

2,713,658

POWER SUPPLY FILTER NETWORK

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Application November 26, 1946, Serial No. 712,332

6 Claims. (Cl. 320—1)

(Granted under Title 35, U. S. Code (1952), sec. 266)

This invention relates to electrical impulse power generating systems and in particular to systems for producing high power impulses having substantially uniform level for the entire pulse duration and having low filter requirements.

Systems for delivering high power electrical impulses of constant power level to a load impedance have been available in the past. Satisfactory systems have employed a storage capacitance which was charged to a selected voltage and then allowed to discharge to the load impedance upon the operation of a switch. Such a prior art impulse power supply system, although economically providing high peak power for short periods of time of necessity involved a switch element having high current capabilities to initiate and maintain the current flow through the load impedance for high peak power output. At high impulse rates where operation of a mechanical switch is inadequate, an electron discharge device is necessary to control the rapid switching of power.

Gaseous electron discharge devices are not, as a rule, desirable in such a power supply system because they are subject to considerable variation in characteristics whenever the temperature and pressure of the discharge medium is altered and further require complete discharge of the power supply system. Such complete discharge requires a matching of the power supply system to the load impedance which frequently is inconvenient.

It is therefore an object of the present invention to provide an impulse power generator system in which a hard tube discharge switch is employed to control the flow of power from the supply system to the load circuit.

Another object of the present invention is to provide an impulse power supply system employing a current controlling impedance network in series with the load circuit in which the initial voltage loss across the current controlling impedance network is a small fraction of the voltage of the power supply system.

Another object of the present invention is to provide an impulse power supply system having low storage requirements.

Other and further objects and features of the present invention will become apparent upon a careful consideration of the accompanying drawing and following detailed description.

Fig. 1 shows a schematic diagram, partly in block, of one embodiment of the features of the present invention.

Fig. 2 shows a group of theoretical voltage waveforms taken to illustrate the operation of the apparatus of Fig. 1.

In accordance with the fundamental concepts of the present invention, a high vacuum electron tube, gated by means of a supplementary pulse source, is employed to control the partial discharge of a high voltage storage condenser through a serially arranged impedance path including a load impedance and a bilateral current controlling impedance. A current controlling impedance is employed having a surge impedance less than the load impedance and current maintaining characteristics such that

a constant power input to the load is experienced for the duration of the impulse output.

With reference now to Fig. 1, a storage capacitance 10 is maintained in a charged condition by a voltage supply such as the type shown in which a transformer 11 is employed to step up an A.-C. voltage from source 12. The secondary voltage of the transformer 11 is rectified by the unilateral elements 13, 14 to provide D.-C. charging of capacitance 10.

Periodic partial discharge of capacitance 10 to a load impedance 15 which may include impedance matching elements is controlled by a high vacuum electron tube 16 which must be capable of operating at the peak voltages and peak currents encountered. Tube 16 is normally maintained in a non-conductive condition by a suitable biasing arrangement such as the grid leak biasing elements 17, 18. Positive impulses having the duration and repetition frequency desired for the energy applied to the load 15 are supplied to the grid of tube 16 from an impulse generator 19 through a coupling transformer 20.

Included in the discharge path of capacitance 10 and in series with the load impedance 15 is a current controlling impedance 21. Impedance 21 consists of a plurality of serially connected anti-resonant tuned circuits, 22, 23, 24, 25 having capacitive elements 26, 27, 28, 29 each equal in capacitance value to one half that of the capacitance 10. One anti-resonant circuit, preferably 22, is tuned to the fundamental frequency of the output pulses applied to load 15, the fundamental frequency of the pulses being defined as the reciprocal of the pulse duration. Other tuned circuits, preferably 23, 24, 25, in that order are tuned to the second, third, and fourth harmonics of the tuned frequency of circuit 22.

In the circuit of Fig. 1, the surge impedance of the controlling impedance 21 is made considerably less than the impedance of the load 15 and only a partial discharge of capacitance 10 is permitted to occur during an output impulse so that a large percentage of the voltage existing across capacitance 10 will be supplied to the load 15. This results in a condition wherein the voltage rating of the capacitance 10 need only exceed the desired load impulse voltage by a small amount rather than be twice that of the load voltage where the impedance of network 21 is equal to the impedance of the load 15 in the matched impedance condition. Furthermore where the available voltage delivered to the load is a large percentage of the voltage existing across capacitance 10, the voltage handling requirements of tube 16 will be substantially less than the case where the surge impedance of the controlling element 21 is equal to the impedance of the load 15. Also in this present system the embodiment of a special impedance variation element permits substantial reduction in the size of capacitance 10 for a given pulse shape compared to the size of that element required in prior art systems.

In this circuit, the minimum size of the capacitance 10 required to give a constant power output impulse having a duration (T) may be calculated by the following equation:

$$C_{10} = \frac{iT}{2KE_s}$$

where

C_{10} = capacitance in farads

i = load current desired (amperes)

K = a constant equal to the fraction of the initial voltage charge on capacitance 10 which initially appears across the controlling impedance 21

E_s = initial voltage across capacitance 10

KE_s = initial voltage across controlling impedance 21

An inspection of this equation will reveal that where it is desired to keep the percentage of the voltage across

What is claimed is:

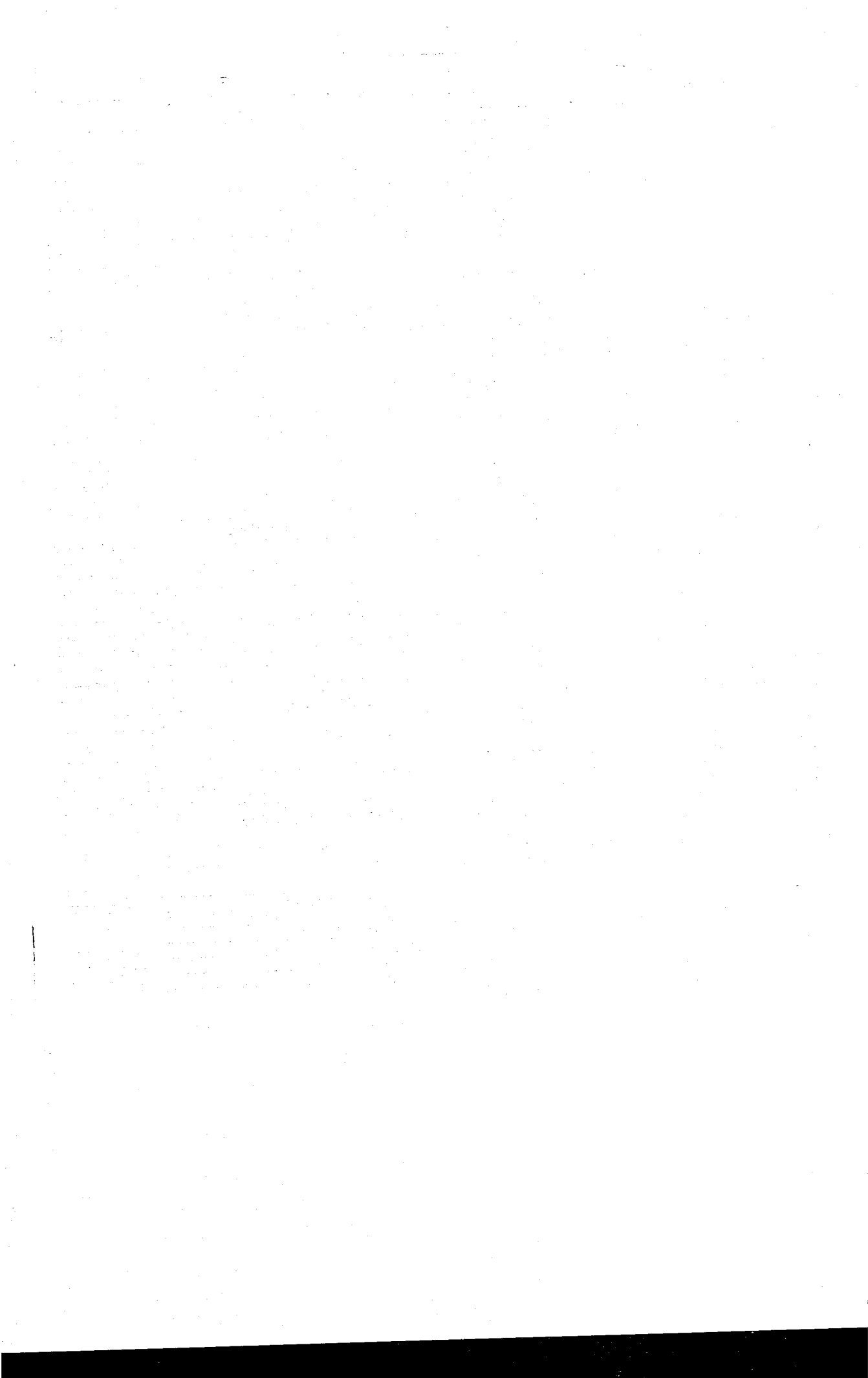
1. In combination, a storage capacitor, a network resonant at a plurality of harmonically related frequencies and a dissipative load serially coupled across the storage capacitor, the capacitor and load having a discharge time constant, the fundamental frequency of the network having a period much less than the discharge time constant of the capacitor and load, hard tube switch means operative to discharge the capacitor through the network into the load, and means effecting conduction of the tube for a limited period substantially equal to the fundamental period.
2. In an electrical impulse generator productive of output impulses, a capacitance, means charging said capacitance to a selected voltage, a discharge circuit for said capacitance coupled across the same and including a serially coupled load impedance and a bilateral current limiting impedance, said load impedance having an impedance value substantially greater than the surge impedance of said bilateral impedance, said bilateral current limiting impedance including a plurality of serially arranged inductance-capacitance tuned circuits having capacity elements equal in size to one half the size of said capacitance, a first of said tuned circuits being tuned to parallel resonance at the fundamental frequency of the output impulses and subsequent tuned circuits being tuned to parallel resonance at subsequent harmonic frequencies of the output impulses, a pulse signal source for producing pulses of known duration, and a hard tube switch interposed in the discharge path of said capacitance and responsive to pulses from said pulse signal source for controlling the duration of the discharge period of said capacitance.
3. An electrical impulse power generator system, comprising, means generating a keying pulse of selected duration, a capacitive energy storage device, means charging said capacitive energy storage device, discharge means for said capacitive storage device coupled across the same and including a serially disposed load impedance, a bilateral current limiting impedance, and a hard tube discharge switch, said load impedance having an impedance value substantially greater than the surge impedance of said bilateral impedance, said hard tube discharge switch being responsive to keying pulses produced by the first named means for permitting a partial discharge of said capacitive energy storage device during the keying pulse, said bilateral current limiting impedance including a plurality of serially arranged anti-resonant tuned circuits having, separately and respectively, harmonically related frequencies with a fundamental frequency equal to the fundamental frequency of the keying pulse, each of said anti-resonant tuned circuits possessing a capacitor equal in size to one half the capacitance of said capacitive energy storage device.
4. An electrical impulse power generator system, comprising; means generating keying pulses of selected duration, a capacitive energy storage device, means charging said capacitive energy storage device to a selected voltage, discharge means for said capacitive energy storage device coupled across the same and including a serially dis-

- posed load impedance, a bilateral current limiting impedance having a surge impedance less than the load impedance, and a hard tube discharge switch, said hard tube discharge switch being responsive to keying pulses produced by the first named means for permitting a partial discharge of said capacitive energy storage device during each of the keying pulses, said bilateral current limiting impedance including a plurality of serially arranged anti-resonant inductance-capacitance circuits having, separately and respectively, harmonically related frequencies with a fundamental frequency equal to the fundamental frequency of the keying pulses, each of said anti-resonant tuned circuits possessing capacitance elements equal in size to one half the capacitance of said capacitive energy storage device.
5. In combination, a storage capacitor, a current limiting network having as a whole a surge impedance value and including a plurality of serially coupled anti-resonant circuits, each circuit including a condenser capacitively half equal to said storage capacitor and an inductor in parallel with said condenser, said inductors having different inductance values for rendering said circuits separately and respectively anti-resonant for a fundamental frequency and harmonic frequencies thereof, a dissipative load of an impedance value greater than the surge impedance value of said network, hard tube switch means adapted to be rendered intermittently conductive, said network, load, and switch means being serially coupled across said storage capacitor.
 6. An electrical impulse generator comprising in combination; a dissipative load of preselected impedance value, a source of keying input pulses having preselected equal individual periods determinative of the pulse fundamental frequency, a storage capacitor of a capacitance value yielding with the impedance value of said load a discharge time constant substantially exceeding said keying pulse periods, means for charging said capacitor to a selected voltage, a plurality of anti-resonant circuits serially coupled in a network, each circuit including a condenser capacitively half equal to said storage capacitor and an inductor in parallel with said condenser, said inductors having different inductance values for rendering said circuits separately and respectively anti-resonant for the keying pulse fundamental frequency and harmonic frequencies thereof, hard tube switch means operable to conduct responsive to said keying pulses, said load, switch means and network being serially coupled across said storage capacitor.

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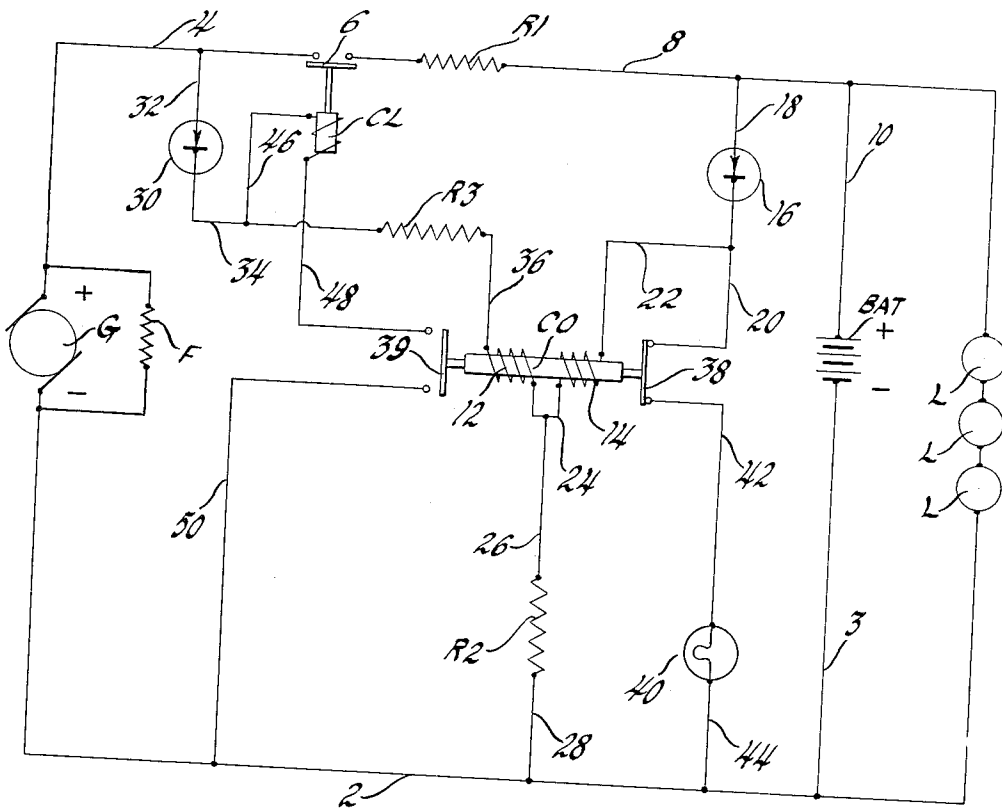


July 19, 1955

L. L. JOHNSON
BATTERY CHARGING CONTROL

Filed Jan. 4, 1954

2,713,659



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