ELECTRON TUBES

RCA Application Note

AN - 131
March 1, 1948

Electronic Timers Employing Thyratrons 2D21 or 2050

Timing circuits employing the RCA-2D21 or the RCA-2050 are particularly suitable for controlling small time intervals. Because these tubes are thyratrons of the tetrode type designed to operate with low grid current, they permit the use of high values of resistance in the grid circuit to control the duration of timing intervals over a relatively wide range. They also have a high control ratio and, therefore, a small and relatively linear portion of the exponential charge or discharge curve of the capacitor in the grid circuit can be used to give accurate and consistent timing control. As is common to all gas tubes, these tubes provide a sudden transition from non-conduction to full conduction which facilitates accurate control of both the start and the end of timing intervals. Thyratrons also have the ability to control substantial amounts of power and, therefore, can be used to energize directly relatively large relays.

This Note describes three representative electronic timing control circuits which can utilize either the 2D21 or the 2050. These circuits for small time intervals have an accuracy in the order of one per cent obtainable with standard components. If voltage-regulated power supplies are used, even greater precision is obtainable.

On-Off Interval Timer

An electronic timer for intervals adjustable from 0.3 to 30 seconds is given in Fig.1. This timer is useful in applications in which a definite time interval is required for the performance of a specific operation such as, for example, turning the light source of a photographic enlarger on and off.

In this circuit, the timing interval is controlled by the voltage obtained from the resistance-capacitance network in the grid circuit of the thyratron. When switch S_2 is actuated, the ac input circuit is completed and the timing operation begins. This switch applies ac voltage

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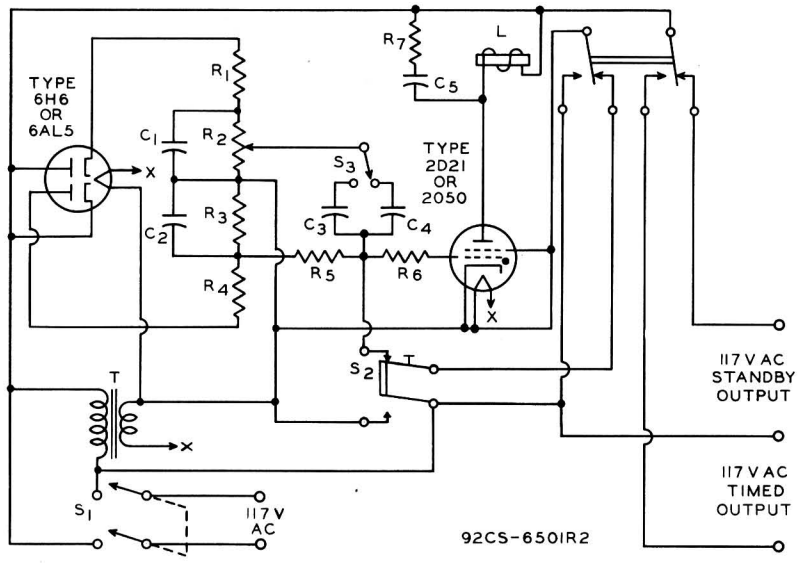


R1: 500 ohms, 0.5 watt
R2: Timing control, potentiometer, 15000 ohms
R3 R4: 15000 ohms, 1.0 watt
R5 R6: 5 megohms, 0.5 watt
R7: 1000 ohms, 2 watts
C1 C2 C5: 4 μf, electrolytic, 300 volts
C3: 4 μf, paper, 300 volts
C4: 0.4 μf, paper 300 volts
T: Filament transformer 6.3v @ 1.0a
S1: Switch, double-pole, single-throw
S2: Push-button actuating switch, non-locking, double-pole, single-throw
S3: Switch, single-pole, double-throw
L: Relay, 115v dc coil, 3000 ohms

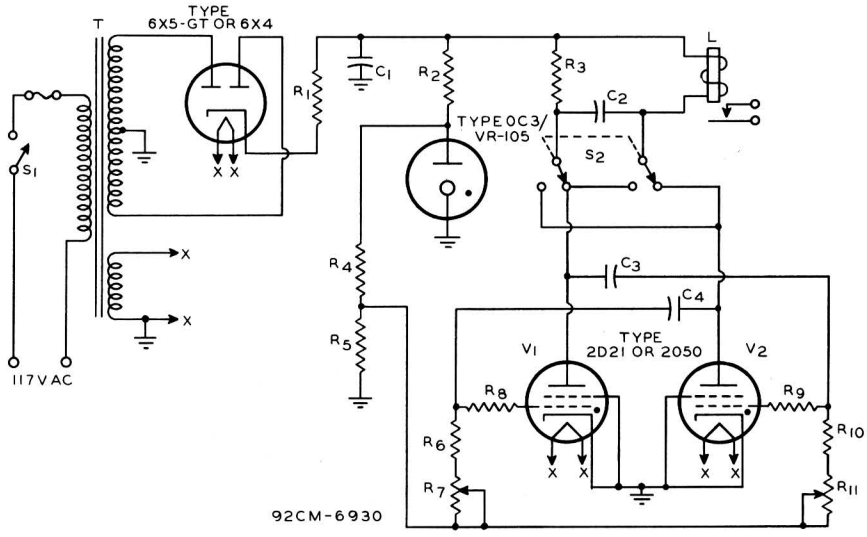
Fig. 1 - On-Off Interval Timer

to the plates of the twin diode and the thyratron, and energizes the relay L. One set of relay contacts completes the output circuit so that power is supplied to one pair of the output terminals. The other set of contacts completes the ac input circuit so that it is not broken when the actuating switch S_2 is released. The 6H6 operates as a voltage doubler. The grid voltage for the 2D21 (or 2050) is taken from the rectified output at R_2. Initially, the voltage on the grid is positive with respect to the cathode, but as C_3 or C_4 charges, the grid voltage becomes increasingly negative until it drops below the critical grid-voltage value. The thyratron then cuts off when the anode voltage is passing through a negative half cycle and stays cut off as long as the grid voltage is negative.

Because the charging time of C_3 is fixed, largely by the value of R_5, the timing interval is determined by the voltage obtained from the potentiometer R_2, the timing interval control. An interval ranging from 0.3 to 3 seconds is obtainable with C_3 (0.4 μμf) and an interval ranging from 3 to 30 seconds is obtainable with C_4 (4 μμf). The capacitors whould be high-quality paper or oil-filled. The circuit constants are chosen so that the portion of the charging curve used is essentially linear. As soon as the operation cycle is complete, the grid capacitor is discharged through the relay contacts and the timer is ready for the next operation.

Repeating Sequence On-Off Interval Timer

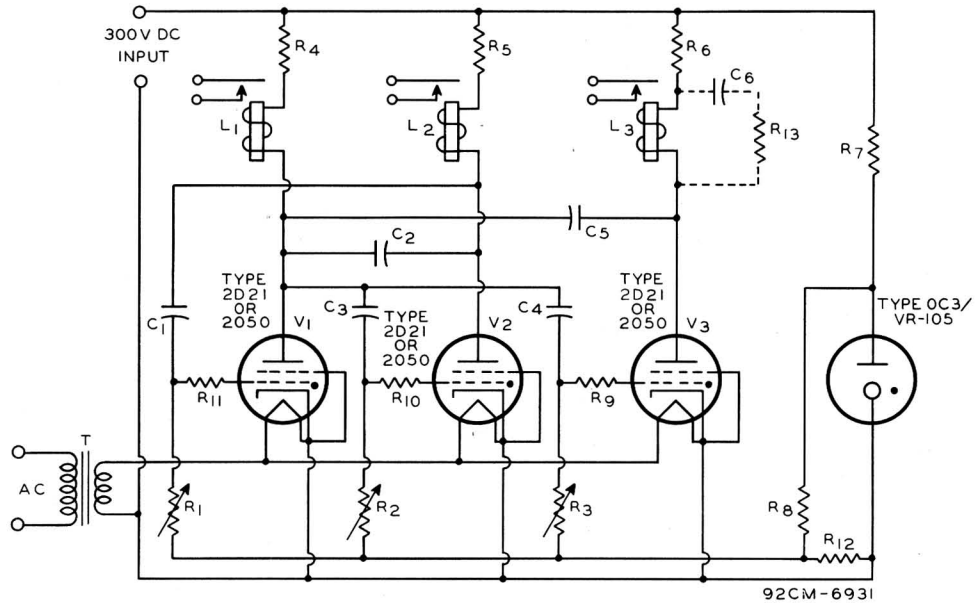
An electronic timer which automatically repeats a sequence consisting of a definite "on" interval followed by a definite "off" interval is given in Fig.2. In this circuit, the timing intervals are controlled by the resistances in the grid circuit of each thyratron. The thyratrons are used in a circuit resembling that of a free-running multivibrator with positive grid return except that the anodes are connected through a commutation capacitor C_2 so that when one tube starts to conduct, both the anode voltage and the grid voltage of the other tube will be reduced below the values required for conduction. The commutation capacitor is required because the anode voltage of the thyratron operating with a dc supply must be considerably reduced before the grid can take control. Capacitor C_2 charges or discharges rapidly and the anode voltage of the non-conducting tube is quickly restored but after the grid takes control. The resistance-capacitance network in the grid circuit, determines the rate at which the grid voltage goes positive and, therefore, determines the tube firing time. Tubes V_1 and V_2 may be adjusted by means of resistors R_1 and R_2 for conducting intervals ranging from 0.3 to 40 seconds. Switch S_2 shifts the relay from the anode circuit of one tube to the anode circuit of the other and thus provides a simple method of quickly interchanging the "on" and "off" intervals.



R1: 2500 ohms, 10 watts
R2: 1000 ohms, 1.0 watt
R3: 3000 ohms, 10 watts
R4: 51000 ohms, 0.5 watt
R5: 30000 ohms, 0.5 watt
R6: 860000 ohms, 0.5 watt
R7: Timing control, potentiometer, 7.5 megohms
R8: 1 megohm, 0.5 watt
R9 R10: 100000 ohms, 0.5 watt
R11: Timing control, potentiometer, 1 megohm

C1: 40 μf, electrolytic, 450v
C2 C3 C4: 4 μf, paper 400v
T: Power transformer 300-0-300 volts RMS, 70 ma., 6.3v @ 2.0a
S1: Switch, single-pole, single-throw
S2: Switch, double-pole, double-throw
L: Relay, 115v dc coil, 3000 ohms

Fig. 2 - Repeating Sequence On-Off Interval Timer

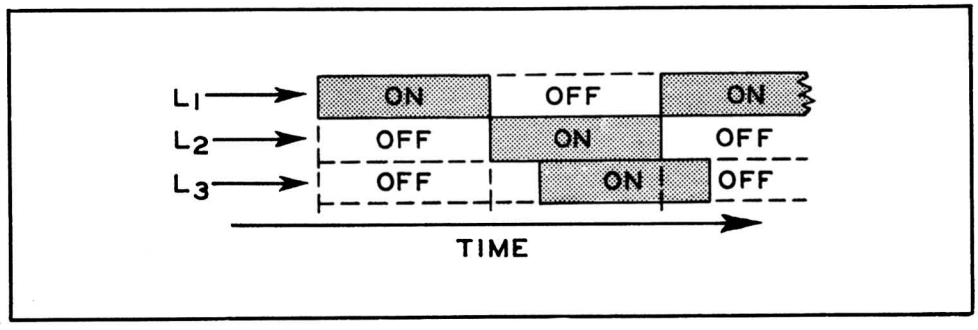


R1 R2 R3: Timing control, potentiometer, 5 megohms
R4 R5 R6: 5000 ohms, 10 watts
R7: 7500 ohms, 10 watts
R8: 5000 ohms, 0.5 watt
R9 R10 R11: 100000 ohms, 0.5 watt
R12: 300000 ohms, 0.5 watt
R13: 1000 ohms, 2 watts
C1 C2 C3 C4 C5: 4 μf, paper, 400 volts
C6: 8 μf, electrolytic, 150 volts
T: Filament transformer, 6.3v @ 2.0a
L1 L2 L3: Relay, 115v dc coil 3000 ohms

Fig.3 - Repeating Sequence 3-Step Interval Timer

Repeating Sequence 3-Step Interval Timer

An electronic timer which energizes and de-energizes three relays in sequence is given in Fig.3. This circuit is similar to the preceding one but it has an additional thyratron V_3 which is connected so that its conduction interval follows that of V_2. The conduction interval of V_1 is terminated when either V_2 or V_3 starts to conduct. The start of conduction for V_2 is controlled by R_2; the start of conduction for V_3 is controlled by R_3. The conduction interval of V_2 and V_3 is terminated when V_1 starts to conduct. If it is desirable to have L_3 de-energize slightly later than L_2, a filter (C_6; R_{13}) connected as in Fig.3 will delay its drop-out. A diagram illustrating the on and off sequence of each relay is given below.



The circuits described above are typical timing control circuits and serve to illustrate principles which may be readily applied to other timing devices.

ELECTRON TUBES

RCA Application Note

July 15, 1948

ERRATUM NOTICE

for

Application Note AN-131 "Electronic Timers Employing Thyratrons 2D21 or 2050".

Page 3, paragraph 1, line 17. Timing control potentiometers R_7 and R_{11} are incorrectly identified as R_1 and R_2. Please change R_1 to R_7 and R_2 to R_{11}.

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