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PULSE FORMING CIRCUIT

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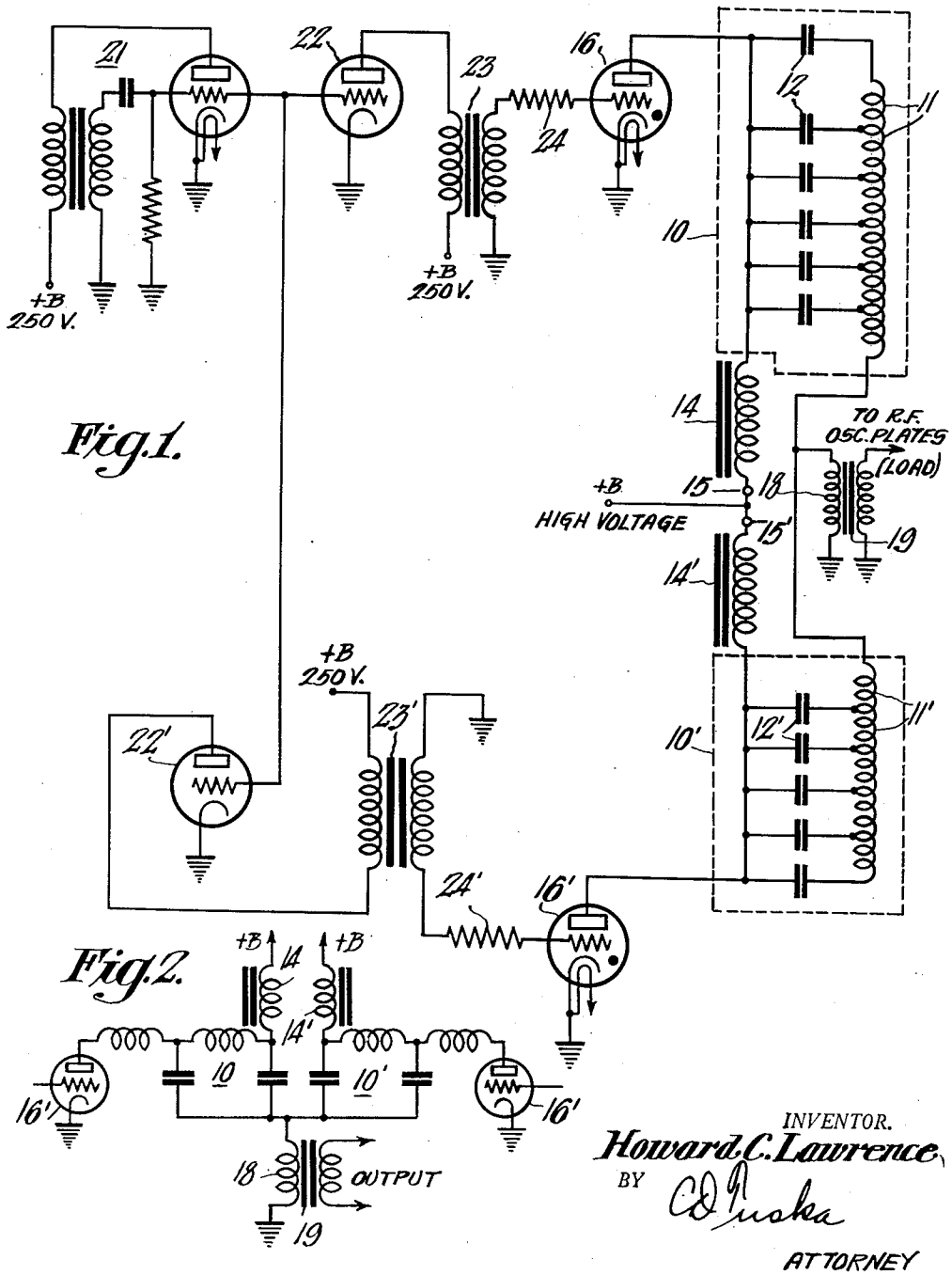



Fig. 1.

Fig. 2.

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## PULSE FORMING CIRCUIT

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6 Claims. (Cl. 250—27)

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The invention covered herein may be manufactured and used by or for the Government of the United States for any governmental purpose without payment to me or assigns of any royalty thereon.

My invention relates to the production of electrical pulses and particularly to systems wherein energy which is stored in pulse-forming lines or networks is discharged through two or more gas or vapor discharge tubes to produce an electrical pulse.

An object of the invention is to provide an improved circuit for producing pulses having average and/or peak powers above the capabilities of a single discharge tube.

A further object of the invention is to provide a pulse-forming system of the above-mentioned type wherein the duration of a pulse is not changed by failure of a discharge tube.

A further object of the invention is to provide a system of the above-mentioned type in which, upon failure of a discharge tube, the duration of the pulses remains substantially unchanged and in which the power of the pulses is only slightly reduced.

A further object of the invention is to provide an improved pulse-forming circuit which remains operative to produce usable pulses after failure of a discharge tube.

In one preferred embodiment of the invention, there are two pulse-forming delay lines which are charged through two reactors or choke coils, respectively, and which have a common pulse output circuit. There is a separate gas discharge tube for each pulse-forming line, the two discharge tubes being triggered through separate tubes by pulses from a single blocking oscillator or the like. The failure of either discharge tube will have only a slight effect on the power output and no effect on the pulse length.

The invention will be better understood from the following description taken in connection with the accompanying drawing in which Figures 1 and 2 are circuit diagrams of two embodiments of the invention. In the two figures, similar parts are referred to by similar reference characters.

Referring to Fig. 1 of the drawing, the invention comprises pulse-forming networks 10 and 10' which may be in the form of low-pass filters having series inductance coils 11 and 11' and shunt capacitors 12 and 12', respectively. An equivalent pulse-forming network may be substituted for the type illustrated. The pulse-forming networks 10 and 10' are charged to a suitable potential from a direct-current source (not shown) which is connected to the networks 10 and 10' through charging reactors 14 and 14', respectively. It may be desirable to include ammeters 15 and 15' to meter separately the discharge currents of the two networks. The charging reactors 14 and 14' present

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such high impedance at the pulse frequency that the networks 10 and 10' are substantially open circuited and, therefore, are reflecting at one end. The inductance of each charging reactor is usually chosen to be of such value that it will resonate the total capacity in each pulse-forming line at a frequency equal to or lower than ½ the repetition rate of the pulses formed. A typical value for each reactor coil is 80 henries. The outputs of the two pulse-forming lines are connected in parallel to the primary 18 of a pulse output transformer 19. A voltage pulse (of negative polarity) is produced across the primary winding as explained below.

It is well known that a rectangular voltage pulse may be formed by discharging certain types of networks such as the networks 10 and 10' through a load preferably having an impedance substantially equal to the characteristic impedance of the network. In Fig. 1, the networks 10 and 10' are discharged periodically through a pair of gas or vapor discharge tubes 16 and 16', respectively, and through the primary 18 of a transformer 19 coupled to the load (not shown) to produce the desired voltage pulses. The load may be a magnetron which is to be keyed by the applied pulses for the production and transmission of pulses of high frequency radio energy. The gas discharge tubes 16 and 16' may be hydrogen Thyratrons, for example.

The discharging path for the networks 10 and 10' may be traced from one end of each network on the output transformer side through the primary winding 18 to ground, through ground to the cathodes of the discharge tubes 16 and 16', and through the tubes 16 and 16' to the other side of the networks 10 and 10', respectively.

The periodic pulses for causing the gas discharge tubes 16 and 16' to break down and discharge the networks 10 and 10' may be produced by a blocking oscillator 21. The positive blocking oscillator pulses are applied to vacuum tubes 22 and 22' which function as buffer amplifiers to isolate the grid circuits of the gas discharge tubes 16 and 16' from each other. The pulses from tubes 22 and 22' are passed through pulse inverting transformers 23 and 23' and applied through grid current limiting resistors 24 and 24' with positive polarity to the grids of the gas discharge tubes 16 and 16'. Resistors 24 and 24' may be eliminated with some types of gas discharge tubes.

The invention is not limited to the specific circuit of Fig. 1. As shown in Fig. 2, for example, the charging choke coils 14 and 14' may be connected to the inductance coil side of the networks 10 and 10', and the other connections changed accordingly.

The invention is not limited to the use of two gas discharge tubes. Any number of gas discharge tubes may be employed. Each tube must have its own driver or buffer and its own pulse-form-

ing line and charging reactor. The outputs of all of the pulse-forming lines are then connected in parallel at the primary of the pulse output transformer.

The advantages of the present invention over previous proposals for operation of two or more gas discharge tubes in parallel are: (1) Upon removal of one gas discharge tube through failure, the remaining tube or tubes will assume a large percentage of the load formerly taken by the tube which has been removed; (2) The pulse length will not be affected by the failure of one tube; (3) It is possible to meter separately the currents of the two gas discharge tubes thereby facilitating maintenance, the proportion of the load assumed by each gas discharge tube being determined from the meter readings; (4) The tubes are operated in such manner that should they not be identical in characteristic when they are placed in operation, thereby causing them to assume disproportionate percentages of the load power, they will be aged in such a way that the load becomes more nearly equally divided.

I claim as my invention:

1. In a pulse generating circuit, a plurality of pulse-forming delay networks, a plurality of reactance units connected to said networks, respectively, through which charging currents are supplied to said networks, said reactance units presenting a high impedance to the frequency components of the pulses to be generated, a load circuit that is common to said networks and which has an impedance that is substantially equal to the characteristic impedance of said networks as viewed from said load circuit whereby said networks discharge into said load circuit substantially without reflection, a plurality of discharge tubes connected to said networks respectively for discharging them through said load circuit, and means for causing said discharge tubes to periodically discharge said networks simultaneously.

2. In a pulse generating circuit, a pair of pulse-forming delay networks, a pair of reactance units connected to said networks, respectively, through which charging currents are supplied to said networks, said reactance units presenting a high impedance to the frequency components of the pulses to be generated, a load circuit that is common to said networks and which has an impedance that is substantially equal to the characteristic impedance of said networks as viewed from said load circuit whereby said networks discharge into said load circuit substantially without reflection, a pair of discharge tubes connected to said networks respectively for discharging them through said load circuit, and a source of driving pulses connected to said discharge tubes for causing them to discharge said networks periodically and simultaneously.

3. A pulse generator comprising a pair of delay networks, an output circuit common to said networks and which has an impedance that is substantially equal to the characteristic impedance of said networks as viewed from said output circuit whereby said networks discharge into said output circuit substantially without reflection, means for charging one of said networks through a comparatively high impedance reactance coil, means for charging the other of said networks through a second comparatively high impedance reactance coil, means including a discharge tube for discharging one of said networks through said output circuit periodically, and means including a second discharge tube for discharging the other of said networks through said output circuit simultaneously with the discharging of said one network.



4. In a pulse generating circuit, a plurality of pulse-forming delay networks, a plurality of reactance units connected to said networks, respectively, through which charging currents are supplied to said networks, said reactance units presenting a high impedance to the frequency components of the pulses to be generated, a load circuit that is common to said networks and which has an impedance that is substantially equal to the characteristic impedance of said networks as viewed from said load circuit whereby said networks discharge into said load circuit substantially without reflection, a plurality of discharge tubes connected to said networks respectively for discharging them through said load circuit, a plurality of buffer tubes connected to said discharge tubes, respectively, and a source of driving pulses connected to said discharge tubes through said buffer tubes for causing them to discharge said networks periodically and simultaneously.

5. In a pulse generating circuit, a plurality of pulse-forming delay networks, a plurality of reactance coils, each of said networks having one of said coils connected thereto through which charging currents are supplied to the network, said reactance coils presenting a high impedance to the frequency components of the pulses to be generated, a load circuit that is common to said networks and which has an impedance that is substantially equal to the characteristic impedance of said networks as viewed from said load circuit whereby said networks discharge into said load circuit substantially without reflection, a plurality of discharge tubes, each of said networks having one of said discharge tubes connected thereto for discharging it through said load circuit, a plurality of buffer tubes, and a common source of driving pulses connected to each of said discharge tubes through a separate buffer tube for causing the discharge tubes to discharge said networks periodically and simultaneously.

6. A pulse generator comprising a plurality of delay networks and which has an impedance that is substantially equal to the characteristic impedance of said networks as viewed from said output circuit whereby said networks discharge into said output circuit substantially without reflection, an output circuit common to said networks, means for charging said networks through a plurality of comparatively high impedance circuits, respectively, and means including a plurality of discharge tubes for periodically and simultaneously discharging said plurality of networks, respectively, through said output circuit.

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## Certificate of Correction

Patent No. 2,446,838. August 10, 1948.

HOWARD C. LAWRENCE, JR.

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

Column 4, lines 54 and 55, claim 6, strike out the comma and words ", an output circuit common to said networks" and insert the same after "networks" and before "and" in line 49, same claim;

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

Signed and sealed this 8th day of February, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
*Assistant Commissioner of Patents.*

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