TECHNICAL NOTE

THREE-RELAY ALTERNATOR CIRCUIT[1]

Often, when wiring an operant conditioning experiment with conventional relay equipment, it is necessary to alternate between two states with successive pulses from a single source. This function is performed by a "flip-flop" with solid-state equipment. The commercially available products that provide this function for relay equipment fall into two categories. Mechanical devices are available that operate by rocking an armature or by rotating a cam in step-wise fashion with successive pulses. Every other input moves the mechanism so that it operates a set of contacts. These devices, while reliable and inexpensive, have one feature that may be a disadvantage under certain circumstances. The mechanical alternator retains a particular state despite a disruption in current. Thus, if each session must start with the alternator in one particular state, it is necessary to check its position at the start of a session and change its state when incorrect.

In addition to the alternating function, occasionally it is useful to delay a change in state until the offset of an input signal. This function is available as an integral part of a cam-type alternator; relay-type alternators usually change state when a pulse is applied.

The circuit diagrammed here uses only three relays and two diodes (plus spark suppressors) to perform both the alternating and delaying functions. It can be easily wired externally on standard snap lead relay panels using several leads and two back-path eliminators (diode leads), or it can be wired as a single unit with an input and several programming contacts. It uses no timing circuitry that must be precisely adjusted, and the input pulses can be of any length sufficient to operate the component relays. The relays themselves can be any conventional continuous duty type with a sufficient number of contacts and adequate contact load rating for the external programming.

The circuit is basically a latching circuit (relays 1 and 3) and an input switching relay (relay 2). When current is applied to the relay coils, relay 2 is operated and relays 1 and 3 are at rest. The first input latches relay 1 and on its offset releases relay 2. The second input operates relay 3, releasing relay 1, and on its offset operates relay 2 again. Thus, relays 1 and 2 operate and release with successive pulses to the input. Relay 1 changes state with the onset of an input, and relay 2

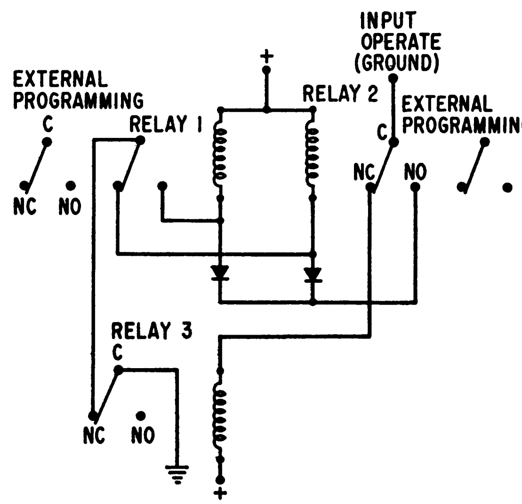

Fig. 1. The three-relay alternator circuit. Diagram shows the circuit in the power-off state with all relays at rest. When plus and ground are applied, relay 2 is operated. Components are described in the text. Spark suppressor circuitry is not shown.

changes state with the offset of an input. The contacts of relays 1 and 2 can be used to program alternating states, and relay 2 can also be used to delay a change in state until the offset of an input signal. The device can be reset to a standard position (relay 2 operated, relay 1 not operated) by merely removing the ground to the common of relay 3. This can be done by turning off the power to the entire apparatus or by opening an external switch controlling this ground (*e.g.*, a push button or a relay).

This alternating circuit has several advantages. First, it is economical, requiring only readily available components: three relays (*e.g.*, Sigma 62R2-24DC @ $3.50), two diodes (*e.g.*, Motorola 1N4003 @ 25c each), wire, and mounting material. Second, it is reliable, being relatively independent of timing and voltage variables. Normal operating speed is determined by the pull-in time of the relays. Third, it can be easily restored to a set position by removing current from the relay coils.

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