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Berkeley, California

Contract No. W-7405-eng-48

# A HIGHLY STABLE TIME-DELAY CIRCUIT

Warren C. Struven

April 5, 1955

Printed for the U. S. Atomic Energy Commission

# A HIGHLY STABLE TIME-DELAY CIRCUIT

Warren C. Struven

Radiation Laboratory, Department of Physics
University of California, Berkeley, California

April 5, 1955

A precision time-delay circuit has recently been developed in connection with the Bevatron magnet-timing equipment. The operating conditions required a circuit with a stability of at least 1 part in 1,000 over a delay range of 150 milliseconds to 2.5 seconds. This circuit has a lower limit of 3 milliseconds and an indefinite upper limit (restricted only by the maximum value of timing capacitor used). The circuit also provides relay contacts for external use if desired.

The circuit used is a modified form of Schmitt trigger where the hysteresis (usually associated with the Schmitt) is determined mainly by the operation time of the relay. The hysteresis of the usual Schmitt trigger is determined mainly by the value of cathode resistance. The cathode resistance is determined by input tube gain, the transconductances, plate resistances, and the plate load resistances.[1]

In the rest state, "C" (see Fig. 1) is charged to -E (relay position No. 1). When a positive gate is applied to the pentode grid, the pentode is caused to conduct, energizing the relay and moving the swinger to relay position No. 2. The triode is immediately cut off, and remains cut off until the grid voltage just passes the cutoff voltage, at which time positive feedback cuts off the pentode and restores the circuit to its rest position. The capacitor charges toward +E. In the operation, it is noticed that the end of the timing cycle occurs when the capacitor voltage is just slightly more positive than the cathode. Note that both +E and -E are of equal value. Therefore, if +E and -E vary, the timing accuracy is not materially affected.[2] This voltage is most easily obtained by grounding the center top of a regulated supply. The Bevatron magnet pulse timing equipment uses two such circuits; one has a variable range of 0.15 sec to 2.5 sec (time of rectification cycle), and a 2.5-sec lockout circuit to insure that a particular repetition rate is not exceeded. Both circuits have operated for 1-1/2 years with a long-term stability of better than 1 part in 1,000. The jitter (from cycle to cycle) is less than 1 part

1. O. Schmitt, A Thermionic Trigger, J. Sci. Instr. 15 No. 1, p. 24, Jan. 1938.
2. S. Wald, Precision Interval Timer, Electronics 21 p. 88, Dec. 1948.

in 2,000.

This work was performed under the auspices of the U. S. Atomic Energy Commission.

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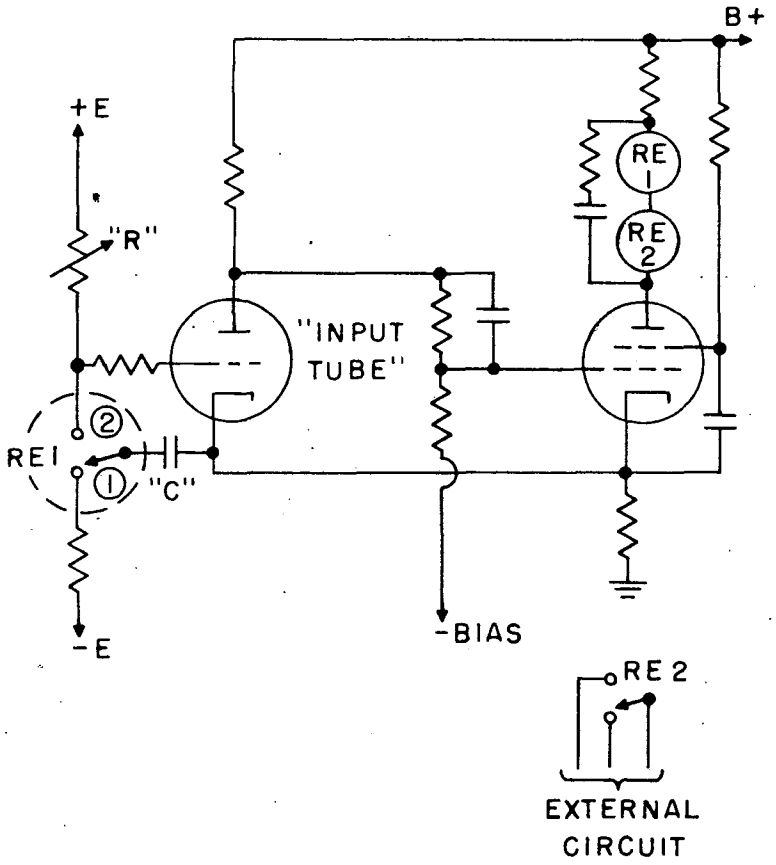


Fig. 1. Time-Delay Circuit

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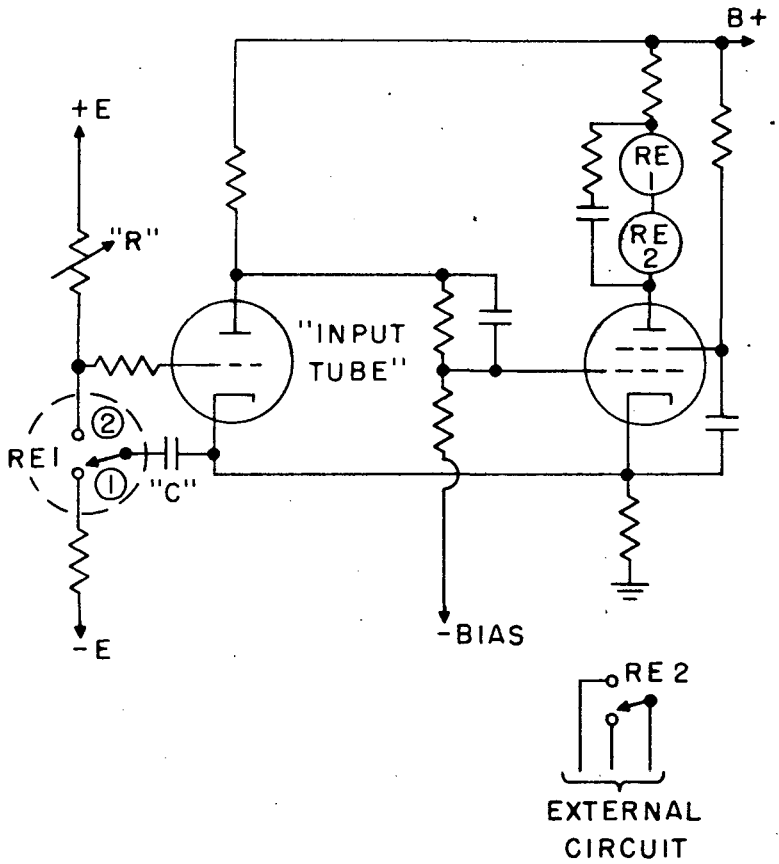


Fig. 1. Time-Delay Circuit



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