORMONES, neurohumors and environmental manipulations all modify the level of spontaneous activity in rats. A complete understanding of the nature of these changes, however, requires more than a study of revolutions/time. It should also include the temporal duration and patterning of individual bouts of running. The present paper describes an apparatus that allows one to obtain these data.

A standard 35.6 cm Wahmann activity wheel was modified by the addition of two heavy gauge sheet metal barriers shaped to conform to the wheel and mounted on the side wall by means of L-shaped flanges (Fig. 1). The purpose of these barriers is to limit exploration, thereby increasing the likelihood of bar pressing. One barrier holds a Lafayette bar press switch rewired to be normally closed; the upper portion of the barrier is angled toward the axle to prevent perching on the switch. The barrier's position represents a compromise between placing the bar parallel to the ground (maximizing the gravitational preload on the switch) and placing the bar in line with the running surface (maximizing accessibility for the animal). The other barrier,

positioned above the axle, keeps the animal from climbing onto the axle but allows greatest running space.

The revolution counter was disconnected from the axle and replaced by a V-belt pulley. A steel sleeve, I.D. = 0.79 cm, O.D. = 1.27 cm, centers the pulley on the axle. The drive pulley was connected to the wheel pulley by a V-belt which was notched to increase flexibility (see Fig. 1).

Selection of a motor is governed by two criteria: (1) The motor must be of relatively low r.p.m. due to gearing limitations imposed by commercially available pulley combinations, and (2) the motor should sufficiently resist the tendency of the wheel to turn during the rat's explorations. A 100 V a.c. gear motor (Dayton 3M097) with an output of 50 r.p.m. geared down 2:1 to achieve a wheel speed of 25 r.p.m. was used.

Figure 2 illustrates the timing circuit which operates from a 12 V d.c. power supply. Closing switch S-1 activates the timer and energizes relays K-1 and K-2. Depression of the bar opens switch S-2 momentarily, de-energizes K-1 and

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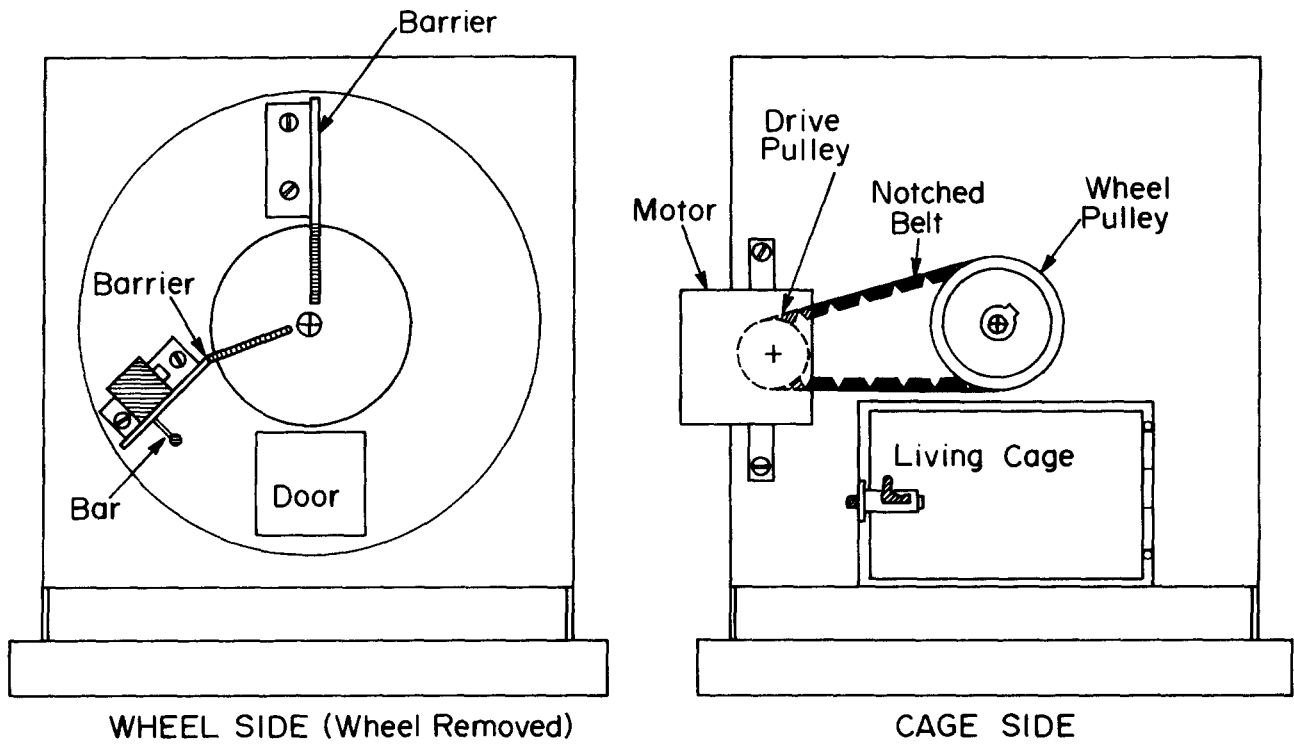


FIG. 1. Diagram of the apparatus.

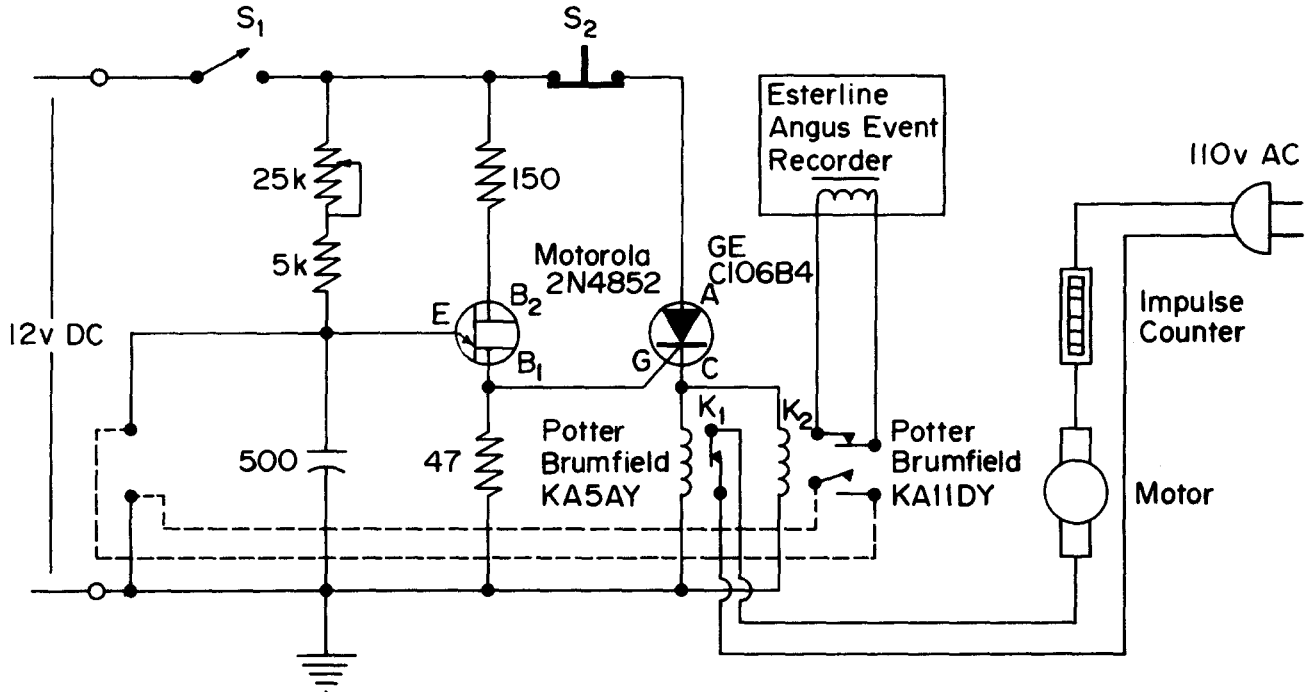


FIG. 2. Circuit diagram for the timer and recording devices.

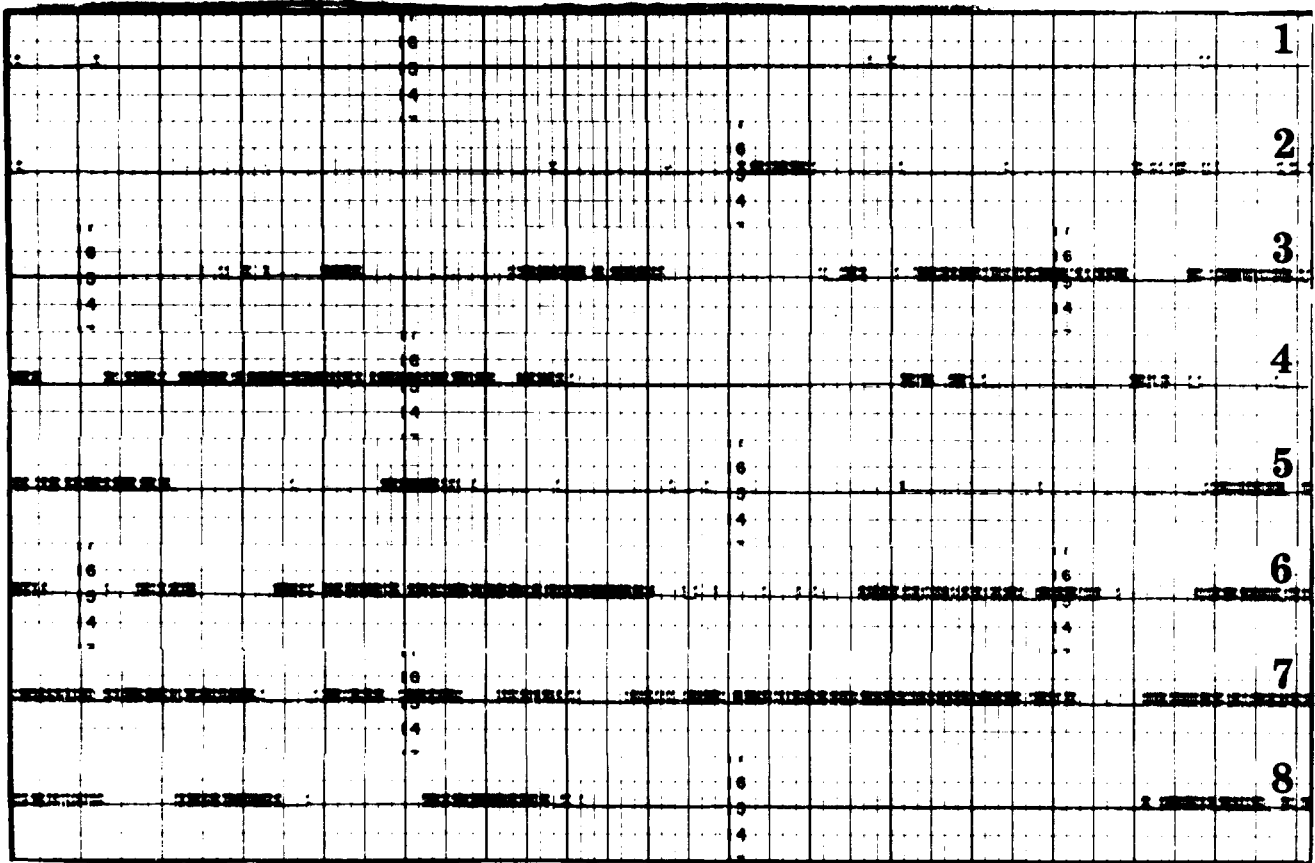


FIG. 3. Typical Esterline Angus record for a female rat bar pressing for 5 sec of running. Proceeding from right to left, the record represents activity during the first 8 hr of darkness.

K-2, and starts the motor. As the bar is released, S-2 closes and the capacitor begins to charge. The rate at which the capacitor charges is governed by the setting of the 25k potentiometer and can be varied from 3–30 sec. When the capacitor reaches trigger voltage, the unijunction – SCR network causes K-1 and K-2 to re-energize, thereby stopping the motor until the sequence is reactivated by another bar press. One of the two poles of relay K-2 insures that operation of S-2 during the timing sequence will not result in summed timing.

Bar presses are recorded by a heavy duty 110 V a.c. digital impulse counter wired in series with the motor. A more descriptive time analysis is made possible by a switch type Esterline Angus event recorder connected to the second pole of K-2. Figure 3 shows a typical Esterline Angus record obtained with this equipment.

There are several reasons why the apparatus described in this paper might be attractive to the researcher: (a) It is relatively inexpensive, easy to construct and maintain, and is capable of continuous operation over a period of weeks or months. (b) In contrast to other investigations that employed braked wheels freed by pressing a bar in the living cage (e.g., Collier and Hirsch [1]), the present device

places the bar inside the wheel, making it unnecessary for the rat to leave or lean out of the wheel to press the bar. Training is thus facilitated by the elimination of superfluous behavior between the operant and the reinforcement. (c) A motor driven wheel operating for a predetermined period following each bar press allows a number of dependent measures to be derived directly from the record of bar presses. For each press, distance (revolutions) run, effort expended, speed and duration of running are constants. In this manner, bar pressing becomes a direct and reliable indicator of activity. Furthermore, animals in separate but identical devices can be compared by bar press data without the necessity of first equating wheel resistances or running speeds.

The authors are presently employing the apparatus to study the cyclic activity patterns of female rats. Preliminary data show that operant running, like free wheel running, fluctuates predictably over the estrus cycle and, as can be seen in Figure 3, running tends to occur in discrete bursts or bouts. The question of concern is how the rat modifies these individual bouts to effect the overall variations in activity characteristic of the stages of estrus.

#### REFERENCE

1. Collier, G. and E. Hirsch. Reinforcing properties of spontaneous activity in the rat. *J. comp. physiol. Psychol.* 77: 155–160, 1971.