Dec. 2, 1958 F. E. CHURCHILL ET AL 2,863,101

RELAY TRIGGER CIRCUIT

Filed Aug. 9, 1957

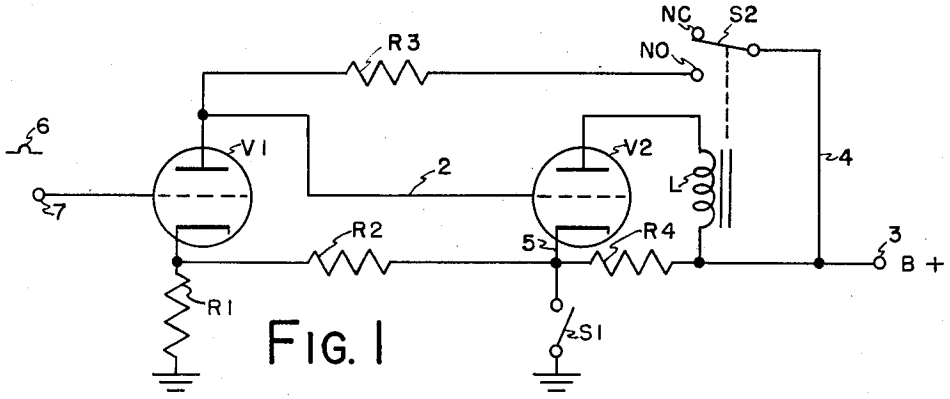


FIG. 1

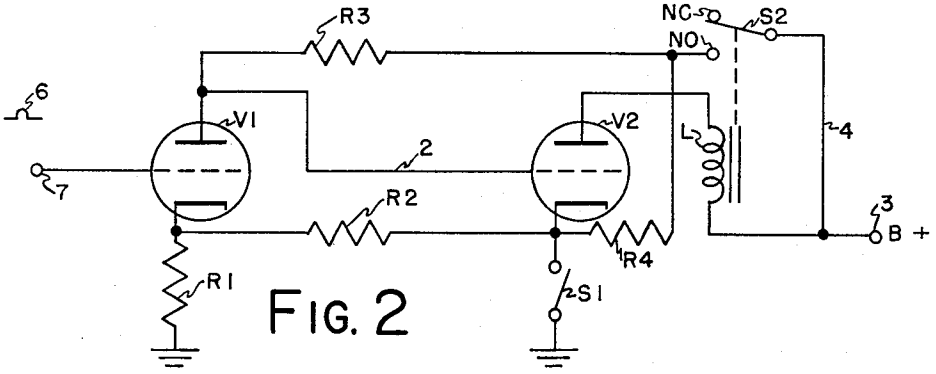


FIG. 2

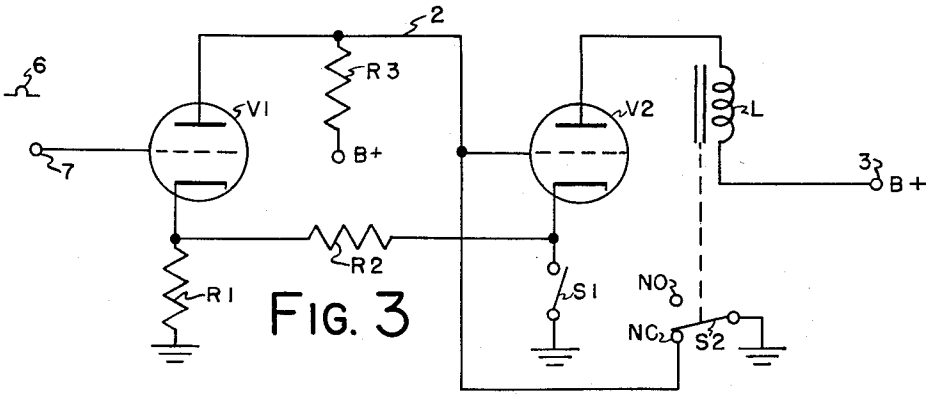


FIG. 3

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United States Patent Office 2,863,101 Patented Dec. 2, 1958

2,863,101

RELAY TRIGGER CIRCUIT

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Application August 9, 1957, Serial No. 677,310

7 Claims. (Cl. 317—149)

This invention relates to circuits for triggering the release of a relay actuated armature.

Circuits employing thyratrons have been used for the purpose of triggering the energization of a relay but are not capable of responding to a triggering impulse to deenergize a relay. Furthermore, even if used for the energizing function in response to a triggering impulse, the initiation of conduction in the thyratron would damp and distort the triggering impulse. The thyratron would not respond to A. C. of radio frequency.

It is an object of this invention to provide a relay trigger circuit which will, in response to a D. C. or A. C. triggering impulse effect a very rapid release of the relay armature, which does not damp the triggering impulse, which is economical of tubes and components, which does not require compensation for variations in tube characteristics, and which reliably provides sufficient current at all times for energizing the relay.

These and other objects and advantages of the invention are realized by two cascaded tubes with direct plate to grid coupling, with the cathodes connected by way of a resistor and with the relay coil in the plate circuit of the second tube. The cathode of the second tube is provided with a direct connection to ground interrupted by a switch.

In the drawings:

Fig. 1 is a schematic diagram of a circuit embodying the invention;

Fig. 2 is a schematic diagram of a modification of the circuit of Fig. 1; and,

Fig. 3 is a schematic diagram of a circuit embodying the invention in a somewhat different form.

Referring more particularly to the drawings, there is shown in Fig. 1 a circuit comprising a pair of triodes V1 and V2. The plate of V1 is directly connected to the grid of V2 by a conductor 2. The cathode V1 is connected to ground by way of a resistor R1 and to the cathode of V2 through a resistor R2.

The cathode of V2 is connected directly to ground by a conductor 5 which is interrupted by a single pole single throw switch S1. The plate of V2 is connected to one terminal of a relay coil L, the other terminal of which is connected to a positive terminal 3 of a source of plate supply voltage indicated as B+. This terminal is also connected to the cathode of V2 by way of a resistor R4. The relay coil actuates a switch S2 having a normally closed contact NC and a normally open contact NO.

In the operation of the circuit of Fig. 1, the relay is unenergized when the switch S1 is open. A momentary closing of S1 energizes the relay by grounding the cathode of V2. Energization of the relay causes B+ voltage to be applied to the plate of V1.

Upon the release of S1, V2 continues to conduct with its grid drawing current with the result that the grid-cathode voltage of this tube settles at approximately zero volts. V1 is approximately cut off by bleeder current from terminal 3 and tube current from V2 through R1.

When a positive trigger voltage, as indicated by the waveform 6, is applied at terminal 7 to the grid of V1, this tube begins to conduct. The triggering impulse may be either D. C. or A. C. The grid of V2 becomes less positive and the tube current of V2 is reduced. This causes a decrease of the cathode bias of V1 which further increases the conduction of this tube.

As the positive voltage on the grid of V1 increases, a point will be reached where the loop gain of the feedback loop through the cathode of V1 becomes greater than one. This point is determined by the proportionate values of R1 and R2. At this point the circuit action becomes regenerative and V2 is driven approximately to cut-off, thereby deenergizing the relay coil. This removes the B+ voltage from V1 and the relay remains deenergized. The purpose of resistor R4 is to provide additional voltage difference between the grid and cathode of V2 so that, when the circuit is triggered, there is a sufficient grid-cathode voltage change at V2 to cause the relay to open quickly.

The circuit of Fig. 2 is the same as that of Fig. 1, with the exception that the resistor R4 is connected to the normally open relay contact NO. This change eliminates the bleeder current through R1 and R2 and R4 when the relay is deenergized. R1 and R2 are of such magnitude as to make the relay current very low under these conditions.

In the form of the invention shown in Fig. 3 the switch arm of switch S2 is connected to ground and the NC contact is connected to the grid of V2.

In the operation of the circuit of Fig. 3, V2 is normally almost cut off by self-bias and the relay is deenergized. A momentary closing of S1 energizes the relay, removing the ground from the grid of V2. This grid will now draw current to hold the grid-cathode voltage of V2 at approximately zero. V2 continues to conduct and the relay remains in the energized state.

As the voltage at the grid of V1 is made less negative by the trigger pulse, V1 begins to conduct and the grid current of V2 decreases. At the point where grid current ceases, the operation of V1 changes to that of an amplifier with a load R3. By proper choice of resistors R1 and R2, the loop gain may be made greater than one at the point where V1 begins to operate as an amplifier, due to the positive current feedback provided by $i2$ R1, where $i2$ is the current through V2, and any further positive change of the applied voltage will cause the circuit to trigger, cutting off V2 and deenergizing the relay.

What is claimed is:

1. A circuit for triggering the deenergization of a relay coil comprising: a pair of electron tubes each having a plate, a cathode and a control grid, means coupling the plate of a first of said tubes to the control grid of the second, a source of supply voltage, means connecting said coil in series with the plate of said second tube and the positive terminal of said source, a resistor connecting the cathodes of said tubes, a resistor connecting the cathode of said first tube to the negative terminal of said source, means including a resistor connecting the plate of said first tube to the positive terminal of said source, means connecting the cathode of said second tube to the negative terminal of said source, and means applying a positive-going pulse of voltage to the control grid of said first tube, the values of said resistors being so related that said pulse causes the conduction of said second tube to be terminated and said coil to be deenergized.

2. A circuit as claimed in claim 1, said means connecting said plate of said first tube to the positive terminal of said source including a switch driven by said relay and closed only when said relay is energized.

3. A circuit as claimed in claim 1, said circuit including means connecting the grid of said second tube to the negative terminal of said source, said means including a switch driven by said relay, said switch being closed when

said relay is deenergized and open when said relay is energized.

4. A circuit as claimed in claim 1, said circuit including means connecting the grid of said second tube to the negative terminal of said source, said means including a switch driven by said relay, said switch being closed when said relay is deenergized and open when said relay is energized, and manually operable means for interrupting the connection of the cathode of said second tube to said source.

5. A circuit for triggering the deenergization of a relay coil comprising: a pair of electron tubes, each having a plate, a cathode and a control grid, means coupling the plate of a first of said tubes to the control grid of the second, a source of supply voltage, load impedance means connecting the plate of each of said tubes to the positive terminal of said source, said load impedance means for said second tube comprising said relay coil, a resistor connecting the cathode of said first tube to the negative terminal of said source, means directly connecting the cathode of said second tube to the negative terminal of said source, means directly connecting the cathode of said second tube to the negative terminal of said source, and a resistor coupling the cathodes of said tubes thereby establishing a feedback loop including said first tube, the values of said resistors being so selected that in the absence of a signal on the control grid of said first tube, said first tube conducts with substantially zero gain and said second tube conducts drawing grid current, and upon the application of an increasingly positive voltage to the control grid of said first tube, said grid current diminishes, said grid current ceasing simultaneously with the rise of the gain of said feedback loop to unity.

6. A circuit for triggering the deenergization of a relay coil, comprising: a source of plate supply voltage, a pair of electron tubes each having a plate, a cathode and a control grid, means coupling the plate of a first of said tubes to the control grid of the second, means operable momentarily to complete a series circuit including

the space current path of said second tube, said relay coil and said source, thereby energizing said relay coil, resistive means coupling the cathodes of said tubes, a pair of resistors, the resistors of said pair being connected respectively to the cathode and the anode of said first tube, means actuated by the energization of said relay coil to complete a series circuit including said pair of resistors, the space current path of said first tube and said source, and means applying an impulse of triggering voltage to said control grid of said first tube, the values of said resistors being so related that said impulse causes the conduction of said second tube to be terminated and said coil to be deenergized.

7. A circuit for triggering the deenergization of a relay coil, comprising: a source of plate supply voltage, a pair of electron tubes each having a plate, a cathode and a control grid, means coupling the plate of a first of said tubes to the control grid of the second, means operable momentarily to complete a series circuit including the space current path of said second tube, said relay coil and said source, thereby energizing said relay coil, resistive means coupling the cathodes of said tubes, means forming a pair of parallel circuit branches, one including the space current path of said first tube and the other including the portion of the space current path of said second tube between the control grid and cathode thereof, means actuated by the energization of said relay coil to apply the voltage of said source across both said parallel branches, and means applying an impulse of triggering voltage to said control grid of said first tube, the resistances of said branches being so related that said impulse causes the conduction of said second tube to be terminated and said coil to be deenergized.

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