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PULSE GENERATING CIRCUIT

Filed April 11, 1945

Fig. 1.

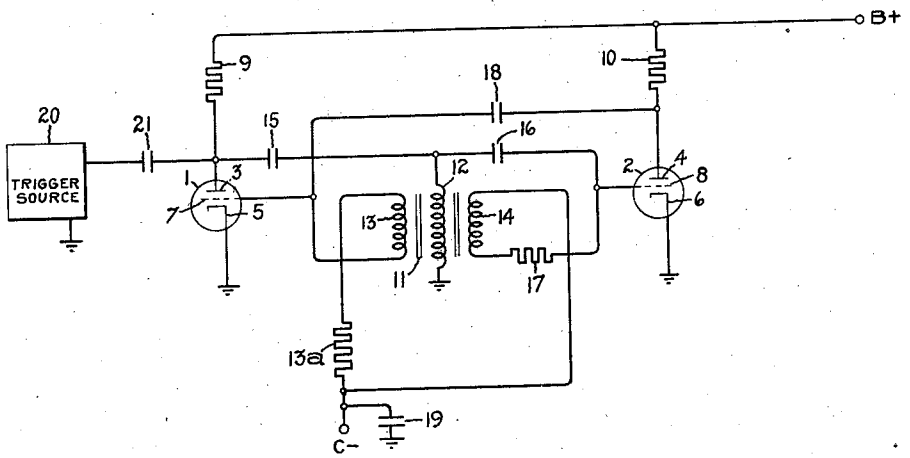
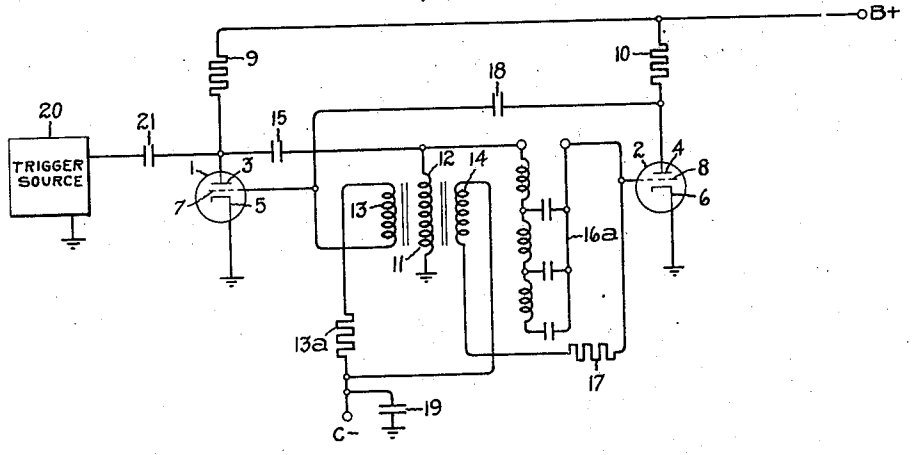


Fig. 2.



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PULSE GENERATING CIRCUIT

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6 Claims. (Cl. 250—27)

1

My invention relates to pulse generating circuits and particularly to pulse generating circuits of the multivibrator type.

It is a general object of my invention to provide a pulse generating circuit of this chraracter which is extremely simple in form and, at the same time, capable of producing pulses of considerable power.

It is a more particular object of my invention to provide a pulse generating circuit of the triggered multivibrator type in which both discharge devices are normally non-conductive thereby to minimize the duty cycle imposed upon the devices.

It is a still further object of my invention to provide a multivibrator pulse generator particularly adapted for pulsing the output of an oscillation generator.

In accordance with the invention, a pair of discharge devices are arranged to be both normally non-conductive. One device is arranged to generate oscillations in response to a trigger potential, while the other device conducts only instantaneously in response to conduction of the triggered device and operates to terminate conduction in the triggered device at a desired time.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, both as to its organization and manner of operation together with further objects and advantages thereof may best be understood by referring now to the following detailed specification taken in conjunction with the accompanying drawing, in which Figs. 1 and 2 are schematic circuit diagrams of pulse generating circuits embodying my invention.

Referring now to the drawing, and particularly to Fig. 1, I have shown a multivibrator type pulse generating circuit comprising a pair of electron discharge devices 1 and 2 containing anodes 3, 4, cathodes 5, 6, and control electrodes 7, 8, respectively. The cathodes 5 and 6 are connected directly to ground, and the anodes 3 and 4 are connected through anode resistors 9 and 10, respectively, to a suitable source of unidirectional potential positive with respect to ground and indicated upon the drawing at B+.

In a regenerative feedback circuit between the anode and control electrode of the discharge device 1, I provide a three-winding transformer 11 including windings 12, 13, and 14. The winding 12 is connected at one end to ground and at the other end to the anode 3 of the discharge device 1 through a coupling capacitor 15. The ungrounded end of the winding 12 is also connected to the control electrode 8 of the discharge device 2 through a timing capacitor 16. The winding 13

2

is connected at one end through a resistor 13a to a source of unidirectional potential negative with respect to ground and indicated upon the drawing as C—. The other end of the winding 13 is connected to the control electrode 7 of the discharge device 1. Similarly, the winding 14 is connected at one end to the potential source C— and at the other end through a resistor 17 to the control electrode 8 of the discharge device 2. Finally, the control electrode 7 of the discharge device 1 is connected through a coupling capacitor 18 to the anode 4 of the discharge device 2, and the negative potential source C— is bypassed by a capacitor 19. The capacitors 18 and 19 and the resistor 13a constitute an alternating current output circuit for the discharge device 2. The transformer windings 12, 13, and 14 are so arranged upon the core that adjacent ends of the windings, as shown on the drawing, are of like polarity. Triggering potential is supplied to the pulse generating circuit from a suitable source 20 of negative triggering impulses through a coupling capacitor 21 to the anode 3 of the discharge device 1. If desired, the winding 12 may be polarized by connection of its ungrounded end to a suitable source of positive potential supply.

In operation, negative triggering impulses are supplied from the source of trigger potential 20 to the anode 3 of the discharge device 1. Through the coupling capacitor 15 these triggering impulses initiate, at the ungrounded end of the transformer winding 12, recurrent negative voltage pulses. Each negative pulse on the transformer winding 12 induces in the transformer winding 13 a positive grid pulse, the induced positive grid pulse in the winding 13 overcoming the negative bias on the control electrode 7 from the source C— thereby to render the discharge device 1 conductive. When the discharge device 1 becomes conductive, the anode potential goes further negative thereby to drive the control electrode 7 further positive by regeneration through the transformer windings 12 and 13, so that the discharge device 1 is driven to saturation very rapidly and the pulse voltage across the anode resistor 9 has a very sharp leading edge. Regeneration thus maintains the device 1 conductive for a predetermined period which may be longer than the duration of the triggering impulses.

To ensure definite termination of the pulse across the anode resistor 9 at a desired time, the discharge device 2 is employed to provide a cut-off impulse. The discharge device 2 is normally non-conductive by reason of the negative bias derived from the source C— through the trans-

former winding 14 and resistor 17. As soon as conduction of the discharge device 1 is initiated, the negative potential maintained at the ungrounded end of the transformer winding 12 by pulse conduction through the discharge device 1 drives the control electrode 8 of the discharge device 2 more than normally negative by coupling through the capacitor 16, thereby to maintain the discharge device 2 non-conductive without increasing the charge upon the capacitor 16. The negative pulse across the winding 12, however, induces in the winding 14 a similar pulse of such polarity that it tends to reverse the charge upon the timing capacitor 16, thereby to drive the control electrode 8 of the discharge device 2 positive. Reversal of the charge upon the capacitor 16 in response to the induced pulse across the transformer winding 14 is delayed exponentially by the characteristics of the R. C. circuit including the capacitor 16 and the resistor 17. After a predetermined time delay, however, the positive pulse across the transformer winding 14 overcomes the negative potential maintained upon the control electrode 8 from the negative source C— and by coupling through the capacitor 16, so that the discharge device 2 is rendered conductive. As soon as the discharge device 2 conducts, the potential of its anode 4 decreases abruptly, and this negative anode pulse, which appears across the plate resistor 13*a*, is coupled through the capacitor 18 to the control electrode 7 of the discharge device 1. When the control electrode 7 is driven negative by conduction in the discharge device 2, conduction in the discharge device 1 is abruptly terminated. As soon as the anode current of the discharge device 1 begins to decrease, regeneration through the transformer windings 12 and 13 aids in the abrupt termination of conduction in the device 1. Additional regeneration is provided through the discharge device 2, for as soon as the potential of the anode 3 increases the grid 8 is driven more positive by coupling through the capacitor 16. This increases conduction in the discharge device 2 and thus increases the negative potential impressed upon the grid 7 by coupling through the capacitor 18.

As soon as the discharge device 1 cuts off, the negative voltage pulse across the transformer winding 12 is terminated, thereby to terminate the positive voltage pulse across the transformer winding 14, so that the negative bias source C— is effective to reverse again the charge upon the capacitor 16 and thus to cut off the discharge device 2. Both discharge devices 1 and 2 remain non-conductive until such time as another triggering impulse appears at the coupling capacitor 21.

At Fig. 2, I have shown another embodiment of my invention wherein an open-ended artificial transmission line section 16*a* is employed for pulse timing in place of the timing capacitor 16 of Fig. 1. In all other respects, Figs. 1 and 2 are identical and like parts have been assigned the same reference numerals. The delay line 16*a* increases the accuracy of pulse timing because decay of voltage thereacross is more rapid than across the capacitor 16 so that the initiation of conduction in device 2 is rendered less dependent upon variation in circuit constants, supply voltage, and the like.

It will now be evident that the duration of the negative pulses generated across the anode resistor 9 is determined primarily by the characteristics of the R. C. timing circuit so that, by change

in the capacitance of the capacitor 16 or the delay line 16*a*, the duration of the pulses may be controlled. Moreover, regeneration through the transformer windings 12 and 13 is effective both upon initiation and termination of conduction of the discharge device 1, so that the pulses generated are of substantially rectangular configuration. It will also be evident that, by providing a pulse generating circuit of the multivibrator type in which both discharge devices are normally non-conductive, the duty cycle of the shut-off valve 2 may be very low so that a relatively small tube may be used for this purpose.

While I have described only a preferred embodiment 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. An electric pulse generating circuit comprising a pair of electron discharge devices having anodes, cathodes and control electrodes, means for impressing anode operating potentials on said anodes, means biasing said control electrodes negatively for normally maintaining both said discharge devices non-conductive, means for applying a triggering potential impulse to a first of said discharge devices in a sense to render it conductive, regenerative coupling means including a transformer connected between the anode and control electrode of said first discharge device, a tertiary winding on said transformer energized for response to initiation of conduction in said first discharge device and arranged to impress a positive potential impulse upon the control electrode of said second discharge device, capacitive time delay means included in circuit between said tertiary winding and the control electrode of said second device for delaying said positive impulse by a predetermined time interval, and feedback means responsive to conduction in said second discharge device for rapidly rendering said first discharge device non-conductive.

2. An electric pulse generating circuit comprising a pair of electron discharge devices having anodes, cathodes and control electrodes, means for impressing anode operating potentials through respective load impedances upon each of said anodes, a source of negative biasing potential arranged normally to maintain both said discharge devices non-conductive, a three-winding transformer having a pair of windings each connected in series between said source of biasing potential and one of said control electrodes, coupling means connecting the anode of a first of said discharge devices to the third winding on said transformer, said transformer being arranged to provide regenerative coupling between the anode and control electrode of said first discharge device, a source of negative triggering potential inpulses coupled to the anode of said first electron discharge device and arranged to render said devices recurrently conductive, a timing capacitor connected between said third winding and the control electrode of the second electron discharge device, a coupling capacitor connected between the anode of said second electron discharge device and the control electrode of said first discharge device, and a resistor connected in series with the transformer winding between said source of biasing potential and the control elec-

trode of said second electron discharge device, said last named winding being arranged to impress upon the associated control electrode through said timing capacitor and resistor delayed positive potential impulses in response to initiation of conduction in said first discharge device thereby to terminate said conduction after a predetermined interval.

3. An electric pulse generating circuit comprising first and second electron discharge devices each having an anode, cathode and control electrode, means for impressing anode operating potentials on said anodes, means for impressing negative bias potentials on said control electrodes sufficient to maintain both devices normally non-conductive, a source of recurrent triggering potential impulses connected to render said first device recurrently conductive, regenerative coupling means including a transformer interconnecting the anode and control electrode of said first device for maintaining it conductive, time delay means energized from said transformer for developing a delayed positive pulse each time said first device is rendered conductive, means for impressing said delayed positive pulse on the control electrode of said second device to render it conductive, and feedback coupling means responsive to initiation of conduction in said second device for rapidly driving both said devices to non-conductive condition.

4. An electric pulse generating circuit comprising first and second electron discharge devices each having an anode load circuit and a grid circuit, means for impressing anode operating potentials upon said anode circuits, means for impressing negative bias potentials on said grid circuits sufficient normally to maintain both said devices non-conductive, means for impressing a triggering pulse on said first device to initiate conduction therein, a transformer including a primary winding, energized in response to the change in anode potential due to conduction in said first device, and a pair of secondary windings each included in one of said grid circuits, said secondary windings being connected to impress positive potentials on the grids of both devices in response to said change in anode potential of said first device, a time delay network in the grid circuit of said second device for producing a predetermined time delay in the resultant positive pulse impressed on the grid of said second device, said positive pulse initiating conduction in said second device, and means including an additional feedback coupling between the anode circuit of said second device and the grid circuit of said first device for rapidly driving said first device to non-conductive condition when said second device becomes conductive.

5. An electric pulse generating circuit comprising first and second electron discharge devices each having an anode load circuit and a grid circuit, means for impressing anode operating potentials upon said anode circuits, means for impressing negative bias potentials on said grid

circuits sufficient normally to maintain both said devices non-conductive, means for impressing a triggering pulse on said first device to initiate conduction therein, a transformer including a primary winding, energized in response to the change in anode potential due to conduction in said first device, and a pair of secondary windings each included in one of said grid circuits, said secondary windings being connected to impress positive potentials on the grids of both devices in response to said change in anode potential of said first device, and an open-ended transmission line section also included in the grid circuit of said second device for producing a predetermined time delay in the resultant positive pulse impressed on the grid of said second device, said positive pulse initiating conduction in said second device, and means including an additional feedback coupling between the anode circuit of said second device and the grid circuit of said first device for rapidly driving said first device to non-conductive condition when said second device becomes conductive.

6. An electric pulse generating circuit comprising first and second electron discharge devices each having an anode, cathode and control grid, means for impressing anode operating potentials on said anodes through respective anode load impedances, means for impressing negative bias potentials on said grids sufficient to maintain both devices normally non-conductive, means for impressing a triggering pulse on said first device to initiate conduction therein, regenerative coupling means including a transformer interconnecting the anode and grid of said first device for thereafter maintaining it conductive, means comprising an open-ended transmission line energized from said coupling means for developing a delayed positive pulse in response to the change in anode potential when said first device is rendered conductive, means for impressing said delayed positive pulse on the grid of said second device to render it conductive, and means comprising an additional feedback coupling between the anode of said second device and the grid of said first device for rapidly restoring both said devices to non-conductive condition in response to conduction in said second device.

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