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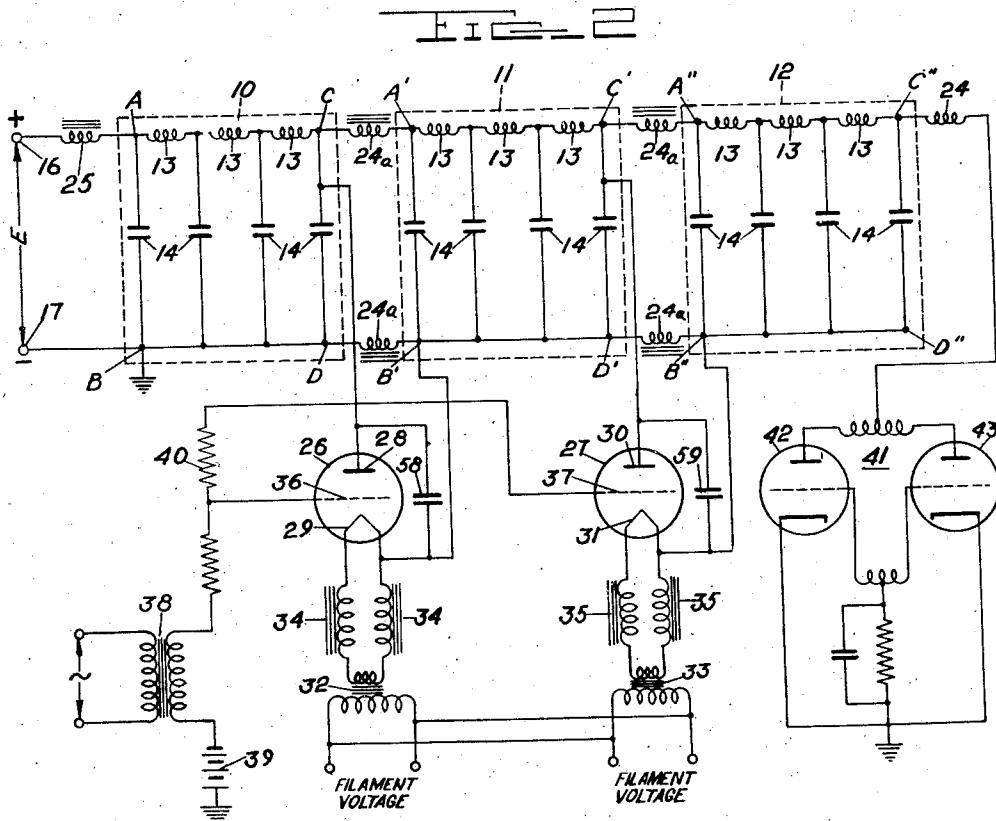
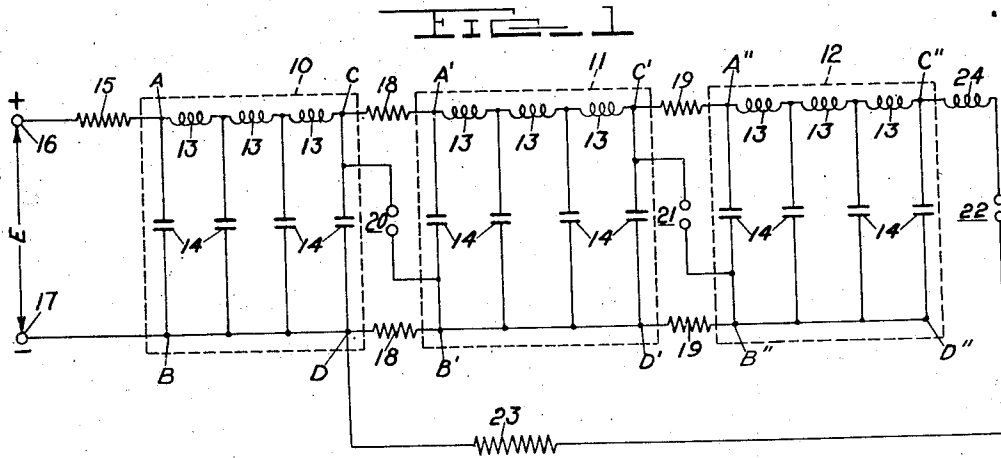
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2,408,824

IMPULSE GENERATOR

Filed March 27, 1942

2 Sheets-Sheet 1



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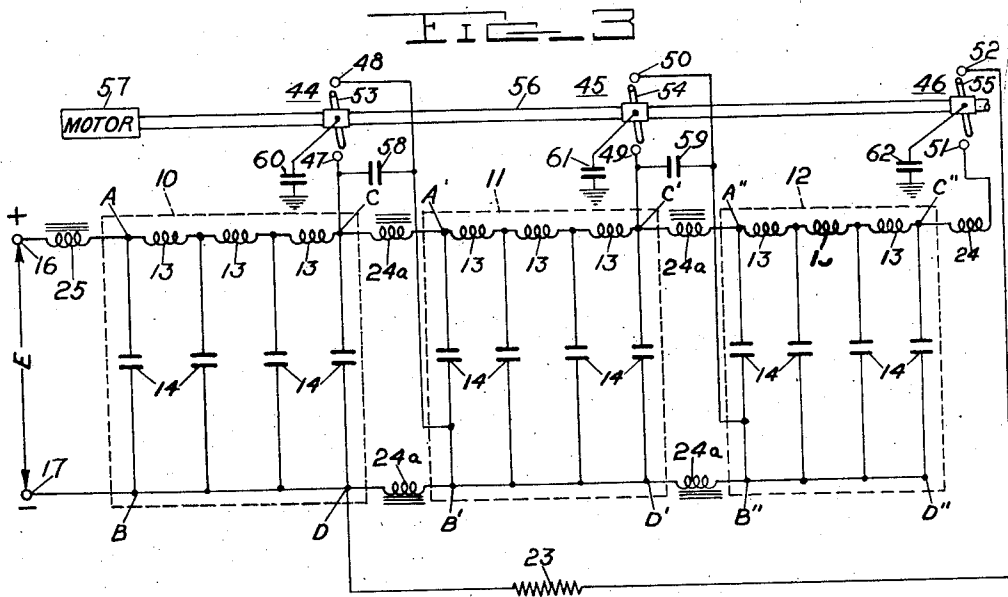
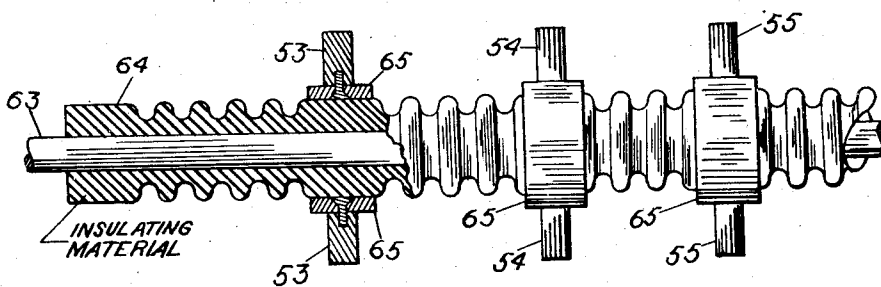


FIG. 4



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2,408,824

IMPULSE GENERATOR

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Application March 27, 1942, Serial No. 436,483

26 Claims. (Cl. 171-97)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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This invention relates to electrical impulse generators and more particularly to electrical apparatuses for generating rectangular or flat topped wave forms.

There has been a long need in the art for relatively simple, highly efficient novel means capable of generating high voltage electrical impulses of rectangular wave forms that may be utilized for controlling operation of various high frequency electrical apparatuses, such as high frequency oscillators for example.

The principal object of the present invention is to provide such means.

Another object is to provide an electrical impulse generator capable of producing high voltage electrical impulses of rectangular wave form from a relatively lower voltage source.

Another object is to provide an impulse generator having the foregoing characteristics which includes novel means for periodically generating such electrical impulses.

Another object is to provide an electrical impulse generator of the above type capable of producing electrical impulses at a rate controlled by a predetermined synchronizing source.

Still another object of the invention is to provide an electrical impulse generator having a plurality of artificial electrical lines with potential storing characteristics, with an arrangement for continually charging the lines with a source of potential in parallel relation and for automatically periodically serially discharging the lines through an impedance whereby the discharge current remains substantially constant for a time interval determined by the electrical lengths of the lines.

Still another object is to provide an impulse generator of the foregoing type wherein the artificial lines comprise low pass constant k filter networks, the capacitances of which are charged with potential in parallel relation and serially discharged.

Still another object is to provide novel means for serially connecting the filter networks of an impulse generator of the above character, which is capable to synchronously serially connect a plurality of filter networks.

Other objects and features of the invention will appear more fully from the following detailed description when considered in connection with the accompanying drawings which disclose several embodiments of the invention. It is to be expressly understood, however, that the drawings are designed for purposes of illustration only, and not as a definition of the limits of the in-

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vention, reference being had to the appended claims for the latter purpose.

In the drawings, wherein similar reference characters denote similar parts throughout the several views:

Fig. 1 is a diagrammatic illustration of an electrical impulse generator embodying the principles of the present invention;

Fig. 2 is a diagrammatic showing of another embodiment of the invention;

Fig. 3 is a diagrammatic showing of still another embodiment of the invention, and

Fig. 4 is a diagrammatic illustration, partly in section, of a novel device employed in the present invention.

With reference more particularly to Fig. 1 of the drawings, an electrical impulse generator embodying the principles of the present invention is disclosed therein including a plurality of artificial lines such as multi-section, low pass filter networks 10, 11 and 12. Networks 10, 11 and 12 may be of conventional construction and are disclosed herein including a plurality of serially connected inductances 13, with a plurality of capacitances 14 connected in parallel relation therewith, thus forming filter networks of the constant k type. Each of the filter networks further includes high and low potential input and output terminals; the high and low input potential terminals of the networks are respectively designated at A and B, while the high and low potential output terminals are respectively designated at C and D, with the designations representing the terminals of network 11 being primed numerals while the numerals representing the terminals of network 12 have double primes. Capacitances 14, of network 10, are charged with potential through a decoupling impedance, such as resistance 15, from a source of potential applied to input terminals 16 and 17. Output terminals C and D, of filter network 10, are connected through suitable impedances, such as resistances 18, 18, to the input terminals A', B' of network 11, while output terminals C' and D' of the latter network are connected to input terminals A'' and B'' of filter network 12 by means of resistances 19, 19. With the foregoing arrangement, capacitances 14 of filter networks 10, 11 and 12 are charged in parallel relation from the source of potential applied to terminals 16 and 17. It is to be expressly understood that any desired number of filter networks may be connected in the above manner.

As mentioned heretofore, one of the objects of the present invention is to provide an electrical

impulse generator for producing high voltage electrical impulses of rectangular or flat top wave forms from a relatively low electrical source. It is contemplated by the present invention to provide means for serially discharging the potential stored in filter networks 10, 11 and 12, through a suitable impedance, for maintaining a constant potential, greater than the potential applied to terminals 16 and 17, across the impedance for a period of time determined by the electrical lengths of the filter networks. Such means, as shown in Fig. 1, comprises a plurality of suitable discharge devices, such as spark gaps 20, 21 and 22, which function to automatically periodically discharge the filter networks in series with an impedance, such as resistance 23. One electrode of spark gap 20 is connected to high potential terminal C of network 10 while the other electrode thereof is connected to low potential input terminal B' of network 11. The electrodes of spark gap 21 are respectively connected to terminal C' of network 11 and terminal B'' of network 12, while one electrode of spark gap 22 is connected to high potential output terminal C'', through inductance 24, the purpose of which will appear more fully hereinafter. The other electrode of spark gap 22 is connected to one end of resistance 23, while the other end of the latter is electrically connected to low potential output terminal D of network 10.

When the potentials across capacitances 14 reach a sufficient value, a difference in potential appears at the electrodes of spark gap 20 to cause the latter to discharge, and thus to increase the potential at terminal B' to a value substantially equal to the potential at terminal C. Such an increase in potential propagates through network 11 to apply a proportional increase in potential at terminals C' and B''. The increase in potential at terminal B'' will lag a similar increase in potential at terminal C'' since resistance 19 is positioned between terminals D' and B''. Such a lag in potential increase causes a momentary differential between the potentials at the electrodes of spark gap 21 to thus initiate discharge thereof. Filter networks 10, 11 and 12 are thus connected in such a manner to cause the capacitances included therein to serially discharge through spark gaps 20 and 21. The total potential of the filter network is thus applied to one electrode of spark gap 22, from terminal C'', to cause discharge at the latter spark gap and to thus serially discharge the total energy of the filter networks through resistance 23.

It has been found that when an artificial electrical line, such as a low pass filter network of the type disclosed, is charged with a considerable potential and then discharged through an impedance equal to the characteristic impedance of the line, that the discharged current remains substantially constant for an interval of time determined by the electrical length of the line, and then abruptly decreases to zero. During such time the voltage across the impedance is substantially constant, of a magnitude approximately equal to one-half the potential at which the line was charged. When filter networks 10, 11 and 12 are serially discharged through resistance 23, the discharge current remains substantially constant for a period of time approximately equal to $\pi\sqrt{LC/3}$, where L and C are the unit inductance and capacitance values of the networks. During such time interval the voltage across resistance 23 remains substantially constant, at an amplitude a number of times greater

than one-half the potential value applied to terminals 16 and 17 equal to the number of filter networks. To avoid an excessive voltage peak at the start of discharge, it is desirable to employ mid-series termination of the filter networks. This is accomplished by including inductance 24 in the discharge circuit.

In order to obtain rectangular or flat top voltage forms of still greater amplitude, with respect to the potential applied to terminal 16 or 17, resistance 23 may be increased to a value greater than the characteristic impedance of the filter networks. Under these conditions, the voltage across resistance 23, upon discharge of the filter networks, will be substantially constant for a time interval equal to $\pi\sqrt{LC/3}$, and of an amplitude equal to

$$E_c \left(\frac{R}{Z+R} \right)$$

where E_c is the potential charge of condensers 14, R is the value of discharge resistance 23, and Z the characteristic impedance of filter sections 10, 11 and 12. After lapse of the discharge time interval the voltage across resistance 23 abruptly drops from the value given by the above formula and then varies to zero potential. It is to be expressly understood, however, that the voltage forms generated in the foregoing manner are substantially constant for the discharge interval of the filter networks, with an abrupt decrease in amplitude to a value less than the constant amplitude value, after lapse of such time interval. As will appear more fully hereinafter, an oscillator load, or the load of any electrical device, may be made to cease functioning upon such abrupt decrease in amplitude.

In operation of the electrical impulse generator disclosed in Fig. 1, a constant source of potential is continually applied to input terminals 16 and 17. Since the input and output terminals of filter networks 10, 11 and 12 are interconnected in a manner noted heretofore, capacitances 14 included in each of the networks are charged in parallel relation from the applied potential. When the charge on capacitances 14 reach a sufficient value, spark gaps 20, 21 and 22 automatically progressively discharge to serially connect filter networks 10, 11 and 12 with resistance 23. For the reasons mentioned heretofore substantially constant current flows through resistance 23 for a period of time determined by the electrical lengths of the filter networks, during which time substantially constant voltage is maintained across the resistance. When the discharged time of the generator lapses, capacitances 14 are again charged in parallel relation from the potential source applied to terminals 16 and 17 until a sufficient charge is obtained to cause spark gaps 20, 21 and 22 to again discharge. It is to be expressly understood, therefore, that with the foregoing construction electrical impulses of rectangular or flat top wave forms are periodically generated across resistance 23 at a predetermined rate determined by the values of the circuit elements. Such wave forms, by the proper selection of the value of resistance 23, may comprise voltage amplitudes a number of times greater than the value of the potential applied at terminal 16 and 17.

Another embodiment of the invention is shown in Fig. 2. In this embodiment choke coils 24a are employed to connect the input and output terminals of filter networks 10, 11 and 12 instead of resistances 18 and 19 utilized in the generator

disclosed in Fig. 1. Also, choke coil 25 is utilized as the decoupling impedance between terminal 16 and input terminal A of filter network 10. The use of choke coils 24a and 25 is shown in order to illustrate the variety of coupling impedances that may be employed to thus obtain various operating frequencies. In the instant case, the time constant of choke coils 24a and the filter section capacities are to be relatively large with respect to the discharged time of the filter networks in order to maintain the discharged current through the choke coils at a relatively small value.

As stated heretofore, means are provided by the present invention for generating electrical impulses of rectangular wave form in accordance with a suitable synchronizing source whereby pulses may be obtained at a very high rate. As shown in Fig. 2, such means comprises gaseous discharge tubes 26 and 27 which are adapted to connect filter networks 10, 11 and 12 in such a manner to serially discharge the filter networks in accordance with a suitable synchronizing source. Plate 28, of tube 26, is connected to high potential output terminal C of filter 10, while filament 29 thereof is connected to low potential input terminal B' of network 11. Plate 30 and filament 31, of tube 27, are respectively connected to the high and low output and input terminals C' and B'' of filter networks 11 and 12. When tube 26 is rendered conducting, the potential charge of filter network 10 flows through tube 26 to terminal B' of network 11, while the combined potentials of networks 10 and 11 are applied to terminal B'' of network 12, when tube 27 is rendered conducting. Filaments 29 and 31 are supplied with suitable potential through transformers 32 and 33, while choke coils 34 and 35 are associated with each of the filament circuits to provide proper synchronization of the system. Choke coils 34 and 35 are to have a time constant substantially equal to the time constant of choke coils 24a. Control grids 36 and 37, of tubes 26 and 27 respectively, are connected to the output of transformer 38 and to a suitable bias supply 39. A synchronizer voltage is applied to the input of transformer 38 in order to render tubes 26 and 27 conducting at a predetermined rate. Grids 36 and 37 are connected together through impedance 40 which functions to produce a time delay between the application of similar voltages thereto, thus insuring the discharge through tube 26 prior to a similar operation of tube 27. Condensers 58 and 59, respectively connected across the plate and filament of tubes 26 and 27, function to produce a high surge of current at the instant tubes 26 and 27 are rendered conducting to thus decrease the time for serially connecting the filter networks while maintaining the proper synchronization. With this arrangement, filter networks 10, 11 and 12 are caused to serially discharge at a periodic rate controlled by the synchronizing voltage applied to transformer 38.

The impulse generator disclosed in Fig. 2 is shown interconnected with a high frequency oscillator 41 in such a manner that intermittent flow of constant current is applied thereto at a rate controlled by the synchronizing voltage. More particularly, the high potential output terminal C'' of network 12 is connected through inductance 24 to the plates of tubes 42 and 43 of the oscillator. The series discharge circuit is completed through tubes 42 and 43 to the low potential terminal of network 10.

In Fig. 3 a still further embodiment of the present invention is disclosed. In this embodi-

ment the filter networks 10, 11 and 12 are employed and are interconnected in a manner similar to the arrangement disclosed in Fig. 2. However, rotary spark gaps 44, 45 and 46 are provided for connecting filter networks 10, 11 and 12 in series relation during discharge thereof. More particularly, stationary electrodes 47 and 48, of spark gap 44, are connected to terminals C and B'; electrodes 49 and 50, of spark gap 45, are respectively connected to terminals C' and B'', while electrode 51, of spark gap 46, is connected through inductance 24 to terminal C'' and electrode 52 of the latter spark gap is connected to resistance 23. Each of the spark gaps 44, 45 and 46 have a rotary electrode 53, 54 and 55 respectively associated therewith. The rotary electrodes are mounted on shaft 56, which is rotated at a suitable speed by means of motor 57, to cause the spark gaps to discharge at a predetermined rate. When the spark gaps are simultaneously discharged, the electrical energy stored in filter networks 10, 11 and 12 is serially discharged through resistance 23, and substantially rectangular voltage wave forms are generated across the resistance in a manner similar to operation of the impulse generators described heretofore. Condensers 58 and 59, respectively connected across the stationary electrodes of spark gaps 44 and 45, are employed for a purpose similar to the purpose of condensers 58 and 59 previously described with reference to Fig. 2, in order to produce a high surge of current at the instant the spark gaps discharge to thus synchronize discharge of the spark gaps.

In order to further improve the synchronization of discharge of spark gaps 44, 45 and 46 the rotary electrodes of the spark gaps are connected to ground potential through a suitable capacitance. As shown, rotary electrodes 53, 54 and 55 are respectively connected to ground potential through capacitances 60, 61 and 62. When spark gap 44 discharges, the stationary electrodes of spark gaps 45 and 46 will abruptly increase in potential, while the rotary electrodes 54 and 55 thereof will receive an increase in potential determined by the values of capacitances 61 and 62. If capacitances 61 and 62 are of substantially large value, the increase in potential at rotary electrodes 54 and 55 will be less than the potential increase at the stationary electrodes by an amount proportional to the capacitance values. With the foregoing arrangement, a relatively large difference in potential at the stationary and rotary electrodes of spark gaps 45 and 46 appears at the instant spark gap 44 discharges. Such potential differential causes spark gaps 45 and 46 to progressively discharge immediately following the discharge of spark gap 44.

In Fig. 4 of the drawings a rotor including the rotary electrodes of spark gaps 44, 45 and 46 is disclosed including means providing the potential differentials mentioned heretofore. As shown, the rotor comprises a metallic shaft 63 which is rotated by motor 57. A cylindrical sleeve 64, of insulating material having circumferential corrugations on the periphery thereof, is mounted on shaft 63 and is adapted to rotate therewith. Rotary electrodes 53, 54 and 55 are secured to the outer periphery of metallic bands 65 which are mounted on sleeve 64. With this construction, a certain capacity exists between metallic bands 65 and metallic shaft 63 and thus provides the advantageous results obtained from

use of capacitances 60, 61 and 62 as shown in Fig. 3.

There is thus provided by the present invention a novel electrical impulse generator for producing high voltage impulses of rectangular or flat top wave forms from a relatively lower voltage source. The impulse generators utilize a plurality of artificial lines, such as low pass, constant k filter networks having potential storing characteristics, which are adapted to be charged with a source of potential in parallel relation and discharged in series through an impedance. Several arrangements are disclosed and described herein for serially connecting the outputs of certain of the filter networks to the inputs of certain other of the networks for serially discharging the networks through the impedance, with novel means associated with such discharge devices for insuring synchronous operation thereof. The impulse generators disclosed by the present invention are of such character that the same may be utilized for applying impulses of the proper wave forms and of sufficient amplitude to adequately control operation of various high frequency electrical apparatuses, such as high frequency oscillators for example.

Although several embodiments of the invention have been disclosed and described in detail herein, it is to be expressly understood that various changes and substitutions may be made therein without departing from the spirit of the invention as well understood by those skilled in the art. Reference therefore will be had to the appended claims as a definition of the limits of the invention.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. An electrical impulse generator comprising a plurality of artificial lines having potential storing characteristics, means charging said lines in parallel relation from a source of potential, a discharge circuit having an impedance, and means serially discharging said lines through said discharge circuit for applying a constant voltage across said impedance for a period of time determined by the electrical length of said lines.

2. An electrical impulse generator comprising a plurality of artificial lines having potential storing characteristics, means charging said lines in parallel relation from a source of potential, a discharge circuit having an impedance, and means serially discharging said lines through said impedance for applying a constant voltage, greater than the potential of said source, across said impedance for a period of time determined by the electrical length of said lines.

3. A periodical wave repeater for producing output pulses comprising a plurality of artificial electrical lines having potential storing characteristics, a source of potential for charging said lines in parallel relation, a discharge circuit having an impedance, and means periodically discharging said lines in series relation through said discharge circuit for periodically applying a constant potential, greater than said source, across said impedance for a period of time determined by the electrical lengths of said lines.

4. An electrical impulse generator comprising a plurality of artificial lines, capacitance means included in each of said lines, means applying a source of potential to each of said lines for charging

said capacitance means in parallel relation, a discharge circuit including an impedance, and means serially discharging said lines through said discharge circuit for applying a constant potential across said impedance for a period of time determined by the electrical lengths of said lines.

5. A periodic wave repeater for producing output pulses comprising a plurality of artificial lines, capacitance means included in each of said lines, means applying a source of potential to said lines for charging said capacitance means in parallel relation, a discharge circuit including an impedance, and means periodically discharging said lines in series relation through said discharge circuit for periodically applying a constant potential across said impedance for a period of time determined by the electrical lengths of said lines.

6. An electrical impulse generator comprising a plurality of artificial lines having potential storing characteristics, a source of potential, means charging said lines in parallel relation from said source, a discharge circuit including an impedance, means serially discharging said lines through said discharge circuit for applying a constant potential across said impedance for a period of time determined by the electrical length of said lines, and last-named means including means positioned between certain of said lines for automatically connecting said lines in series relation with said discharge circuit when the potential stored in said lines reaches a predetermined value.

7. An electrical impulse generator comprising a plurality of artificial lines having potential storing characteristics, each of said lines having high and low input and output terminals, means connecting the output terminals of certain of said lines to the input terminals of other of said lines, means applying a source of potential to the input terminals of one of said lines for charging said lines in parallel relation, a discharge circuit having an impedance connected between the high potential output terminal of another of said lines and the low potential output terminal of said one line, and means serially discharging said lines through said discharge circuit for applying a constant potential across said impedance for a period of time determined by the electrical length of said lines.

8. An electrical impulse generator comprising a plurality of artificial lines having potential storing characteristics, each of said lines having high and low input and output terminals, means interconnecting certain of said input and output terminals for connecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging said lines in parallel relation, a discharge circuit having an impedance connected between the high potential output terminal of the last line of said parallel connected lines and the low potential output terminal of said first line, and means connecting the high potential output terminal of certain of said lines to the low potential input terminal of the next line of said parallel connected lines when the potentials at said output terminals reach a predetermined value for serially discharging said lines through said discharge circuit whereby a substantially constant potential is applied across said impedance for a period of time determined by the electrical length of said lines.

9. An electrical impulse generator comprising a plurality of artificial lines having potential storing characteristics, each of said lines having high and low input and output terminals, means interconnecting certain of said input and output terminals for connecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging said lines in parallel relation, a discharge circuit having an impedance connected between the high potential output terminal of the last line of said parallel connected lines and the low potential output terminal of said first line, a spark gap connected between the high potential output terminal of certain of said lines and the low potential input terminal of the next line of said parallel connected lines, said spark gaps adapted to discharge when the potentials at said high potential output terminals reach a predetermined value for serially discharging said lines through said discharge circuit whereby a substantially constant potential is applied across the said impedance for a period of time determined by the electrical lengths of said lines.

10. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharging circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, and means serially discharging said capacitance means through said discharge circuit for applying a substantially constant potential across said impedance for a period of time determined by the electrical lengths of said lines.

11. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharging circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, and means connecting the high potential output terminal of certain of said lines to the low potential input terminals of the next lines of said parallel connecting lines when the potentials at said output terminals reach a predetermined value for serially discharging said lines through said discharge circuit whereby a substantially constant potential is applied across said impedance for a period of time determined by the electrical lengths of said lines.

12. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in

parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharging circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, and a spark gap connected between the high potential output terminals of certain of said lines and between the low input potential terminals of the next lines of said parallel connected lines, said spark gap adapted to discharge when the potential at said high output terminals reach a predetermined value for serially discharging said capacitance means through said discharge circuit whereby a substantially constant potential is applied across said impedance for a period of time determined by the electrical lengths of said lines.

13. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said input and output terminals, means continually applying a source of potential to the input terminals of the first line of said connected lines for charging said capacitance means included in said lines in parallel relation, a discharge circuit having an impedance connected between the output of the last line of said connected lines and said first line, and means periodically discharging said capacitance means of each of said lines in series relation through said discharge circuit for periodically applying a substantially constant potential across said impedance for a period of time determined by the electrical lengths of said lines.

14. An electrical impulse generator comprising a plurality of low pass filter networks, means connecting said networks in parallel relation, means applying a source of potential to the first network of said parallel connected networks for charging said networks in parallel relation, a discharge circuit having an impedance connected between the output of the last network of said parallel connected networks and said first network, and means serially discharging the potential stored in said networks through said discharge circuit for applying a substantially constant potential across said impedance for a period of time determined by the characteristics of said networks.

15. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharging circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, a discharge device connected between the high potential output terminals of certain of said lines and between the low potential output terminals of the next line of said parallel connected lines, means periodically discharging said devices for serially discharging the capacitance means included in each of said lines through said discharge circuit whereby a substantially constant

potential, greater than the potential of said source, is periodically applied across said impedance for a period of time determined by the electrical lengths of said lines.

16. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharge circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, an electron discharge device connected between the high potential output terminals of certain of said lines and between the low potential input terminals of the next line of said parallel connected lines, and means periodically rendering said devices conducting for serially discharging the capacitance means included in each of said lines through said discharge circuit whereby a substantially constant potential, greater than the potential of said source, is periodically applied across said impedance for a period of time determined by the electrical lengths of said lines.

17. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharging circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, an electron discharge device connected between the high potential output terminals of certain of said lines and between the low potential input terminals of the next line of said parallel connected lines, and a source of synchronizing voltage for periodically rendering said devices conducting for serially discharging the capacitance means included in each of said lines through said discharge circuit whereby a substantially constant potential, for a period of time determined by the electrical lengths of said lines, is periodically applied across said impedance.

18. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharge circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, an electron discharge device connected between the high potential output terminals of certain of said lines and between the low potential input terminals of the next line of said parallel connected lines, a source of synchronizing voltage

for periodically rendering said devices conducting for serially discharging the total capacitance means included in each of said lines through said discharge circuit whereby a substantially constant potential, for a period of time determined by the electrical lengths of said lines, is periodically applied across said impedance, and means synchronizing the discharge of said devices whereby the devices progressively discharge for progressively connecting said lines in series relation.

19. An electrical impulse generator comprising a plurality of artificial lines having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharging circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, a plurality of discharge devices having a rotary electrode and a pair of stationary electrodes associated with said rotary electrode, means connecting one of the stationary electrodes of each of said devices to the high potential output terminal of certain of said lines and the other stationary electrode of each of said devices to the low potential input terminal of the next line of said parallel connected lines, and means rotating said rotary electrodes at a predetermined rate of speed for periodically progressively discharging said devices whereby said lines are periodically serially discharged through said discharge circuit for periodically producing a substantially constant potential across said impedance for a period of time determined by the electrical lengths of said lines.

20. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharge circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, a plurality of discharge devices having a rotary electrode and a pair of stationary electrodes associated with said rotary electrode, means connecting one of the stationary electrodes of each of said devices to the high potential output terminal of certain of said lines and the other stationary electrode of each of said devices to the low potential input terminal of the next line of said parallel connected lines, means rotating said rotary electrodes at a predetermined rate of speed for periodically progressively discharging said devices whereby said lines are periodically serially discharged through said discharge circuit for periodically producing a substantially constant potential across said impedance for a period of time determined by the electrical lengths of said lines, and a condenser connected between each of said rotary electrodes and ground potential for synchronizing discharge of said devices.

21. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharge circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, a plurality of discharge devices having a rotary electrode and a pair of stationary electrodes associated with said rotary electrode, means connecting one of the stationary electrodes of each of said devices to the high potential output terminal of certain of said lines and the other stationary electrode of each of said devices to the low potential input terminal of the next line of said parallel connected lines, an electrical grounded rotating shaft for simultaneously rotating said rotary electrodes at a predetermined speed for progressively discharging said devices whereby said lines are periodically serially discharged through said discharge circuit for periodically producing a substantially constant potential across said impedance for a period of time determined by the electrical lengths of said lines, and capacitance means positioned between said shaft and said rotary electrodes for synchronizing discharge of said devices.

22. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharging circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, an electron discharge device connected between the high potential output terminals of certain of said lines and between the low potential input terminals of the next line of said parallel connected lines, means periodically rendering said devices conducting for serially discharging the total capacitance means included in each of said lines through said discharge circuit whereby a substantially constant potential, greater than the potential of said source, is periodically applied across said impedance for a period of time determined by the electrical lengths of said lines, and a condenser connected between the input and output of each of said devices for accelerating and synchronizing the serial discharge of said capacitance means.

23. An electrical impulse generator comprising a plurality of artificial lines each having a plurality of serially connected inductance means with a plurality of capacitance means connected in parallel relation therewith, each of said lines having high and low potential input and output

terminals, means interconnecting said lines in parallel relation, means applying a source of potential to the input terminals of the first line of said parallel connected lines for charging the capacitance means included in said lines in parallel relation, a discharging circuit having an impedance connected between the output of the last line of said parallel connected lines and said first line, discharge means connecting the high potential output terminal of certain of said lines to the low potential input terminals of the next lines of said parallel connected lines when the potentials at said output terminals reach a predetermined value for serially discharging said lines through said discharge circuit whereby a substantially constant potential is applied across said impedance for a period of time determined by the electrical lengths of said lines, and a condenser connected across each of said discharge means for synchronizing discharge of said devices.

24. An electrical impulse generator comprising a plurality of low pass filter networks, means connecting said networks in parallel relation, means applying a source of potential to the first network of said parallel connected networks for charging said networks in parallel relation, a discharge circuit having an impedance connected between the output of the last network of said parallel connected networks and said first network, means serially discharging the potential stored in said networks through said discharge circuit for applying a substantially constant potential across said impedance for a period of time determined by the electrical characteristics of said networks, and means included in said discharge circuit for producing mid-series termination of said networks whereby excessive voltage flow is prevented at instant said networks are discharged.

25. An apparatus for synchronously discharging a plurality of electrical systems comprising a plurality of discharge devices, each of said devices comprising a pair of fixed electrodes and third electrode means rotatably mounted to periodically establish a discharge circuit between the associated pair of fixed electrodes and means for simultaneously rotating the third electrode means and periodically discharging the electrical systems including an electrically grounded shaft rotatable at a predetermined rate of speed, a sleeve of insulating material positioned on said shaft, and metallic collars mounted on said sleeve for carrying the third electrode means, the shaft, insulating sleeve and collars constituting a stabilizing capacity for maintaining the rotary electrode means at ground potential for establishing a discharge between the fixed electrodes by discharge to the rotary electrodes across the potential of the fixed electrodes to ground.

26. A periodical wave repeater for producing output pulses comprising potential storing electrical circuit means, potential supply means for charging the storing circuit means, and a discharge circuit including a load impedance connected across the storing circuit means through synchronous discharge means comprising a pair of fixed electrodes and third electrode means rotatably mounted on a shaft for periodically establishing a circuit between the fixed electrodes to discharge the storing circuit means through the load impedance.

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