May 22, 1951 W. A. MILLER 2,554,308

TRIGGER CONTROLLED OSCILLATOR

Filed Aug. 6, 1946

Fig. 1

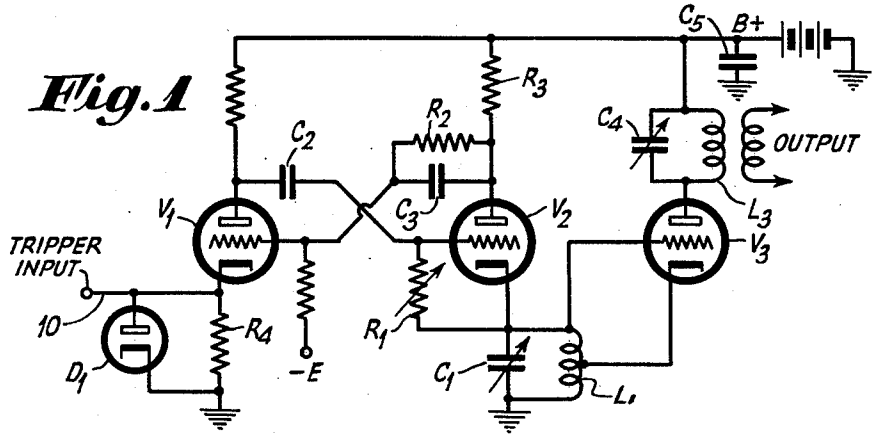


Fig. 2

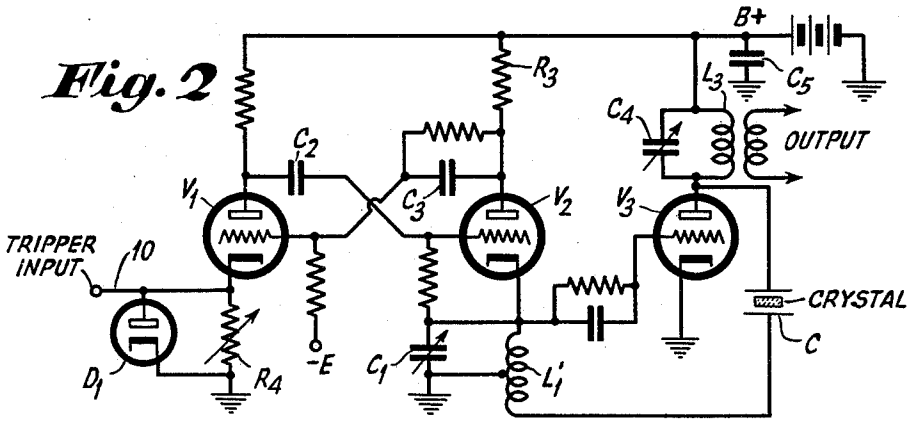
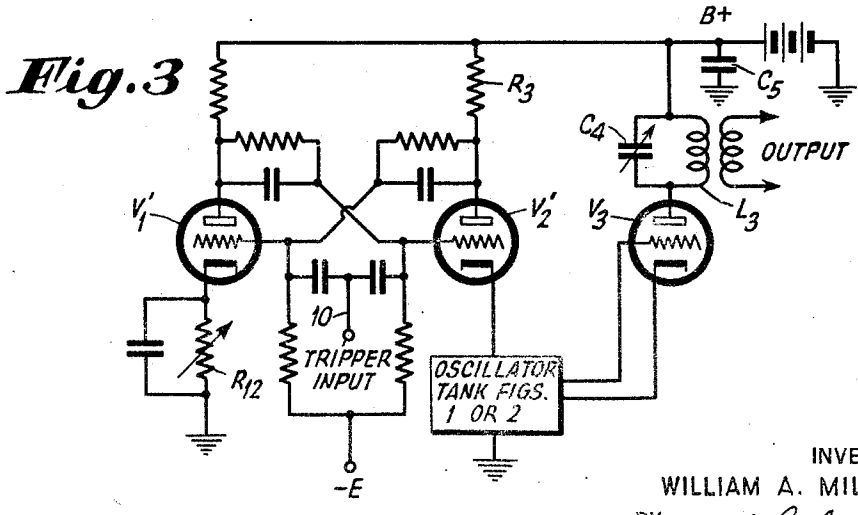


Fig. 3



INVENTOR
WILLIAM A. MILLER
BY H. S. Brown
ATTORNEY

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TRIGGER CONTROLLED OSCILLATOR

William A. Miller, Port Jefferson, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

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9 Claims. (Cl. 250—36)

1

This invention relates to improvements in trigger-controlled oscillators and has for one of its objects, to provide a trigger-controlled oscillator in which the time delay or phase between the triggering or initiating pulse and the start of oscillations in the output of the oscillator remains constant regardless of the random character of the triggering pulse.

Trigger-controlled oscillators of the invention have numerous uses in systems wherein it is desirable to provide a source of standard frequency which is controllable and which may be started and stopped easily; for example, in time-lapse measuring instruments (interval timers) and in frequency-shift keying systems. One application of the present invention is in a frequency-keying system such as is described in my copending application, Serial #591,730 filed May 3, 1945, now U. S. Patent 2,491,387 granted December 13, 1949.

A more detailed description follows in conjunction with a drawing wherein Figs. 1, 2 and 3 illustrate three different embodiments of the present invention.

Throughout the figures of the drawing, the same parts are represented by the same reference numerals.

Referring to Fig. 1, there is shown a trigger circuit comprising a pair of vacuum tube electrode structures V1 and V2 shown in separate envelopes, although it should be understood that if desired, both electrode structures may be located in the same evacuated envelope. The two tubes V1 and V2 are unsymmetrically biased. The grid and anode electrodes of both tubes V1 are connected regeneratively: The anode of tube V1 is connected to the grid of tube V2 through a condenser C2 while the anode of tube V2 is connected to the grid of tube V1 through a resistor-shunt condenser arrangement R2, C3. Tube V1 is normally non-conducting in the absence of an initiating pulse applied to its cathode, while tube V2 is normally conducting. Tube V1 is normally biased to cut-off by means of source—E. This condition of operation wherein tube V1 is normally non-conducting and tube V2 normally conducting is called the stable state. In the active or non-stable state which begins when a tripping negative pulse of sufficient magnitude is applied to lead 10, the current passing conditions of tubes V1 and V2 are reversed from that just described. After an interval of time in this active state, depending in part upon the time constants of the condenser C2 and resistor R1, the trigger will restore itself to the stable state.

2

It will be seen that the trigger circuit has only one degree of electrical stability. It should be noted that the cathode of the tube V1 has in circuit therewith, a resistor R4 which is shunted by a diode D1. This resistor may be of relatively high value. The diode D1 is an open circuit for the negative initiating pulse to be applied to lead 10. The use of the diode and resistor R4 in the location shown, enables the quick dissipation of the negative input pulse which initiates the active period of the trigger circuit, and thus obviates any effect the duration of the input pulse might have had on the trigger circuit during its active state. The condenser C3 which is of relatively small size is used across resistor R2 in order to hasten the change over from one conductive state to the other.

Coupled to the trigger circuit is a Hartley type of oscillator comprising a vacuum tube V3 having a main tank circuit L1, C1. The tank or tuned circuit L1, C1 is connected between the cathode of tube V2 of the trigger circuit and ground. Different points on the inductance coil L1 are connected to the grid and cathode of tube V3. Connected between the anode of tube V3 and the positive terminal B+ of a source of anode polarizing potential, is an output tuned circuit L3, C4. A bypass condenser C5 is provided between ground and terminal B+ for providing a low A. C. impedance to ground, thus preventing interaction or feedback from one vacuum tube to the other. This tuned circuit L3, C4 is tuned to the frequency of oscillation but has substantially little effect on the frequency of the oscillator. For the lower frequencies, the tuned circuit L3, C4 can be replaced by a resistor while at the higher frequencies of oscillation, this tuned circuit can be replaced by an inductance coil (choke).

During the time the trigger circuit V1, V2 is in the stable state, the tube V1 will be non-conductive and the tube V2 conductive. In this condition, the tuned circuit L1, C1 which is the main tank circuit controlling the frequency of oscillation of the oscillator tube V3, is effectively shunted to ground by a low resistance composed primarily of the D. C. resistance of tube V2 in series with the anode resistor R3. In this condition wherein tube V2 is conductive and shunts the tank circuit L1, C1, the generation of oscillations is prevented in the oscillator V3. As soon as a negative tripping pulse is impressed on lead 10 of such magnitude as to cause tube V1 to conduct and V2 to cease conducting (that is, change the trigger circuit from the stable state

to the active state), then cessation of current through tube V2 removes the low resistance shunted across the main tank circuit L1, C1 and enables the oscillator V3 to generate oscillations. This oscillator will continue to generate oscillations with a period determined by the time constants of L1, C1 (also, to a small extent, by the tuning of tank circuit L3, C4) until such time as the trigger circuit returns to its normal or stable state.

I have thus been able to provide an output sine wave whose phase is held constant with respect to the initiating or tripping pulse applied to the trigger circuit, regardless of the random character of the triggering or initiating pulses.

Fig. 2 is a modification of the system of Fig. 1 wherein a crystal C is used to control the frequency of oscillations of the oscillation generator, thus enabling the oscillator to produce pulses of radio frequency energy in response to triggering input pulses. These radio frequency pulses consist of sections of as accurate a sine wave as the crystal C will permit. The length of the wave train from the oscillator follows the length or width of the trigger output pulses and is under control of the operator or attendant controlling the duration of the trigger output pulses. Fig. 2 operates in substantially the same manner as does Fig. 1 except for the crystal-control feature.

Fig. 3 is a still further modification and shows a trigger circuit V'1 and V'2 which requires a triggering pulse to change the states of conduction of the two tubes V'1 and V'2 and a second pulse to restore the trigger circuit to its original state. Putting it in other words, if tube V'1 is conductive and tube V'2 non-conductive, a tripping input pulse to lead 10 will cause tube V'1 to conduct and tube V'2 to cease conducting by virtue of the regenerative cross connections between the grids and anodes of the two tubes, while a second pulse is required to cause tube V'2 to conduct and V'1 to cease conducting. The trigger circuit V'1 and V'2 thus has two degrees of electrical stability and operates in a manner analogous to a locking circuit. It should be understood, however, that this trigger circuit V'1 and V'2 is not a free running multivibrator.

The sine wave oscillator V3 which may be either of the form shown in Fig. 1 (self-excited) or of the form shown in Fig. 2 (crystal controlled), thus has its times of initiation and termination (start and stop) externally controlled.

The bias on tube V'1 is provided by the resistor R12, and this bias need not be nearly great enough to cause tube V'1 to be cut off due to the bias voltage but need be only great enough to insure that at the time when the potentials are first applied to the equipment, that tube V'1 will tend to draw less current than tube V'2. This condition assures the fact that initially tube V'1 will be non-conducting and tube V'2 conducting at the start of operations.

In the operation of the system of Fig. 3, assuming that at the start tube V'1 is non-conductive and tube V'2 conductive, the application of a triggering pulse of positive polarity to lead 10 will cause tube V'1 to turn on (become conductive) and tube V'2 to turn off (become non-conductive). These tubes will remain in this condition until another positive pulse is applied to the lead 10. When this second positive pulse is applied to lead 10, the grid of tube V'2 will go positive as a result of which the tube of V'2 will turn on (become conductive) and tube V'1 turn off (become non-conductive). The trigger

circuit will then remain in this last condition until another positive triggering pulse reverses the states of conduction of the two triggering tubes. This mode of operation of the trigger circuit V'1 and V'2 will also occur though in a slightly different manner if only negative triggering pulses are applied to lead 10. Assuming that tube V'1 is turned off and tube V'2 turned on, then a negative triggering pulse to lead 10 will turn tube V'2 off and turn tube V'1 on due to the regenerative cross connections. The triggering circuit will remain in this condition until the next negative triggering pulse is applied to lead 10 which will turn tube V'1 off and V'2 on.

The ready position for operation of trigger circuit is tube V'1 turned off and tube V'2 turned on. The bias —E in Fig. 3 drops the potential of the grids of tubes V'1 and V'2 below ground.

When tube V'2 is turned off (non-conductive), the oscillator V3 will start oscillating because of the removal of the low resistance shunt path from the tank circuit L1, C1. When tube V'2 conducts, the oscillator V3 will not oscillate by virtue of the low resistance shunt across the main oscillator tank circuit L1, C1.

What is claimed is:

1. A trigger-controlled oscillator system comprising a pair of vacuum tube electrode structures each having an anode, a cathode and a grid, cross-connections between the anodes and grids of said electrode structures for regeneratively connecting said structures together, whereby the flow of maximum current through one tube is accompanied by the flow of minimum current through the other tube, and vice versa, and an oscillation generator circuit including an electron discharge device having a frequency determining element in the cathode circuit of one of said electrode structures, whereby the flow of current through said one electrode structure provides a shunt path for said frequency determining element, thereby preventing oscillations from being produced in said oscillation generator, said discharge device having an output tuned circuit separate and apart from said frequency determining element, and means for deriving alternating current output energy from said output circuit.

2. A trigger-controlled oscillator system comprising a pair of vacuum tube electrode structures each having an anode, a cathode and a grid, cross-connections between the anodes and grids of said electrode structures for regeneratively connecting said structures together, whereby the flow of maximum current through one tube is accompanied by the flow of minimum current through the other tube, and vice versa, and an oscillation generator circuit having a frequency determining element in the space current path of one of said electrode structures, whereby the state of conduction of said one electrode structure controls the operativeness of said oscillation generator, said oscillation generator circuit including an electron discharge device having a control electrode and an anode, a connection from said control electrode to said frequency determining element, means for deriving alternating current output energy from said anode, and a circuit for applying a pulse of such polarity and magnitude to one of said electrode structures as to reverse the states of conduction of said pair of electrode structures.

3. A trigger-controlled oscillator system comprising a pair of vacuum tube electrode structures each having an anode, a cathode and a grid, cross-

connections between the anodes and grids of said electrode structures for regeneratively connecting said structures together, whereby the flow of maximum current through one tube is accompanied by the flow of minimum current through the other tube, and vice versa, and an oscillation generator having a frequency determining reactance element in the space current path of one of said electrode structures, whereby the state of conduction of said one electrode structure controls the operativeness of said oscillation generator, and a circuit for applying a pulse of such polarity and magnitude to one of said electrode structures as to reverse the states of conduction of said pair of electrode structures, said oscillation generator also having in circuit therewith a tuned circuit separate and apart from said reactance element for developing alternating current output energy.

4. A trigger-controlled oscillator system comprising a pair of vacuum tube electrode structures each having an anode, a cathode and a grid, cross-connections between the anodes and grids of said electrode structures for regeneratively connecting said structures together, whereby the flow of maximum current through one tube is accompanied by the flow of minimum current through the other tube, and vice versa, and an oscillation generator having a pair of parallel tuned circuits one of which is a determining circuit in the space current path of one of said electrode structures and the other of which is an output circuit developing alternating current energy, whereby the state of conduction of said one electrode structure controls the operativeness of said oscillation generator, and a circuit for applying a pulse of such polarity and magnitude to one of said electrode structures as to reverse the states of conduction of said pair of electrode structures.

5. In a signalling system, an electron discharge device having electrodes regeneratively coupled by a circuit which includes a reactance, for the production of oscillatory energy, a pair of electron discharge tubes each having an anode, a cathode and a control electrode, impedances cross-coupling the anodes and control electrodes of said tubes, a source of unidirectional current connected by impedances between the anode and cathode of each tube, the arrangement being such that when current flow is started through one tube the other tube is biased to cut-off and vice versa, leads coupling the impedance between electrodes of one of said tubes in shunt to a portion at least of said reactance of said device, the space path of said device being independent of the cross-coupling circuit of said pair of tubes, and means for applying the control potential to an electrode other than the anode of one of said tubes for reversing the conduction states of said tubes.

6. In combination, a self-restoring trigger circuit comprising a pair of electron discharge devices coupled together regeneratively to have one degree of electrical stability, whereby one device is normally conductive and the other device normally non-conductive in the stable state, and vice versa in the active state of the trigger circuit, an oscillation generator having an electron discharge device whose space path is independent of the regenerative coupling between said first pair of devices, said generator having a frequency controlling reactance element in the space current path of one of said devices, and a lead for supplying control pulses to said trigger circuit of such polarity and magnitude as to trip said trigger circuit from the stable to the active state.

7. In combination, a trigger circuit comprising a pair of electron discharge devices each having an anode, a cathode and a grid, impedances cross-coupling said anodes and grids in regenerative manner, bias connections for said devices whereby when one device is conductive, the other device is non-conductive and vice versa, a resistor across the grid and cathode of one of said devices, a connection for supplying triggering pulses to said trigger circuit, and an oscillation generator having a frequency controlling element in the space current path of said one device, said oscillation generator including an electron discharge device whose space path is independent of the regenerative coupling between said pair of devices.

8. A trigger-controlled oscillator comprising a pair of electron discharge device structures each having an anode, a cathode and a grid, resistors cross-coupling said anodes and grids, a pair of condensers connected between said grids, a lead for supplying triggering pulses to the junction point of said condensers, individual resistors from said grids to a common source of negative biasing potential, whereby one structure is conductive and the other structure non-conductive, and vice versa in response to a triggering pulse, and an oscillation generator having a parallel tuned circuit a portion of which at least is in the space current path of one of said structures, said oscillation generator also having another tuned circuit across which alternating current output energy is developed.

9. The combination with a trigger circuit having a pair of electron discharge device electrode structures regeneratively coupled together so that when one structure is conductive, the other is non-conductive and vice versa, of an oscillation generator having a pair of tank circuits at least a portion of only one of which is in the space current path of one of said structures, whereby the operativeness of said oscillation generator is controlled by the conductivity of said one structure.

WILLIAM A. MILLER.

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