JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1967, 10, 515-516 NUMBER 6 (NOVEMBER)

TECHNICAL NOTE

A VERSATILE PROGRAMMER FOR RATIO AND INTERVAL SCHEDULES USING A PUNCHED-TAPE READER[1]

A versatile programmer has been developed using a seven-channel, bi-directional, punched paper-tape reader[2]. When the subject's responses are used to advance the tape reader, it may be used to program fixed-, variable-, progressive-, adjusting-, or random-ratio schedules. When the reader is advanced by time, it may be used to program fixed-, variable-, progressive-, adjusting-, or random-interval schedules. Schedule parameters may be changed by switching manually or automatically, from one channel to another. Since five tape channels are available for programming, up to five schedules are simultaneously available. By replacing the channel selection switch with relays, remote switching of schedule parameters is possible. The schedules may be generated automatically by a computer program with punched tape output or may be produced manually by a Flexiwriter or other punched-tape typewriter. Mylar coated tape should be used because the holes in uncoated paper tape can become enlarged with repeated use, resulting in multiple output pulses. Free- or low-cost time on these tape punching units can usually be obtained at a university or other institutional computer facility. A surplus Teletype tape puncher, which can be bought for about $100, is also suitable. For lengthy programs, however, a computer program is recommended.

With 6-in. tape reels, the unit has a capacity of about 40,000 characters. In terms of schedule parameters, this would be 40,000 responses or 11 hr of continuous operation if the tape were advanced by a timer at a rate of one character per second. If the particular sequence of characters is not critical, the capacity of the unit can be doubled by using the end-of-tape report to reverse tape direction. Still larger capacities can be obtained by using larger reels. The large capacity of this unit is particularly advantageous in work with primates where very large response requirements and very long sequences without recycling are often necessary (Hodos and Trumbule, 1967). The instrumentation of such large capacity programs is frequently cumbersome with conventional electromechanical systems. Other advantages of this unit are its high speed of operation and reset (60 characters per sec) and quiet performance.

The programmer consists of two main parts: (1) the tape reader mechanism which is commercially available for approximately $600. Surplus or rebuilt tape readers may be available at lower cost; (2) the control panel, which may be constructed in the laboratory for about $150 in materials.

A hole in the tape is sensed by a star wheel which actuates single-pole double-throw switches. A 4.5-msec, 24-v pulse is required to move the tape from one hole to the next. Five channels are available for programming and the sixth channel is reserved for resetting tape. Most tape-punching devices reserve the seventh channel for parity checking.

The control panel contains seven conventional 28-v relays. Relay Ry_0 is connected in a pulse former configuration (Saslow, 1964; Swinnen, 1964). It shapes the incoming subject key pulses to standard pulses of 50 msec duration. This procedure eliminates key chatter. Relay Ry_1 is connected in the same configuration, but its pulse duration is 4.5 msec. To achieve this extremely short duration for a relay circuit, an ultra-fast mercury relay is employed.

If a hole is present in the channel selected by switch Sw_3, relay Ry_2 actuates for 4.5 msec and in turn energizes the pulse "stretcher" relay Ry_3. A pulse appears at the reward output for a duration of 50 msec. The contacts on relay Ry_3 also disable relay Ry_1, eliminating input pulses during the reward output period. Switches Sw_2 and Sw_3 may be replaced by relays if remote automatic channel-switching or tape direction changes are required.

The motor of the tape advance mechanism runs continuously as long as ground is applied to the operate input, which energizes relay Ry_5, and as long as interlock switch Sw_1 stays closed.

The 4.5-msec pulse interrogates the tape and advances it by one character; *i.e.*, one feed hole. The advance clutch, however, operates through a built-in mechanical delay, so that current can never flow through a reader contact while it is opened by the advancing tape. This "dry-switching" increases the life of the contacts to several billion operations.

Switch Sw_2 is used to select the forward or the reverse coil on the advance clutch, moving the tape either forward or backward.

Whenever ground is applied to the reset input, or whenever the manual reset button is pressed, relay Ry_4 is energized. The contacts of relay Ry_4 disable relay Ry_1 to eliminate input pulses during the homing operation. The contacts also supply reset pulses to that coil on the clutch which is not in use for normal advance operation. This assures that the homing direction will always be opposite to the normal advance direction. The homing pulses consist of half-wave rectified, but not filtered, pulses from a 25-v ac supply,

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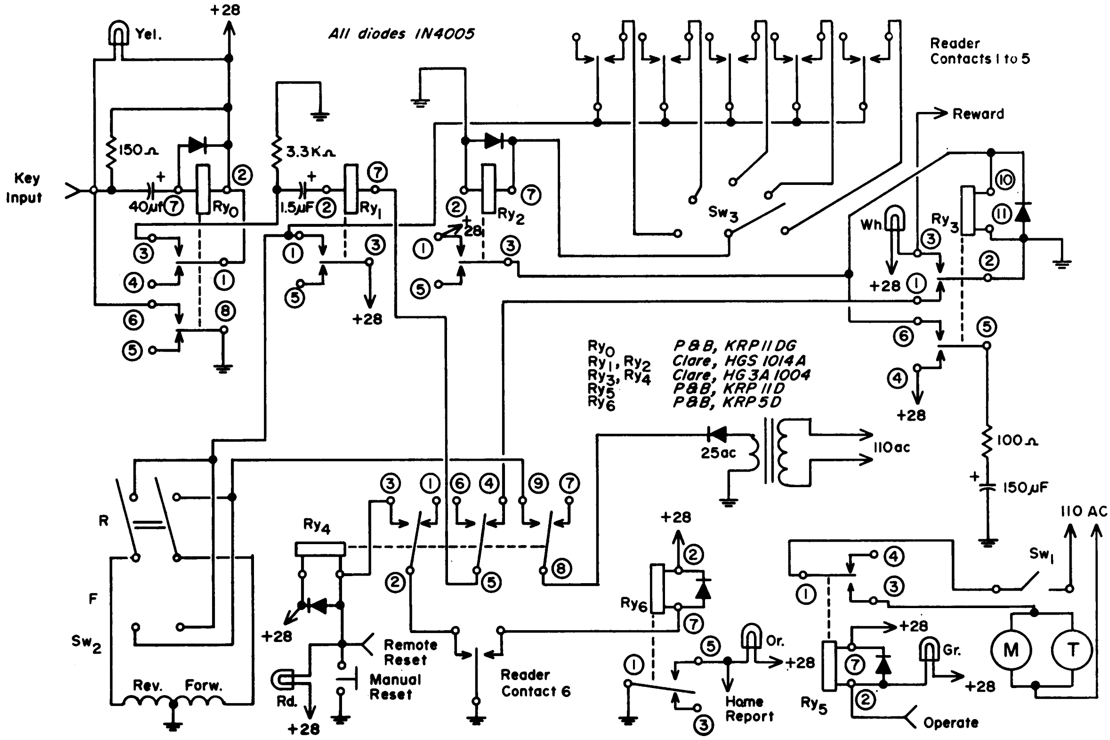

Fig. 1. Schematic diagram of the control panel.

isolated from the ac power line by transformer T_1. The tape homes at a speed of 60 holes per sec, until reader contact #6 detects a hole. Relay Ry_6 energizes and ground appears at the home report output. If a hole has been punched in channel 6 both at the beginning and end of the tape, the tape can be operated and homed in either direction.

Signal lights of different colors have been connected parallel to the input and outputs as a visual aid to the experimenter.

The absence of tubes or transistors makes this unit absolutely insensitive to radiated relay noise. The device is entirely compatible with existing 24-v relay equipment used extensively in behavioral research laboratories, and, with an appropriate interface unit, should be compatible with most solid-state systems now in use.

Two identical devices have been in continuous use since June 1963 (Hodos, 1965; Hodos and Trumbule, 1967). The only maintenance required is the lubrication of the tape-drive mechanism every 300 hr. A running time meter, T, parallel to the motor, indicates when this preventive maintenance is due. The unit performed satisfactorily during this period except for the replacement of the mercury relay which had exceeded its rated number of operations.

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