Trigger Circuits

H. J. Reich

University of Illinois, Urbana, Illinois

Amplifiers in which the direct output current or voltage changes abruptly from one stable value to another stable value at a critical value of direct input voltage or current and changes back abruptly to approximately its original value at a different critical input voltage or current are called "trigger" amplifiers. Trigger circuits are of value in the measurement of short time intervals,[1] in high-speed counting,[2] as the basis of relaxation oscillators,[3] and in numerous other applications.

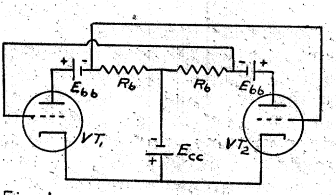

Fig. 1

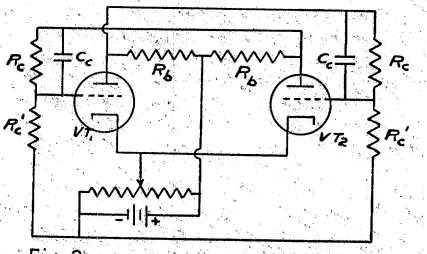

Fig. 2

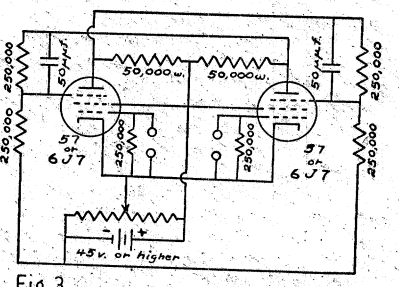

Fig. 3

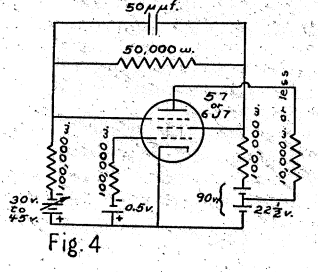

Fig. 4

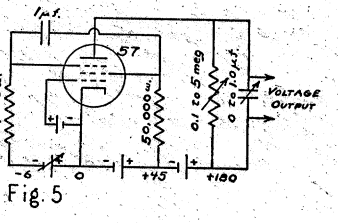

Fig. 5

FIGURE LEGENDS

Fig. 1. Basic form of Eccles-Jordan trigger circuit.
Fig. 2. Practical form of Eccles-Jordan trigger circuit.
Fig. 3. Improved form of Eccles-Jordan circuit using pentodes.
Fig. 4. Trigger circuit using a single pentode.
Fig. 5. Relaxation oscillator for the production of saw-tooth voltages.

The best known type of trigger amplifier using high-vacuum tubes is the Eccles-Jordan circuit,[4] shown in basic form in Fig. 1. This circuit functions by virtue of the fact that only one tube at a time passes plate current. This may be shown by assuming that both tubes carry equal currents. Then any small increase in the current of tube 1 raises the IR drop in its plate resistor, and thus increases the negative grid voltage of tube 2. This in turn reduces the current of tube 2 and hence lowers the negative voltage of the grid of tube 1 and increase its plate current still further. The action is cumulative, the current building up with great rapidity in tube 1 and falling to zero in tube 2. The current can be caused to transfer from tube 1 to tube 2 by applying a negative voltage in series with the grid or plate of tube 1 or a positive voltage in series with the grid or plate of tube 2. The plate current of either tube may be used to operate a relay or other current-controlled device, or the voltage drop in either plate resistor may be applied to the grid of another tube, the plate current of which is used to operate a relay or other device. In practice the circuit is modified so as to require only a single source of voltage, as shown in Fig. 2.

The writer has found that the Eccles-Jordan circuit may be advantageously modified to make use of pentodes, as shown in Fig. 3. The cathodes, plates, and suppressor grids are connected in the same manner as the triode electrodes in the circuit of Fig. 2, and a fixed positive voltage is applied to the screen grids. The control grids are used for tripping the circuit, a negative voltage of half a volt or less on the grid of the conducting tube being sufficient to cause the current to transfer. The circuit is very insensitive to positive voltage applied to the control grids. This lack of response to positive voltage is an advantage in some applications of the circuit.[5]

Another type of trigger circuit which the writer believes to be new is shown in Fig. 4. When the circuit is correctly designed and adjusted, there are two stable values of screen current and two corresponding values of plate current. When the voltages are properly chosen, the plate current corresponding to the higher value of screen current is zero. The plate current increases when the screen current decreases. The plate current may be increased by an increase of negative control-grid voltage, an increase of plate voltage, a decrease of screen voltage, or a decrease of negative suppressor voltage, the control grid being the most sensitive triggering element. Either the plate or the screen current may be used to operate a relay, or the voltage across the plate or screen resistor may be used to control an amplifier tube.

To use a trigger circuit as the basis of a relaxation oscillator it is only necessary to design the circuit so that the abrupt change in current from one stable value to the other is followed by the charging or discharging of a condenser, the voltage of which in turn causes the current to return to its original value at a critical condenser voltage. The multivibrator, based upon the circuit of Fig. 1, and the van der Pol oscillator, based upon the circuit of Fig. 4, are two well-known types of relaxation oscillator. The writer has found that the circuit of Fig. 4 may be used as the basis of another relaxation oscillator, which generates a saw-tooth voltage. The circuit of this oscillator is shown in Fig. 5. This oscillator has proved to be very satisfactory as a source of sweep voltage for a cathode-ray oscillograph. A very small portion of the cycle is taken up in the return sweep of the luminous spot, and no difficulty has been experienced in obtaining oscillation at frequencies up to 20,000 cycles per second. There appears to be no reason why the frequency range cannot be extended into the radio frequencies by proper design of the circuit.

BIBLIOGRAPHY

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5. H. J. Reich, R. S. I. *9*, (1938).