Nov. 14, 1950 G. J. SCOLES 2,530,033

SENSITIVE FLIP-FLOP CIRCUIT

Filed Jan. 30, 1948

Fig. 1.

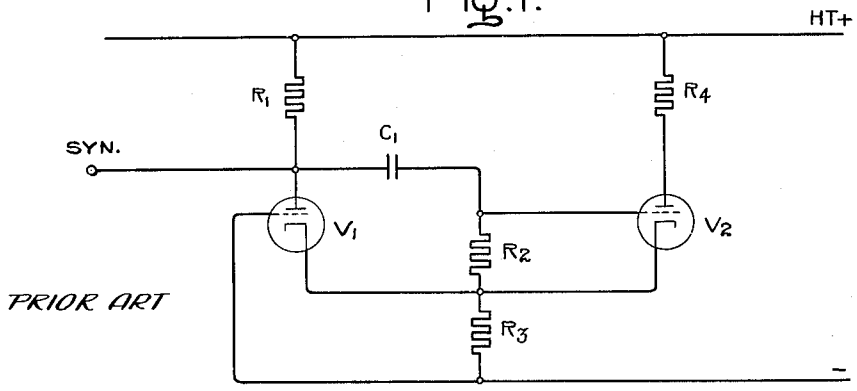


Fig. 2.

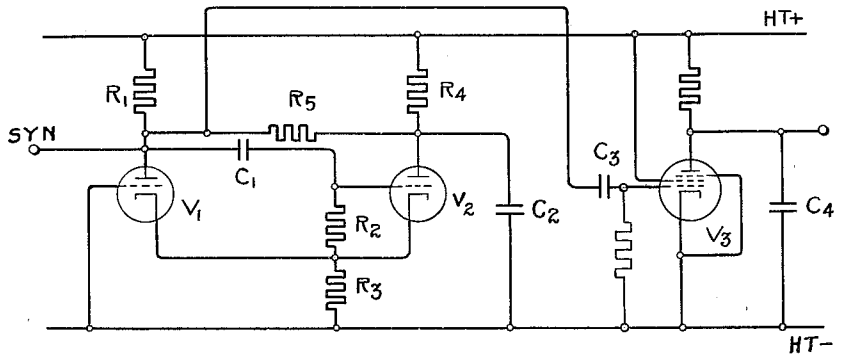
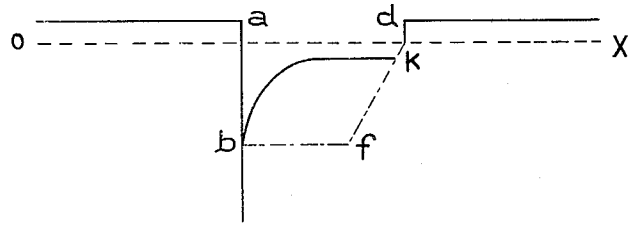


Fig. 3.



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SENSITIVE FLIP-FLOP CIRCUIT

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6 Claims. (Cl. 250—27)

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This invention relates to flip-flop, or Eccles-Jordan circuits of the kind in which a primary valve upon receipt of a synchronizing signal applies a negative potential to the grid of a secondary valve so as to drive the secondary valve from the conducting to the non-conducting state, in which state it remains until the negative charge on the control grid leaks away sufficiently to render it once more conducting. More particularly the invention relates to a feedback arrangement in such circuits whereby the secondary valve is conditioned for actuation by a relatively small triggering signal to return to the conductive state.

The time period during which the secondary valve is in the non-conducting state depends upon the time constant of the leakage circuit to the control grid and is predeterminable by suitable choice of the constants of the circuit. In certain applications, such as in the control of time base circuits which have to cover a wide range of sweep duration, it is convenient to make the time constant of the discharge circuit long and to terminate the time period by the application of a triggering signal. Since the grid of the secondary valve will normally be driven well past cut-off a large triggering signal is usually required.

The main object of the invention is to enable substantially the same result to be obtained with a relatively smaller triggering signal.

According to the present invention, feedback is arranged between the anode and control grid of the secondary valve such that shortly after initial tripping the positive-going anode potential is applied to the control grid of the secondary valve so as partially to counteract the negative-going potential from the primary valve and hence reduce the extent by which the secondary valve is driven beyond cut-off. It will be appreciated that with such an arrangement only a relatively small triggering signal is required to render the secondary valve once again conducting and to terminate the time period.

In carrying out the invention in the case of a cathode coupled flip-flop circuit having the anode of the primary valve coupled through a condenser with the control grid of the secondary valve, a resistance may be connected between the anodes of the primary and secondary valves to provide the feedback and a capacitance connected between the anode of the secondary valve and earth.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and

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method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 shows a normal prior art form of cathode-coupled flip-flop; Fig. 2 shows the arrangement of Fig. 1 modified to include the invention and arranged to control a time base circuit, Fig. 3 illustrates the potential wave forms in Figs. 1 and 2.

Referring to Fig. 1, V_1 is the primary valve above referred to and V_2 the secondary valve.

Fig. 1 shows an arrangement in which V_2 is normally conducting so that the voltage drop through the common cathode resistor R_3 is sufficient to cut-off the valve V_1. If now a negative-going signal is applied to the terminal SYN this will be applied through C_1 to the grid or control electrode of V_2. This will reduce the current through V_2 and hence the voltage drop across R_3. V_1 accordingly conducts so that its anode voltage falls and increases the effect so that the action becomes cumulative and rapidly results in V_1 conducting with V_2 cut-off. The circuit will remain in this condition for a time determined mainly by the values of C_1 and R_2, and the amplitude of the excursion of the grid of V_2 relative to its cathode. After such time delay V_2 will again become conducting and the circuit will reset to its initial condition. In certain applications, such as in the case of time base circuits which have to cover a wide range of sweep duration, it is convenient to make R_2 and C_1 very large and to terminate the cycle by the application of a triggering signal applied for example across R_3 as described in my application for United States Letters Patent Serial No. 5,357 filed of even date herewith. This normally means that a relatively large triggering signal is required as the grid of V_2 is usually driven well past cut-off with the arrangement described above. In the arrangement of Fig. 2 a condenser C_2 is connected between the anode of V_2 and earth, while a resistance R_5 is connected between the anodes of V_1 and V_2. Suppose now a negative-going signal is applied to the terminal SYN. This as above described will trip the circuit. However, due to the effect of C_2 the anode potential at V_2 will not initially vary. The cessation of current through V_2 will allow C_2 to charge mainly through R_4 with the result that the potential at V_1 anode will rapidly change to a new value, less negative than immediately after the trip, and hence the circuit will only require a relatively small knock-off signal to terminate the time period and render V_2

once again conducting. These effects are illustrated in Fig. 3 in which the full line indicates the potential at the grid of V_2 with the arrangement of Fig. 2, while the chain-dotted line represents the potential variation which occurs with the normal arrangement of Fig. 1. The line OX represents the normal cut-off potential for the grid of V_2. The synchronizing pulse is applied at the point *a* whereupon the grid potential immediately assumes a large negative value falling away slightly to the point *b* where the synchronizing pulse terminates. With the normal arrangement of Fig. 1 this negative value will remain until a triggering signal is applied, say at the point *f*, when the potential will rise until the cut-off line OX is reached, when the potential will rise rapidly to the original value at *d*.

It will be appreciated with this arrangement that a relatively large triggering signal is required. With the arrangement of Fig. 2, however, the grid potential will, as shown by the full line, rapidly rise to a value just below the cut-off potential OX so that a much smaller triggering signal is required. If the triggering signal is applied at the point *k*, which has for convenience been taken as the point where the two characteristics intersect, the potential will again rise to the level of OX and then rapidly to the point *d* though clearly a much smaller amount of drive, that is, a smaller triggering signal, is required than in the previous example.

In Fig. 2 the anode of V_1 is connected through a condenser C_3 to the control grid of a pentode valve V_3 which acts as the discharging valve for time base condenser C_4. It will be appreciated, however, that this is only an example of the application of the invention. Preferably R_1 and R_5 in parallel are made equal to the value normally chosen for R_1 in the absence of R_5 so that the sensitivity to trip is not substantially altered.

In certain applications it is desirable for the waveform at the anode of V_2 to be as square as possible and this is of course distorted by the presence of C_2. In such a case the invention may be modified by making R_5 in two portions with C_2 joined between the junction of the two portions and suitable point of reference, such as HT-, or earth.

While I have shown only certain preferred embodiments of my invention by way of illustration, many modifications will occur to those skilled in the art and I therefore wish to have it understood that I intend, in the appended claims, to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A flip-flop circuit comprising a pair of electron discharge devices, each with an anode, a cathode and a control electrode, biasing means for a first one of said devices for biasing said first device to non-conduction during conduction of the second of said devices, said means comprising a common cathode impedance for said cathodes, a long time constant control electrode circuit for said second device connected to the anode of said first device, whereby application of a synchronizing signal to said second device which tends to reduce conduction in said second device causes conduction of said first device, a resistor directly interconnecting said anodes, and a capacitor connected directly from a point of fixed potential to a point on said resistor.

2. A cathode coupled flip-flop circuit with a first and a second electron discharge device, each of said devices having an anode, a cathode and a control electrode, said devices having a common cathode impedance for developing a cut-off biasing potential for either of said devices when the other is conducting, said second device being normally conductive, an anode load impedance for each of said respective devices, a capacitor connecting the anode of the first device to the control electrode of the second device for applying a cut-off impulse thereto, and means for slowly discharging said capacitor, said circuit being characterized by a resistor connecting said respective anodes and a capacitor connected between a point of fixed potential and the anode of said first device in series with at least a portion of said resistor.

3. A cathode coupled flip-flop circuit comprising a pair of electron discharge devices each having an anode, a cathode and a control electrode, an anode load resistor for each of said devices, a capacitor coupling the anode of the first of said devices to the control electrode of the second device, a control electrode leak resistor for said second device, a common cathode impedance for said two devices, the control electrode of said second device being arranged to receive an impulse tending to reduce conduction of said second device, whereby reception of said impulse causes conduction of said first device to provide a negative potential through said capacitor to the control electrode of said second device, and feedback means for limiting the effect of said negative potential, said means comprising a resistor interconnecting said anodes and a capacitor connected between a point on said resistor removed from the anode of said first device and a point in said circuit at which the potential varies to a less extent than at the anode of said first device.

4. A flip-flop circuit comprising a first and a second discharge device, each with an anode, a control electrode and a cathode, means for biasing said first device to a non-conductive condition, said means comprising said second device and being responsive to current flow therethrough, said second device being arranged to receive a current reducing impulse to disable said means to cause said first device to conduct, an anode resistor for each of said devices, means coupling the anode of said first device to the control electrode of said second device for further reducing the current in said second device in response to conduction of said first device, and a feedback network for partially overcoming the effect of said last means a predetermined time after the reduction of current in said second device, said network comprising an energy storage device and means for storing energy in said energy storage device which is principally a function of the potential of the anode of the second device and means for furnishing a portion of said energy to the anode of said first device.

5. A cathode coupled flip-flop circuit with a first and a second electron discharge device, each of said devices having an anode, a cathode and a control electrode, said devices having a common cathode impedance for developing a cut-off biasing potential for either of said devices when the other is conducting, said second device being normally conductive, an anode load impedance for each of said respective devices, a capacitor connecting the anode of the first device to the control electrode of the second device for applying a cut-off impulse thereto, means for slowly dis-

charging said capacitor, and a network for relatively rapidly reducing the intensity of said impulse after the start thereof thereby to condition said second device to receive a small triggering signal to become conductive again, said network comprising a capacitor having one terminal thereof connected to the anode of said second device and the other terminal thereof connected to a relatively fixed potential point, said capacitor chargeable through the anode load impedance of said second device and means for providing at least a portion of said charge to the anode of said first device.

6. A flip-flop circuit comprising a pair of electron discharge devices, each with an anode, a cathode and a control electrode, biasing means for a first one of said devices for biasing said first device to non-conduction during conduction of the second of said devices, said means comprising a common cathode impedance for said cathodes, a long time constant control electrode circuit for said second device connected to the anode of said first device, whereby application of a synchronizing signal to said second device which tends to reduce conduction in said second device causes conduction of said first device, and a feedback

network which tends to increase the anode potential of said first device after said second device becomes non-conductive comprising a capacitor having one terminal thereof connected to the anode of said second device and the other terminal thereof connected to a relatively fixed potential point, said capacitor chargeable through the anode load resistor of said second device and means connected to provide at least a portion of the potential of said capacitor to the anode of said first device.

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