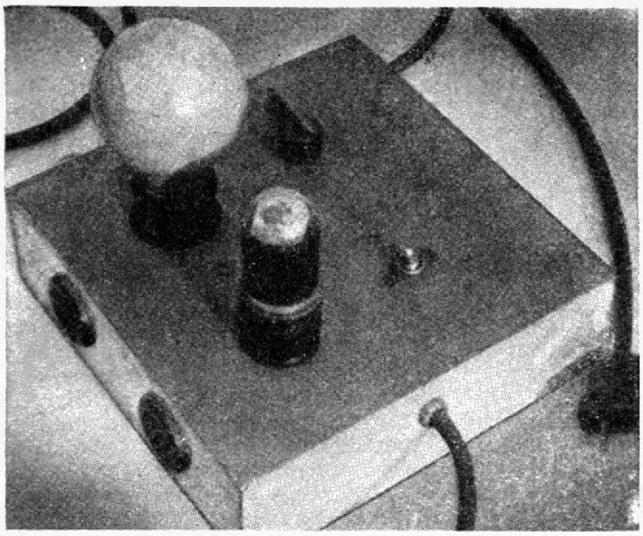
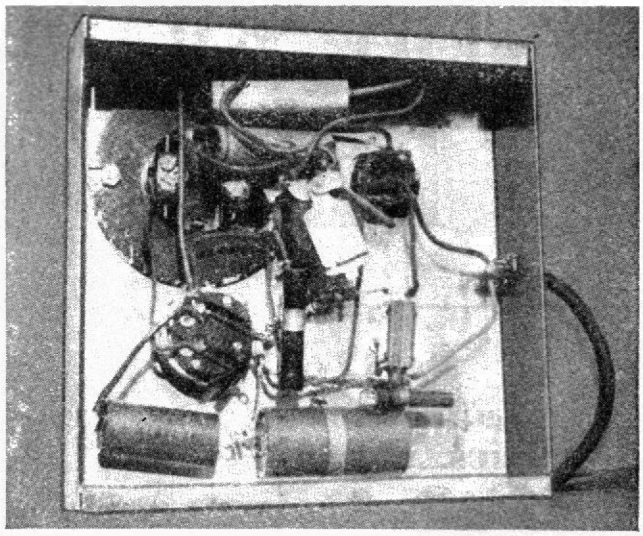


A 40-watt electric-light bulb is used for R_1. For better engineering practice, use a standard line-dropping resistor.



Bottom view of the one-tube electronic timer. A more compact unit may be obtained by employing a smaller chassis.

ELECTRONIC TIMERS

By SAMUEL A. PROCTOR

The design and construction of several electronic timers that provide time intervals from .1 second to several minutes.

THIS device was conceived to meet the need of any operation requiring some simple, inexpensive, and reasonably accurate control of time intervals from .1 of a second to several minutes.

The controlling factors are so arranged that changes in applied voltage have opposing effects on the time interval which contributes to the high degree of accuracy, making it suitable for all operations similar to the timing of photographic prints.

Operation

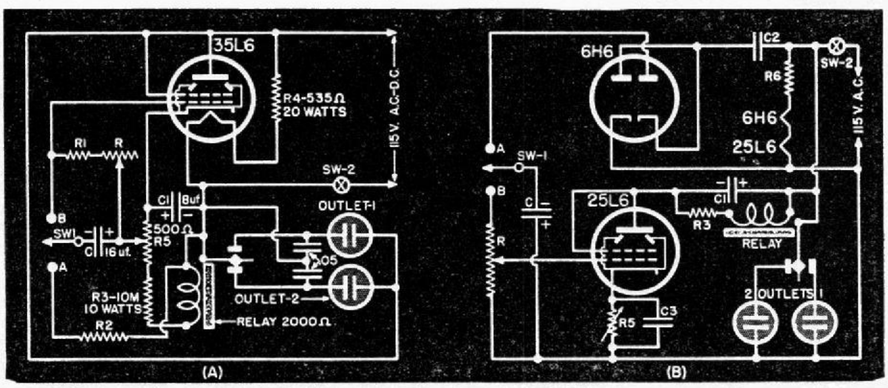
Closing Sw_2 turns the instrument on (Fig. 1A). Normal position for Sw_1 is at *A*, and when in this position, condenser *C* is charged by the rectified *IR* drop across the circuit composed of R_5, R_3, and relay; current in this circuit energizes the relay, holding it closed and applying power to outlet-2. In this position, voltage on the control grid of the tube is low and its conductance is high.

Throwing Sw_1 to position *B*, places condenser *C* in another circuit composed of *C*, R_1, and *R*. This is a closed *RC* circuit and the condenser *C* begins to dissipate its charge through the associated resistors in the circuit. The *IR* drop thus developed is applied to the grid of the tube.

This voltage is negative with respect to tube's cathode and considerably higher than cutoff. In this condition the tube passes no current and the relay releases its armature, which is the arm of a s.p.d.t. switch, energizing outlet-1. The relay remains in this position as long as the negative voltage on the grid is high enough to keep tube current below the required amount to close the relay. As a result of the condenser discharging through the resistor network, the grid voltage drops low enough to allow the tube to pass sufficient current to energize the relay, breaking circuit to outlet-1 and making circuit to outlet-2. The length of time the tube is in a nonconducting condition is determined by the capacity of the condenser *C*, the resistance in the *CR* circuit, the quantity of charge in the condenser, and the characteristics of the tube. Only one of these factors is a variable, resistance *R*, a variable resistance of high ohmic value and the higher we make it the longer it will take *C* to

(*Continued on page* 66)

Fig. 1. Diagram of 1- and 2-tube electronic timers. 25L6, 35L6, or 50L6 tubes are all interchangeable in these circuits, providing the filament dropping resistor is changed.



C—16 μfd. low-leakage type 150-v. elec. or paper cond.
C_1—8 μfd. @ 150-v. elec. cond.
C_2—16 μfd. @ 150-v. elec. cond.
C_3—25 μfd. @ 25-v. elec. cond.
R—500,000-ohm pot.
R_1, R_2—10,000-ohm, ¼-w. res.
R_3—10,000-ohm, 10-w. res.
R_4—535-ohm, 20-w. res.
R_5—500-ohm, screwdriver adjustable pot.
R_6—280-ohm, 30-w. res.
SW_1—S.p.d.t. toggle sw.
SW_2—S.p.s.t. toggle sw. or mounted on pot. R.
Relay—S.p.d.t. sw., 2000-ohm, 10-ma. max.

Electronic Timers

(*Continued from page 53*)

discharge to the point where the tube's conductance will allow sufficient current to flow to activate the relay. This feature provides stepless control over the length of time outlet-1 will be energized.

Accuracy of the instrument will be dependent, somewhat, on line voltage, but the nature of the circuit makes it self-compensating over a reasonable variation in line voltages, since the time interval is a function of both an *RC* circuit wherein

$$T = RC \log E \frac{1}{1 - \frac{E}{e}}$$

where $E =$ initial voltage and $e =$ voltage after the time interval T. Then to keep T constant for a given value of C and R, e must increase or decrease with E. The other controlling factor is the conductance of the tube which varies inversely with E; then to keep T constant, conductance must increase as E decreases, and since conductance of a vacuum tube is a function of grid voltage, which in turn is determined by Q, *i.e.* ($e = Q/C$), this factor works out of phase with the *CR* circuit in its effect on the time interval. An increase of T in one factor is offset by a decrease of T in the other.

For purposes of calibration, compensation for changes in components, and wide variations in line voltages, R_5 is in the circuit. It functions to control the point at which the tube conductance will allow sufficient current to flow to activate the relay, and when adjusted to maximum time interval of any particular instrument, all other time intervals will be as accurate as the original calibration.

The associated schematic gives all parts and their functions. Part values will be determined by requirements that any particular instrument is built to fulfill. If values shown in this schematic are used, the time interval can be anything between .1 of a second and 35 seconds. —30—