A DEVICE FOR MEASURING AND PROGRAMMING THE SPEED OF EXECUTION OF A SINGLE RESPONSE¹

JAMES A. DINSMOOR

Indiana University

Variations in the characteristics of single instances of a given operant have been difficult to measure and to program. This note describes a simple electrical system using the speed of a response involving rotary action (e. g., through a wheel, a lever, or a crank). If a small generator is mounted on the rotating axle, the momentary output of this generator should be proportional to the mechanical energy imparted to the responding device. A given level of output may be selected and used as a threshold or criterion value for the operation of a tallying or programming relay.

The generator suggested for this circuit is a miniature DC motor such as is used in radio-controlled models of boats and planes. The Mighty Midget (e. g., Lafayette Radio, \$2.95), or better, the Micromotor (\$5.95), are designed for heavier duty than other models. Rotation of the shaft establishes a small potential across the terminals normally used for the electrical input. This output may be monitored on a panel microammeter or may be traced by a recording stylus; the output of the transistor may be monitored by inserting a 0-1 DC milliammeter between the collector lead and R3.

The output of the generator also provides a biasing current for the base-emitter circuit of the transistor, and the criterion level for the operation of the programming relay may be set by adjusting R1. The transistor isolates the motor from the grid-bias potential of the thyatron and amplifies its output as a generator. Any junction transistor should be usable, but Raytheon's CK722 is cheap and readily available. Biasing the transistor increases the flow of current through its collector-emitter circuit and thereby reduces the negative bias of the grid (terminal 5) with respect to the cathode (terminal 8) of the thyatron. (Terminals are numbered clockwise from the key, bottom view.) The potential for the grid bias is furnished by rectifying the output of a 6.3-volt filament transformer, which also supplies the heating voltage for the thyatron. If a half-wave rectifier is used, as shown in Fig. 1, it may be necessary to interchange the original output connections

¹ This device was designed and tested under Research Grant NSF-G3472 from the National Science Foundation.

Fig. 1. Schematic wiring diagram for a speed-dependent relay.

from the transformer in order to match the phase of the plate circuit of the thyatron. The initial grid bias is set by adjusting R2, in conjunction with balanced values of R3 and R4, to a point where the thyatron just fails to conduct. The total resistance in the grid-bias circuit is not critical, but large values reduce the sensitivity of the setting at R1.

For a thyatron, the 2051 tube is easy to obtain and relatively cheap. This provides a positive "all-or-none" trigger action for the operation of the relay; conduction through the cathode-plate (8-3) circuit activates the relay. When the subject slows down or stops turning the response device, the relay returns to its normal position. A capacitor (C) in parallel connection with the relay is necessary to smooth out the ripple produced by half-wave rectification of the alternating current supplied to the plate circuit of the thyatron. The resistance of the relay coil is not critical. Separate switches are provided for preliminary warm-up of the thyatron (Sw1) and for the application of power to the relay circuit (Sw2).

List of Parts

R1	25,000-ohm potentiometer
R2	2500-ohm potentiometer
R3, R4	4000-ohm fixed resistors
C	1 - 10-microfarad capacitor
Ry	5000-ohm relay
G	generator (miniature DC motor)
T	6.3-volt filament transformer
Sw1, Sw2	toggle switches
0 - 200 DC	microammeter
half-wave	rectifier (low power)
2051	thyatron
CK722	p-n-p junction transistor