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DEVICE FOR PRODUCING SUCCESSIVE ELECTRICAL IMPULSES

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2 Sheets-Sheet 2

FIG. 2.

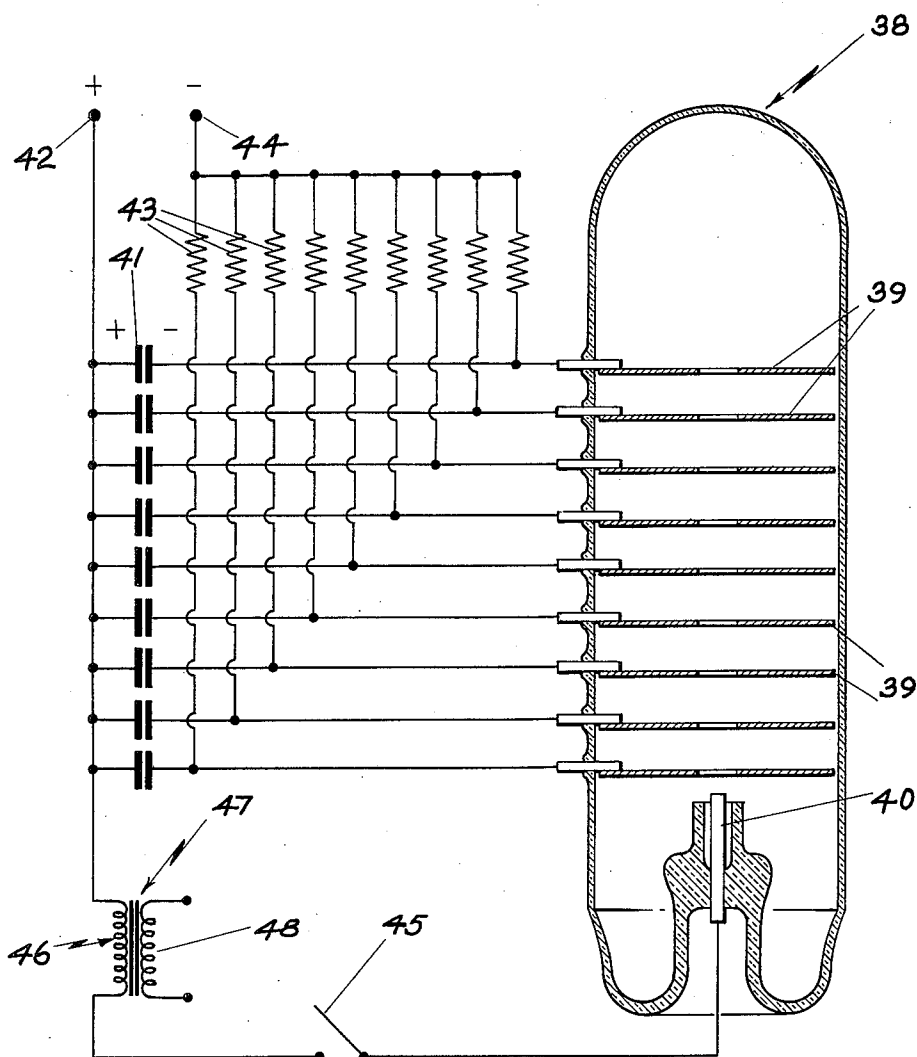
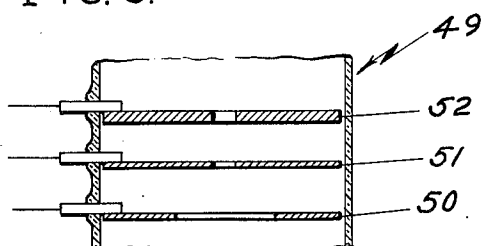


FIG. 3.



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DEVICE FOR PRODUCING SUCCESSIVE ELECTRICAL IMPULSES

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19 Claims. (Cl. 250—27)

This invention relates to means and a method for automatically producing a series of successive electrical impulses.

An object of this invention is the provision of a means and a method for automatically producing a series of successive electrical impulses.

Another object of this invention is the provision of means and a method for automatically producing a predetermined or selected number of successive electrical impulses.

A further object of this invention is the provision of means and a method for automatically producing a predetermined pattern of successive electrical impulses.

Another and further objects of this invention will become apparent and the foregoing will be best understood from the following description of an exemplification thereof, reference being had to the drawings in which

Fig. 1 is a vertical sectional view of a glow discharge tube and a schematic diagram of an associated circuit, embodying my invention;

Fig. 2 is a schematic diagram of a glow discharge tube and associated circuit representing a modified embodiment of my invention; and

Fig. 3 is a fragmentary vertical sectional view of a glow discharge tube showing the glow discharge cathode structure of another modified embodiment of my invention.

Referring now to Fig. 1, the glow discharge tube there illustrated is comprised of an envelope 1 having a suitable gaseous atmosphere, for example argon, neon or other monatomic gases, at a pressure determined by the dimensions and spacing of the various elements and other constructional and operational characteristics of said glow discharge tube, as will be apparent from the following. In order to produce a succession of impulses, a plurality of glow discharge cathodes are provided in envelope 1, the number of cathodes being equal to the number of impulses to be successively produced. The tube illustrated is designed to produce nine successive impulses and for this reason is provided with nine cathodes, 2, 3, 4, 5, 6, 7, 8, 9 and 10. These glow discharge cathodes may be made of any suitable material, such as for example aluminum, and have any suitable form, such as for example the thin round disc-like form illustrated in horizontal arrangement in the drawings. The cathodes may be supported by suitable lead-in and supporting conductors 11 sealed through the wall of the envelope.

In order to produce a lower cathode drop, thus permitting the utilization of lower operating po-

tentials, the cathodes may be provided with an electron-emissive coating, such as for example a coating of barium and/or strontium oxide and/or of other alkali or alkaline earth metal compounds. Hereinafter in this specification and the appended claims wherever the term "alkaline metals" is employed, it is intended to mean alkali metals and alkaline earth metals. To provide a convenient path for the spreading of the discharge from cathode to cathode, each of said cathodes may be provided with a central opening 12. Said central openings may be aligned with each other and with an anode 13, which anode is preferably made of a suitable refractory material, such as tungsten, and is secured through the press portion 14 of the reentrant stem 15. To prevent all but the upper end of the anode 13 from participating in the discharge, I prefer to form a shield 16 on the press portion 14, which shield closely surrounds all but the top of the anode.

In the tube illustrated, the discharge is adapted to occur first between the anode 13 and the nearest cathode, and subsequently to spread successively to other of the cathodes in the order of their proximity to the anode. The anode 13 is arranged adjacent the bottom of the tube and cathode 2 is arranged closest thereto, the other cathodes being spaced from said anode at successively greater distances. The relative spacing between the cathodes is dependent upon the pattern of electrical impulses to be produced, and usually upon the interval which is to elapse between impulses. The cathode arrangement illustrated is designed to produce three successive groups of impulses, each group consisting of three impulses. In each group of impulses an equal time interval is to elapse between each succeeding pulse, but between the last impulse of one group and the first impulse of a succeeding group a larger interval of time is to elapse. For producing the above-described pattern of impulses, cathodes 2, 3 and 4, forming one group, are arranged said equal distance apart, but the distance between cathodes 4 and 5 is greater than said fixed distance. Similarly, the distance between cathodes 7 and 8 is greater than said fixed distance. Thus three groups of equally spaced cathodes with greater spacing between each group is provided for producing a pattern consisting of three groups of impulses in which groups equal intervals elapse between the impulses, but between which groups greater intervals elapse.

In addition to producing a pattern of impulses by allowing different time intervals to elapse between succeeding impulses, my invention is also

adapted to produce a pattern of impulses by producing impulses of different length.

One way of doing this, which is contemplated by my invention, is to provide different coatings and/or different materials for the cathodes in accordance with the predetermined pattern of impulses which is to be produced. These coatings and materials are to differ in their work functions. By selecting the coating and/or material for each of the cathodes the length of the pulses of current produced will be determined according to the work function of the material selected. Since the coating or materials selected depends upon the pattern to be produced, the specific structural and operating conditions encountered, the materials available, etc., and since the selection of coatings and materials in accordance with my invention will be apparent to one skilled in the art in view of the foregoing, further description of this method and means of producing a pattern of different lengths of impulses will be omitted.

Another method and means of producing a pattern of different lengths of impulses are illustrated in Fig. 1. The cathodes are arranged to successively produce three short pulses followed by three longer pulses, followed by another three short pulses. To produce the short pulses cathodes 2, 3 and 4 and cathodes 8, 9 and 10 are of proportionately small surface area, while to produce the larger pulses cathodes 5, 6 and 7 are of proportionately larger surface area. Since it is intended that the glow discharge should spread from cathode to cathode solely through the openings 12, the larger cathodes 5, 6 and 7 preferably extend to a very short distance from the wall of the envelope, while the smaller cathodes 2, 3, 4, 8, 9 and 10, which do not extend to the wall, are provided with annular shields 17, preferably of mica, which extend from adjacent the outer ends of said cathodes to the wall of the envelope. These shields may be secured to their cathodes in any suitable manner.

The glow discharge tube hereinbefore described may be used in any suitable circuit, the one illustrated in Fig. 1 being only one of many circuits that will readily be suggested to those versed in the art from this description. Each of the lead-in conductors 11 may be connected in series with a separate utilization device, such as lamps 18, and in series with a separate resistance 19 to one end of the primary 20 of an output transformer 21, the other end of said primary 20 being connected to a terminal 22. The secondary 23 of transformer 21 may be connected to any other suitable utilization device, as will be more fully explained hereinafter. The anode 13 is arranged to be connected in series with different portions of a tapped resistance 24 by switches 25, 26, 27, 28, 29, 30, 31, 32 and 33. Tapped resistance 24 is in turn connected in series with a current-limiting resistance 34 to terminal 35. Terminals 22 and 35 are to be connected to a suitable source of direct current, terminal 22 being connected to the negative side of said source and terminal 35 being connected to the positive side thereof.

The system is designed so that upon closing of one of the switches 25—33 the glow discharge tube is ignited and a discharge occurs between the anode and at least one of the cathodes, the number of cathodes participating in the discharge being determined by the amount of resistance 24 in the circuit, the less the resistance, the more cathodes participating. One side of each of said switches 25—33 are connected to-

gether and to anode 13, the other side of each of said switches being connected to separate taps on resistance 24. When switch 33 is closed all of resistance 24 is brought into the circuit while the closing of the other switches in the order of their numbering progressively introduces lesser portions of said resistance until, upon the closing of switch 25, the entire resistance 24 is omitted from the circuit.

The value selected from resistance 24 and the location of the taps on said resistance are preferably such, in relation to the other constants of the circuit, that when switch 33 is closed a discharge will take place in said tube solely between the anode and cathode 2, thereby lighting the lamp 18 connected with said cathode and supplying current to the primary 20 of output transformer 21, to produce a pulse of current in the secondary 23 when said secondary is connected to a proper utilization device.

If, instead of closing switch 33, switch 28 is closed, the discharge is adapted to go first to cathode 2, and then to spread successively to include cathodes 3, 4, 5, 6 and 7 in the discharge.

An interval occurs between the spread of the discharge from cathode to cathode, a larger interval occurring between the spread of the discharge from cathode 4 to cathode 5 because of the greater spacing between said last-mentioned cathodes. As the discharge spreads to each cathode its associated lamp is lit and a pulse of current is induced in the secondary 23 of the output transformer 21. The pulses appearing in the secondary have a fixed duration, those produced as the discharge spreads on cathodes 2, 3 and 4 being relatively shorter than those produced as the discharge spreads on cathodes 5, 6 and 7.

In accordance with the above, it will be seen that when switch 25 is closed a succession of impulses consisting of three short, three long, and three short pulses are adapted to be automatically produced.

From the foregoing it will be understood that by closing a selected switch a given number of successive pulses of current will be automatically delivered to the output of transformer 21 and a like number of lights 18 will automatically be successively lit, the number of successive pulses automatically produced, and the number of lights automatically successively lit, being dependent on the switch selected.

According to my present understanding of the theory of operation of the circuit and tube illustrated in Fig. 1, when one of the switches is closed a potential is impressed between cathode 2 and anode 13. A glow discharge thereupon occurs and the current flow increases rapidly as the normal glow spreads. The amount of current that can flow is limited by the impedance of the circuit. If switch 33 is closed the impedance of the circuit will so limit the current that the glow will appear only on cathode 2. Thus it will be seen that when switch 33 is closed the current passing through the primary of the output transformer rises sharply as the normal glow is spreading and then tends to flatten out as the normal glow ceases to spread. Therefore, when the secondary 23 is connected to a suitable utilization device a pulse of current will be induced therein at the time the current in the primary is rising. This pulse will cease when the current in the primary substantially flattens out, and is not changing rather rapidly.

If switch 32 is closed instead of switch 33, the current will increase so that the glow spreads

completely over cathode 2. As the current further increases the cathode fall of cathode 2 increases, tending to make the rise of current much more gradual. After a given time the cathode fall is so great that the glow spreads swiftly to cathode 3 through opening 12 in cathode 2. The current to cathode 3 rises rapidly and the glow spreads thereover until the point is reached where further rise is prevented by the impedance of the circuit. It will thus be seen that after current to cathode 2 has risen rapidly and then flattened out substantially, to thereby produce a first pulse in the output of the transformer, current then flows to cathode 3, which current to cathode 3 at first rises rapidly thereby producing a rising current in the primary of the transformer. This rising current through the primary, which is superimposed on the current already flowing therein, later flattens out, and thus a second pulse of current will be induced in the output of the transformer.

From the foregoing it will be seen that a selected number of successive pulses can be automatically produced, depending on the switch closed. Furthermore, it will be seen that the length of each pulse will be determined in part by the surface area of the cathode. Thus by proper design of the cathodes, successive pulses of different magnitude may be produced in accordance with a predetermined pattern.

Another way of deriving successive impulses from the system hereinabove described is by utilizing the fall of potential produced across one of the resistances 19 when current is flowing to its associated cathode. When the discharge reaches a cathode, current flows through its associated resistance 19 and a fall of potential exists across said resistance. Thus, as the discharge spreads from cathode to cathode, potentials will appear across the resistances 19 successively. The sides of resistances 19, which are connected together, may be connected to an output terminal 36 and each of the other sides of said resistances may be provided with separate output terminals 37. It will be seen that the successive potentials appear at different terminals and may thus be used to time the successive operation of a number of separate devices. However, these terminals may be connected to a single circuit in which the potentials appear successively as will be readily apparent to one skilled in the art. Terminals 36 and 37 may be connected to any suitable utilization device or devices as indicated in Fig. 1. When only the potential fall across resistances 19 is to be used, the transformer 21 may be dispensed with in this system.

The system hereinabove described may be utilized with an almost limitless number of utilization devices as will be readily apparent. For example, as a timer it may be utilized to successively "trigger off" a number of devices in accordance with a prearranged time pattern. It may be used to trigger off a selected number of devices according to the switch which is closed. It may be used to automatically produce an electrical signal of a definite pattern, as for example, in wireless telegraphy or telephony. It may be substituted for the dial telephone by utilizing push buttons instead of switches, and thereby eliminating the mechanical turning of a dial. Other uses, too numerous to mention, are apparent to one skilled in the art.

Referring now to Fig. 2 which shows a modified embodiment of my invention, the tube 38 there illustrated is provided with a plurality of glow

discharge cathodes 39, which are, for simplicity's sake, illustrated as being regularly spaced from the anode 40 and at an equal distance from each other. The circuit illustrated in Fig. 2 differs from that shown in Fig. 1 in that the circuit of Fig. 2 is provided with a plurality of condensers 41 each being connected in series with a separate cathode and being adapted to be discharged between its associated cathode and the anode. These condensers are adapted to be charged from a suitable source of direct current by connecting the positive side of each of said condensers together and to a terminal 42, the negative side of each of said condensers being connected through suitable current limiting impedances, which may be resistances 43, to another terminal 44. Terminal 42 is adapted to be connected to the positive side of a source of direct current potential while terminal 44 is connected to the negative side thereof. To control the discharge of the condensers a switch 45 may be provided in series with the anode 40. Upon the closing of the switch 45, the condensers will discharge themselves successively through glow discharge tube 38, the condenser associated with the cathode nearest the anode 40 discharging first, the other condensers discharging thereafter in the order of the proximity of their associated cathodes to the anode. To utilize the pulses of current produced by the successive discharge of these condensers as the glow discharge spreads within tube 38, I prefer to insert an impedance in series with the anode 40. The impedance may be, for example, the primary 46 of the output transformer 47, which has its secondary 48 connected to a suitable utilization device or devices.

By utilizing condensers, as shown in Fig. 2, and discharging said condensers through the glow discharge tube, the amount of current flowing through the system, as the glow discharge spreads from its nearest cathode until it has encompassed the farthest cathode, is approximately the same, so that large variations in the total current flow do not exist in this system when it is properly designed. Thus, while successive pulses of current appear at predetermined intervals, the steady current flow does not increase substantially as the discharge spreads.

In Fig. 3 is illustrated another way of controlling the intervals between successive pulses and for producing additional pulses with the same number of cathodes. In the fragment of the glow discharge tube 49 illustrated, three glow cathodes 50, 51 and 52 are depicted. Cathode 50 is provided with a relatively wide opening. Cathodes 51 and 52 are provided with relatively narrower openings. Cathodes 50 and 51 may be of the same thickness, but cathode 52 is of greater thickness so that the opening therein has greater depth. When the glow discharge occurs between the anode and cathode 50, the discharge will readily pass through the opening in said cathode to the upper surface of said cathode without affecting the current flow. However, when the glow reaches the lower surface of cathode 51, due to the constricted opening in cathode 51, a considerable amount of energy is necessary before the glow will pass through said opening. Thus the glow will pass from one surface of the cathode 51 to the other surface of the cathode 51 in two discontinuous steps to thereby produce two successive electrical energy impulses. The phenomena described in connection with cathode 51 will also occur in the case of cathode 52 because of its constricted opening. The interval

between the spreading of the glow from the lower surface of the cathode 52 and to the upper surface thereof will, however, be greater because of the greater depth of the opening in cathode 52.

From the foregoing description referring to Fig. 3, it will be apparent that more than one pulse may be obtained from the same cathode by providing a restricted path or opening through which the discharge is adapted to spread, this opening serving to provide an interval between the spreading of the glow discharge from one surface of a cathode to another surface thereof. From the foregoing it will also be apparent that a single cathode may be provided with a number of surfaces with restricted openings between said surfaces through which the discharge is adapted to pass, and thus said cathode may be used to provide a number of successive impulses. It will also be apparent from the foregoing that the interval between these successive impulses may be lengthened or shortened by providing longer or shorter restricted paths respectively for the passage of the discharge. In the embodiment shown in Fig. 2, the openings preferably bear such a relationship to the constants of the respective systems in which they are arranged that the glow spreads without a pause over the entire surface of the individual cathode.

While I have described hereinabove what I now consider to be for certain purposes preferred embodiments of my invention, it will be apparent that numerous other systems may be made in the light of this description which will also embody the gist of my invention. Many apparent changes may be made, and for certain purposes must be made, in the systems described in utilizing my invention. In regard to the tube, obviously the number of electrodes, more particularly the number of cathodes, depend on the maximum number of pulses to be successively produced. Equally obviously, the spacing, size, and material of said cathodes depend on the pattern of pulses to be produced. Changes in the form and relative arrangement of the electrodes are, of course, contemplated by the present invention.

For deriving and selecting the successive impulses, I have described two circuits. In this circuit the impulses may be obtained from the output of transformer 21 or from the terminals 36 and 37, or may be obtained by connecting the inputs of suitable utilization devices in series with the cathodes in place of, or in addition to, lamps 18. It will be obvious that impulses may be derived from the systems here described by other means, such as for example, providing impedances in said system and utilizing the potential drop across said impedances. Furthermore, while I have shown openings in the cathode which are aligned, it will be obvious that these openings may be deliberately misaligned, for example, to provide a higher resistance path for the spread of the glow discharge. Furthermore, while I have shown the cathodes to be planar, it will be equally obvious that the cathodes may be arranged in different planes relative to each other as well as that each of the cathodes individually may be formed so as to extend in several planes. It will also be understood that instead of a multiplicity of cathodes a single cathode system might be provided having various surfaces which are adapted to successively participate in the discharge, the spreading of the discharge to the various surfaces of said cathode being controlled by providing restricted paths between the various surfaces. Numerous other circuits for utilizing this

invention will also be suggested to those skilled in the art by the description herein. It is to be understood that the changes here suggested are solely by way of exemplification and are not intended to embrace all the changes that might be made without departing from the present invention. It is accordingly intended that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. A glow discharge device for automatically producing a number of successive electrical energy impulses comprising an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged in said envelope, means for impressing a substantially continuous unidirectional potential difference between said anode and said cathodes, said cathodes being adapted to successively participate in the discharge.
2. A glow discharge device for automatically producing a number of successive electrical energy impulses comprising an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged in said envelope, said cathodes being arranged at successively increasing intervals from said anode.
3. A glow discharge device for automatically producing a number of successive electrical energy impulses comprising an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged at successively increasing intervals from said anode, said intervals increasing irregularly according to a predetermined pattern to thereby produce a predetermined pattern of electrical impulses.
4. A glow discharge device for automatically producing a number of successive electrical energy impulses comprising an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged in said envelope, said cathodes being provided with surfaces having different work functions and being adapted to successively participate in the discharge.
5. A system for automatically producing a number of successive electrical energy impulses, comprising a glow discharge device having an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged in said envelope, said cathodes being adapted to successively participate in the discharge, a circuit for impressing a substantially continuous positive potential on said anode and substantially continuous negative potentials on said cathodes and means associated with said circuit for deriving a succession of impulses therefrom.
6. A system for automatically producing a number of successive electrical energy impulses, comprising a glow discharge device having an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged in said envelope, said cathodes being adapted to successively participate in the discharge, a circuit for impressing a substantially continuous positive potential on said anode and substantially continuous negative potentials on said cathodes and an impedance arranged in series in said circuit, the fall of potential across said impedance being adapted to be impressed upon a suitable utilization device.
7. A system for automatically producing a number of successive electrical energy impulses,

comprising a glow discharge device having an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged in said envelope, said cathodes being adapted to successively participate in the discharge, a circuit for impressing a substantially continuous positive potential on said anode and substantially continuous negative potentials on said cathodes and an impedance device interposed in series in said circuit.

8. A system for automatically producing a number of successive electrical energy impulses comprising a glow discharge tube comprising an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged in said envelope, said cathodes being adapted to successively participate in the discharge, a plurality of condensers each separately arranged in series with one of said cathodes, and adapted to discharge through said tube, means for charging said condensers, said condensers being adapted upon discharge thereof through said tube to produce a succession of electrical energy impulses, and an impedance device arranged in series in said circuit between said condensers and said tube.

9. A glow discharge device for automatically producing a succession of electrical energy impulses comprising an anode and a plurality of cathodes, said cathodes being adapted to successively participate in the discharge, said cathodes being provided with limited openings to permit the discharge to pass therethrough, the passage of the discharge to one surface of each of the cathodes from the anode providing one electrical energy pulse, the passage of the discharge through said opening to the opposite surface of each of said cathodes providing a subsequent electrical energy impulse.

10. A glow discharge device for automatically producing a succession of electrical energy impulses comprising an anode and a plurality of cathodes, said cathodes being adapted to successively participate in the discharge, said cathodes being provided with limited openings to permit the discharge to pass therethrough, the passage of the discharge to one surface of each of the cathodes from the anode providing one electrical energy pulse, the passage of the discharge through said opening to the opposite surface of each of said cathodes providing a subsequent electrical energy impulse, the size of said openings being selected in accordance with a predetermined pattern to provide a predetermined pattern of intervals between successive impulses.

11. A glow discharge device for automatically producing a succession of electrical energy impulses comprising an anode and a plurality of cathodes, said cathodes being adapted to successively participate in the discharge, said cathodes being provided with limited openings to permit the discharge to pass therethrough, the passage of the discharge to one surface of each of the cathodes from the anode providing one electrical energy pulse, the passage of the discharge through said opening to the opposite surface of each of said cathodes providing a subsequent electrical energy impulse, the depths of said openings being selected in accordance with a predetermined pattern to provide a predetermined pattern of intervals between successive impulses.

12. A glow discharge device for automatically producing a number of successive energy impulses comprising an envelope containing a gaseous atmosphere for supporting a glow discharge,

an anode and a cathode system between which the discharge is adapted to occur, means for impressing a substantially continuous unidirectional potential difference between said anode and said cathode system, said cathode system being provided with a plurality of surfaces which are adapted to participate successively in the discharge, the spreading of the discharge to said various surfaces being adapted to occur discontinuously so as to produce successive pulses of electrical energy.

13. A system for automatically producing a selected number of successive electrical energy impulses comprising a glow discharge device having an envelope containing a gaseous atmosphere, an anode and a glow discharge cathode system provided with a plurality of surfaces adapted to successively participate in a discharge, a circuit for impressing a positive potential on said anode and negative potential on said cathode system, a variable impedance arranged in said circuit and adapted to be varied to select the number of surfaces which are to participate in the discharge, and means associated with said circuit for deriving a succession of impulses therefrom.

14. A glow discharge device comprising an envelope containing a gaseous atmosphere, a plurality of electrodes, all of which are below temperature of substantial thermionic emission during normal operation, one of said electrodes being designed and adapted to operate as an anode, a plurality of said electrodes being designed and adapted to operate as glow discharge cathodes with respect to said anode, said cathodes being spaced successively from said anode, each cathode substantially interrupting the discharge path from said anode to the cathodes beyond said first-named cathode except for at least one restricted discharge opening.

15. In combination, a glow discharge device comprising an envelope containing a gaseous atmosphere, a plurality of electrodes, all of which are below temperature of substantial thermionic emission during normal operation, one of said electrodes being designed and adapted to operate as an anode, a plurality of said electrodes being designed and adapted to operate as glow discharge cathodes with respect to said anode, said cathodes being spaced successively from said anode, each cathode substantially interrupting the discharge path from said anode to the cathodes beyond said first-named cathode, except for at least one restricted discharge opening, means for connecting the positive terminal of a source of potential to said anode, and means for connecting the negative terminal of said source through an impedance to said cathode, said impedance being coupled to an output circuit.

16. A glow discharge device comprising an envelope containing a gaseous atmosphere, a plurality of electrodes, all of which are below temperature of substantial thermionic emission during normal operation, one of said electrodes being designed and adapted to operate as an anode, a plurality of said electrodes being designed and adapted to operate as glow discharge cathodes with respect to said anode, said cathodes being spaced successively from said anode, each cathode substantially interrupting the discharge path from said anode to the cathodes beyond said first-named cathode except for at least one restricted discharge opening, and means for impressing a positive potential on said anode, a negative potential on said cathodes, and a separate current-

responsive device in series with each of said cathodes.

17. The method of producing a succession of electrical energy impulses comprising impressing a substantially continuous unidirectional potential difference between an anode and a plurality of cathodes to produce a glow discharge spreading in stages to said cathodes successively, and deriving a succession of electrical impulses therefrom.

18. The method of generating a succession of electrical energy impulses comprising impressing a substantially continuous positive potential on an anode of a glow discharge tube, impressing a substantially continuous negative potential on a cathode system having a plurality of discontinuous active surfaces coating with said

anode, whereby the glow discharge spreads in predetermined intermittent time intervals over said active surfaces, and deriving a succession of electrical energy impulses therefrom.

19. A glow discharge device comprising an envelope containing a gaseous atmosphere, an anode and a plurality of glow discharge cathodes arranged in said envelope, means for impressing a substantially continuous positive potential on said anode and substantially continuous negative potentials on said cathodes, said cathodes being so disposed relative to said anode and to each other that the discharge of said tube occurs in successive stages to provide a plurality of successive electrical energy impulses.

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