

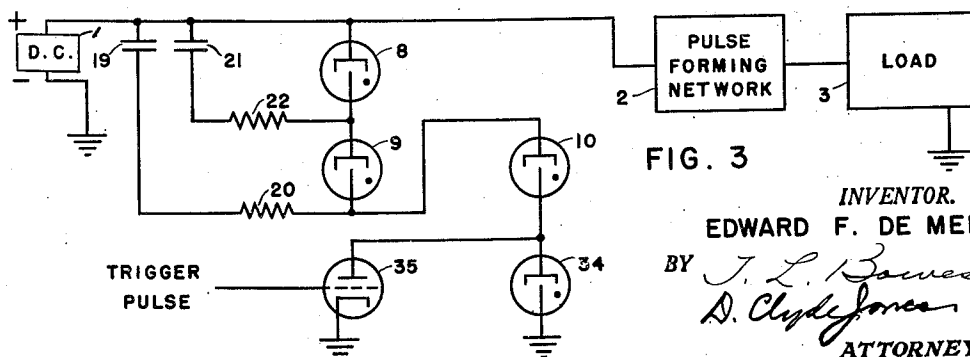
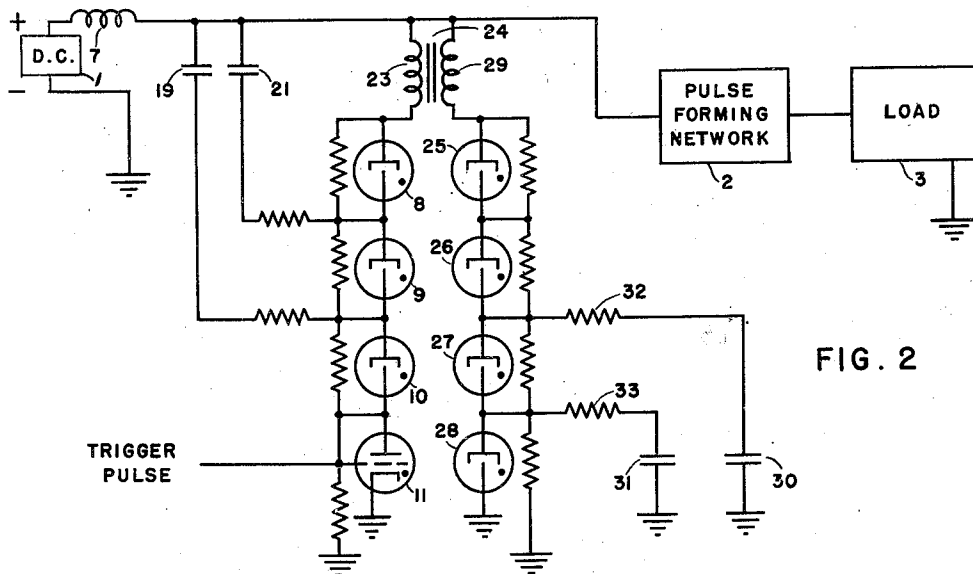
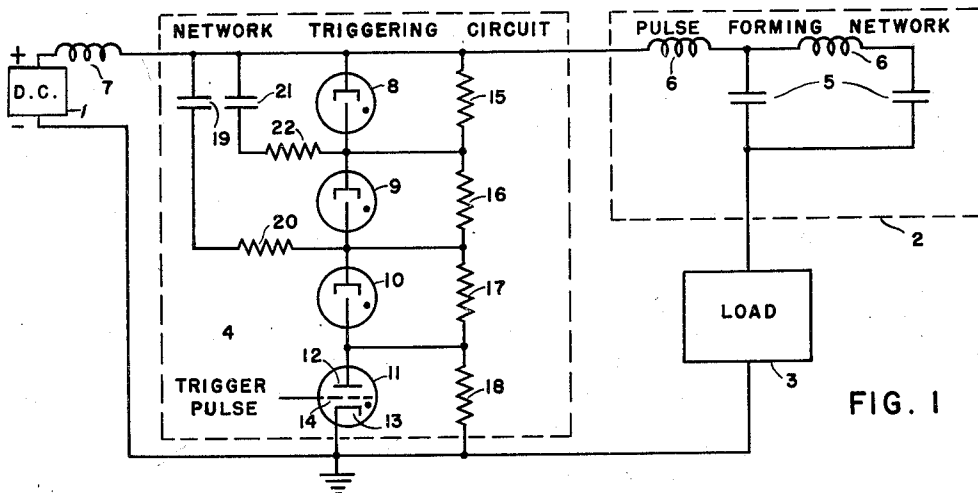
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2,492,850

DISCHARGE INITIATING CIRCUIT

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DISCHARGE INITIATING CIRCUIT

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5 Claims. (Cl. 315-181)

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This invention relates to pulse generating circuits.

In many applications, it is desirable to utilize discrete pulses and to provide means for causing such pulses to be formed at predetermined times. For example, pulse communication and pulse echo systems are arranged to emit relatively short pulses or bursts of wave energy having high peak power. Magnetron oscillators are frequently used in such systems, the magnetron acting as an electronic switch to discharge a capacitive pulse-forming device, as a capacitor or capacitive network. Artificial lines comprising inductance and capacitance are often used as the capacitive network.

My invention is not limited in usefulness to magnetron oscillator circuits, of course, but is of utility in connection with any load fed by a capacitive pulse forming network or capacitive element.

It is, therefore, an object of this invention to provide in a circuit for storing energy in an electrical storage device, means for initiating the discharge of said energy through a load, which is efficient in operation and of simple form.

In accordance with my invention, there is provided a suitable source of direct current voltage, an electrical energy storage element, and a load. The direct current is applied to the element to store electrical energy therein. In order to supply the stored energy to the load at desired intervals, I provide a plurality of arc discharge devices or gaps in series across the element and the load, as well as means to trigger or initiate discharge of at least one of the discharge means. The potential formerly existing across the triggered device is distributed across the remaining non-conducting devices. A capacitor is associated with each of the remaining devices so that one terminal or electrode is maintained briefly at substantially the same potential as existed before initiation of discharge. Since the potential of the other electrode or terminal is appreciably changed by conduction of the adjacent device, the potential across the device is raised above the break-down value and the device conducts. This procedure is repeated from tube to tube until all are conducting and a discharge path is completed for the charged capacitive element or device and the load.

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

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thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 is a circuit diagram illustrating one embodiment of my invention, and Figs. 2 and 3 are modifications of the circuit shown in Fig. 1.

Referring now to Fig. 1, there is shown an embodiment of my invention in which there is provided a suitable source of direct current voltage 1, a pulse forming network 2, and a load 3 connected in series. The charging circuit for the network 2 is obvious. In order to discharge the network 2 through the load there is provided a network triggering circuit 4. As shown, the network 2 may be an artificial line comprising capacitors 5 and inductors 6, but may comprise any capacitive element or elements known to the art. In the circuit arrangement of Fig. 1, the load and network 2 are connected to the source 1 through the inductance 7, or a suitable resistance, if desired.

The network triggering circuit 4 shown in Fig. 1 comprises three arc discharge devices or elements 8, 9, and 10, each of the devices having an anode and a cathode. These devices are connected in series relationship across the source of potential 1 through a fourth discharge device 11, of suitable type, as, for example, a thyatron or a fixed gap fired by a suitable triggering voltage. In the illustrated form of this invention, there is shown a device 11 having an anode 12, a cathode 13, and a control electrode or grid 14. The anode 12 is connected to the cathode of the device 10. The cathode 13 is connected to the negative side of the source of potential 1 and ground. The control electrode 14 is connected to a suitable source of triggering potential.

There is also illustrated in Fig. 1 a potential divider comprising a plurality of series connected resistors 15, 16, 17 and 18, shunting the devices 8, 9, 10, and 11 respectively. The presence of these resistances results in the apportionment of the potential of the source 1, and if the resistance values are properly chosen, in accordance with the voltage ratings of the discharge devices. Thus if each device has the same break-down voltage rating, the resistances will be equal, but if it is desired to combine devices of different ratings, the use of the potential divider makes it possible to maintain the potential across each device at a sufficiently low value to maintain the devices normally non-conducting.

Means is provided to initiate discharge of one of the devices and then render conductive the remaining tubes or devices one after the other.

For this purpose there is provided a capacitor 19 connected between the positive side of the source 1 and the connection between the cathode of device 9 and the anode of the device 10. Wherever necessary, as to avoid exceeding allowable current rating of the device 10 for example, this connection may include a current-limiting resistor 20. Similarly, there is connected a capacitor 21 between the positive side of the circuit and the common connection between devices 8 and 9, the connection including, if necessary, the current-limiting resistor 22.

It will be understood that some inter-electrode capacitance exists between the electrodes of all discharge devices. The capacitance existing between the electrodes (anode and cathode) of the devices 8, 9, and 10 is utilized to render conductive these devices, as hereinafter described. The capacitors 19 and 21 are chosen to have capacitances appreciably greater than those of the discharge devices, as for example, ten times as great. This ratio is easily accomplished with relatively small capacitances inasmuch as inter-electrode capacitances are usually small.

In order to initiate the discharge of network 2, a suitable triggering voltage is applied to device 11 in order to render it conductive. The potential across device 11 drops to the voltage of the arc drop through the device and hence the potential of the cathode of device 10 falls from its former value substantially to ground. Inasmuch as the charge on capacitor 19 cannot follow immediately the change in potential, capacitor 19 tends to maintain constant the potential at the anode of device 10. If the break-down ratings and the source amplitude have been properly chosen, the increased potential will exceed the firing potential and therefore device 10 will break down and become conducting. In other words, the potential across device 10 is increased by a potential approaching that which formerly existed across device 11. The added potential divides inversely between the capacitor 19 and device 10. Since the capacitance of capacitor 19 is approximately ten times that of the device 10, the increase in potential across device 10 is approximately nine-tenths the potential formerly appearing across device 11 so that the potential appearing across device 10 is approximately E_{10} plus $.9E_{11}$ wherein E_{10} and E_{11} represent the initial potentials across devices 10 and 11, respectively. Assuming proper choice of voltage ratings, resistances and source potential, the increase is sufficient to render conducting device 10. Capacitor 19 now charges through devices 10 and 11 in series.

Because of the presence of capacitor 21, approximately nine-tenths of the potential formerly across device 10 is next added to the potential normally across device 9, rendering it conducting to charge capacitor 21. At this point substantially all the potential of the source 1 is applied across device 8 and that device is also rendered conducting. With all devices now conducting, the network 2 discharges through the load 3.

In Fig. 2, there is shown a modification of the circuit of Fig. 1 utilizing parallel branches. The circuit is basically that shown, described, and claimed in copending application Serial Number 538,920, filed June 6, 1944, by Harold Goldberg and Edward F. DeMers and assigned to the same assignee as the present invention. However, the triggering circuit of Fig. 2 is inserted between ground and winding 23 of transformer 24, and a

plurality of tubes or devices 25, 26, 27, and 28 are connected in series relationship between winding 29 of the transformer 24 and ground.

The common connection between devices 26 and 27 is connected to ground through capacitor 30 and current-limiting resistor 32, if necessary. The common connection between devices 27 and 28 is similarly connected to ground through capacitor 31 and resistor 33. Potential-apportioning resistances are also provided as shown. Hence it is unnecessary to connect a capacitor to the common connection between devices 25 and 26. If desired, instead of using four devices of similar characteristics as is implied in Fig. 2, a single device of double voltage break-down rating may be substituted for the two series devices 25 and 26. In some cases it may be possible to omit capacitor 31. If the turns ratio of transformer 24 is one-to-one, substantially the entire source potential will be added to the normal potential across devices 25 and 26, thereby substantially tripling the potential thereacross and rendering these devices conductive.

In Fig. 3 there is shown a modification of the circuit shown in Fig. 1, in which four similar series connected gaps or devices 8, 9, 10, and 34 are disposed across the source 1. In order to initiate discharge, there is provided a triggering device or tube such as triode 35, the anode of which is connected to the connection between devices 10 and 34. When device 35 is rendered conducting by the application of a suitable triggering voltage, the potential at the connection between devices 10 and 34 is reduced suddenly to approximately ground potential. However, the potential of the anode of device 10 is maintained substantially constant by means of capacitor 19 and, as previously explained in connection with Fig. 1, the potential across device 10 is increased sufficiently to cause it to conduct. Assuming removal of the triggering potential at this time, the cathode of device 34 is at ground potential, but the potential of the anode of device 34 is now substantially that of the common connection between devices 9 and 10. To be more exact, the potential across device 34 is now E_{34} plus $.9E_{10}$, assuming the ten to one ratio of capacitances. Therefore, device 34 is next rendered conducting and devices 9 and 8 are rendered conducting, in that order, thereafter.

In practicing my invention, it is not essential that each device be associated with a separate apportioning resistor. It is sufficient that several devices be shunted by a single resistor, but exactness of control is reduced unless there is provided a resistor for each device.

Furthermore, the first device to be rendered conductive may be fired in any desired manner. Instead of using a triggering voltage to energize the grid or control electrode of a thyratron type device, it is possible to short circuit one of the gaps or the devices either mechanically by switch means, or electronically as shown in Fig. 3.

The control device 11 of Fig. 1 may, if desired, be located adjacent to the positive side of the potential source 1 instead of at the ground side thereof. However, in this case it is necessary to insulate the control device for the high voltage of the source.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that other changes and modifications may be made without departing from the invention in its broader aspects. I, therefore, aim in the appended claims to cover

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all such changes and modifications as fall within the true spirit and scope of my invention.

What is claimed is:

1. In combination, a source of direct-current potential: first, second and third arc discharge devices connected in series with said source, each of said devices including a pair of electrodes; means for apportioning the potential of said source among said devices according to the potential break-down ratings thereof, the potential across each of said devices being normally insufficient to cause conduction therethrough; means for maintaining substantially constant the potential at the more positive one of the electrodes of said second device, said means comprising a capacitor connected between the positive side of said source and said one electrode; and means for decreasing the potential at the other electrode of said second device, said means comprising means for rendering said third device conductive; whereby the potential across said second device exceeds its break-down rating and it is rendered conductive.

2. In combination, a source of direct-current potential: first, second and third arc discharge devices connected in series with said source, each of said devices including a pair of electrodes and the potential across each of said devices being normally insufficient to cause conduction therethrough; means for maintaining substantially constant the potential at the more positive one of the electrodes of said second device, said means comprising a capacitor connected between the positive side of said source and said one electrode, the capacitance of said capacitor being substantially greater than the inter-electrode capacitance of said second device; and means for decreasing the potential at the other electrode of said second device, said means comprising means for rendering said third device conductive; whereby the potential across said second device exceeds its break-down voltage and it is rendered conductive.

3. In combination, a source of direct-current potential: first, second and third arc discharge devices connected in series with said source, each of said devices including a pair of electrodes and the potential across each of said devices being normally insufficient to cause conduction therethrough; means for maintaining substantially constant the potential at the more positive one of the electrodes of said second device, said means comprising a capacitor connected between the positive side of said source and said one electrode; and means for decreasing the potential at the other electrode of said second device, said means comprising means for rendering said third device conductive; the capacitance of said capacitor and the inter-electrode capacitance of said second device being so related that sufficient of the resulting increased potential across said sec-

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ond device and said capacitor appears across said second device to exceed its break-down voltage and render it conductive.

4. In combination, a source of direct-current potential: first, second and third arc discharge devices connected in series with said source, each of said devices including a pair of electrodes and the potential across each of said devices being normally insufficient to cause conduction therethrough; means for maintaining substantially constant the potential at the more positive one of the electrodes of said second device, said means comprising a capacitor connected between the positive side of said source and said one electrode; and means for decreasing the potential at the other electrode of said second device, said means comprising means for rendering said third device conductive; whereby the potential across said second device exceeds its break-down rating and it is rendered conductive.

5. In combination, a source of direct-current potential: first, second and third arc discharge devices connected in series with said source, each of said devices including a pair of electrodes and the potential across each of said devices being normally insufficient to cause conduction therethrough; means for maintaining substantially constant the potential at the more positive one of the electrodes of said second device, said means comprising a capacitor connected between the positive side of said source and said one electrode; and means for decreasing the potential at the other electrode of said second device, said means comprising a third electrode in said third device for rendering said third device conductive; whereby the potential across said second device exceeds its break-down rating and it is rendered conductive.

EDWARD F. DE MERS.

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Certificate of Correction

Patent No. 2,492,850

December 27, 1949

EDWARD F. DE MERS

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 3, line 74, for "Fig. 2" read *Fig. 1*;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of June, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.