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2,154,378

START-STOP TUBE OSCILLATOR

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Fig. 1.

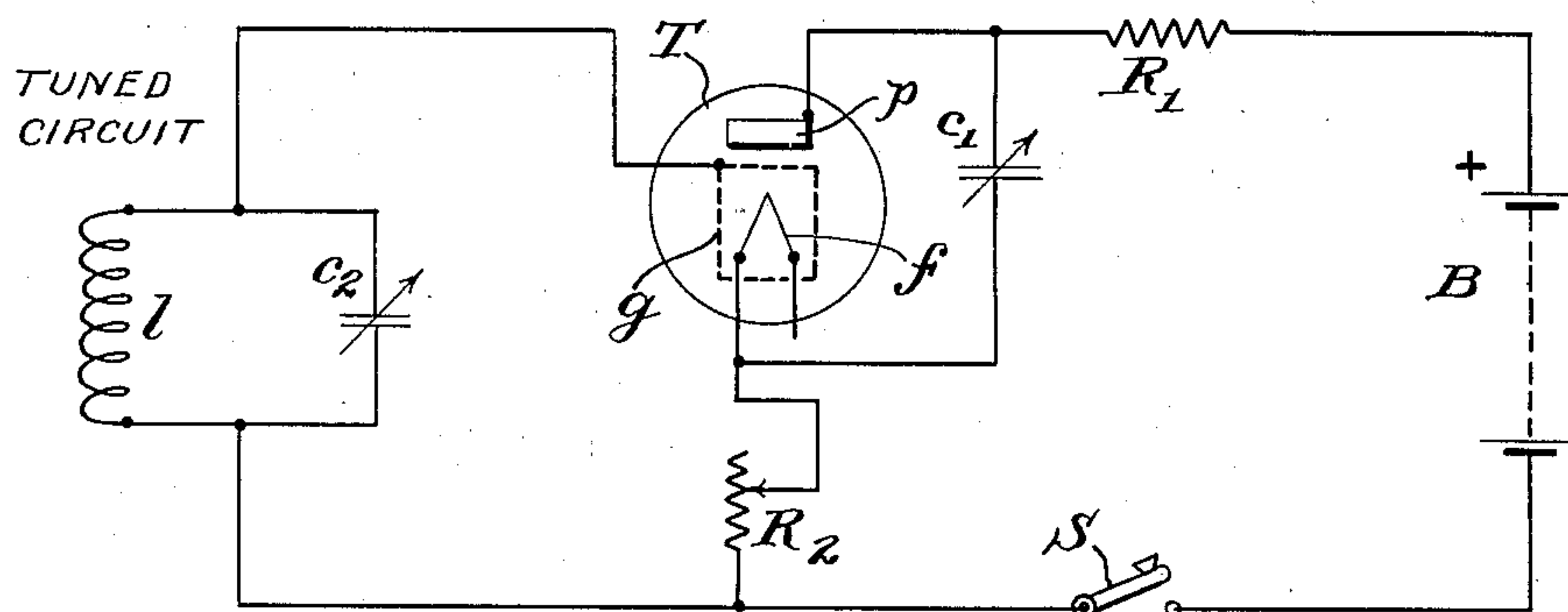
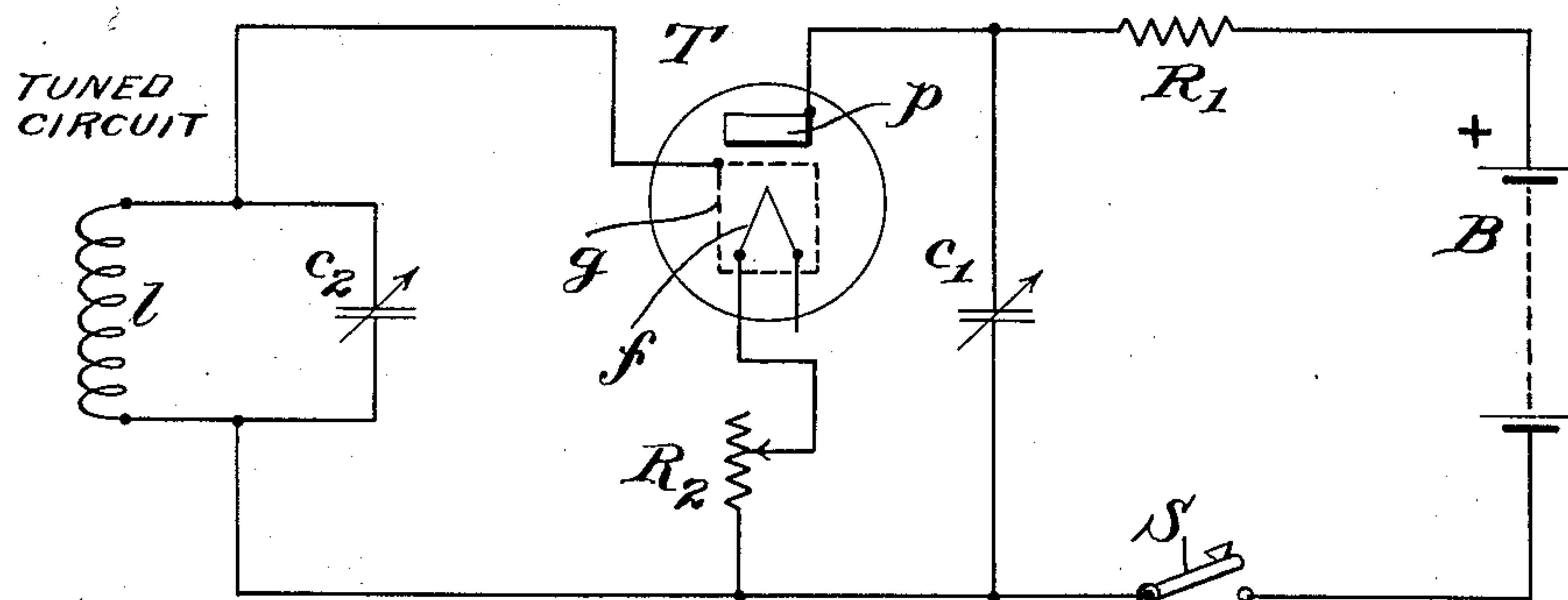


Fig. 2.



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START-STOP TUBE OSCILLATOR

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9 Claims. (Cl. 250—36)

This invention relates to circuit arrangements used in conjunction with a gaseous arc-discharge tube for the production of continuous high frequency oscillations. The object of my invention is to produce an oscillation generator of the impulse type in which a resonant circuit is set into oscillation and is maintained in oscillation by periodically impulsing or exciting the circuit in synchronism with the natural or free oscillations of the circuit.

It has been proposed to provide alternating current generators by sustaining a tuned load circuit in continuous oscillation, exciting it with short impulses from an external source through an amplifier tube of the usual high vacuum type and providing an excessively high grid bias to cause the tube to be conductive through a very short portion of the cycle. A further arrangement has been proposed in which the heavy grid bias is secured by means of a resistance, and employing the customary feed-back principles for sustaining the circuit in oscillation, a portion of the oscillatory circuit being shunted at all times by the cathode-anode circuit of the tube. The resistance of this cathode-anode circuit is always of a finite value, at times quite low, and hence produces a considerable damping effect upon the oscillatory circuit.

It is desirable that the tuned circuit shall have a low decrement, being extremely sharply tuned and of low resistance so that the oscillations when started tend to persist for several cycles. I employ a tube of the start-stop type containing gas or vapor at low pressure and of a construction in which the plate current starts with a low potential on the grid and is extinguished when the grid is made sufficiently negative. A tube of this type is disclosed in United States Patent No. 1,944,888, granted January 30, 1934. Our invention provides an oscillating system in which substantially all damping is removed from the tuned circuit instantly after the grid circuit of the tube is given one impulse of energy.

The nature of the invention will best be understood from the following detailed description taken in connection with the accompanying drawing, in which—

Figure 1 is a diagrammatic circuit drawing of one arrangement embodying our invention.

Figure 2 shows an alternative circuit arrangement.

Referring to Fig. 1, assume that the mercury vapor or other gas-filled thermionic tube T of the start-stop type is idle and that the plate circuit is open. Assume first that the resistance R₂

and the condenser c₁ are removed from the circuit. Then upon closing the switch S, the plate current from battery B will start, since the tube breaks down or flashes with low or zero potential on the grid g. The electron stream flowing from the filament or cathode f to the anode or plate p causes a corresponding current in the grid circuit, a characteristic of gas-filled tubes. This impulse of grid current impinging upon the tuned unit circuit, comprising the inductance l and the condenser c₂, sets it into oscillation at its resonant frequency and due to the low decrement of this tuned circuit, these oscillations will persist for several cycles. The cathode-anode current of the gaseous tube T will flow steadily at its maximum rated value until stopped by some means. During the negative half of the first cycle of the tuned oscillatory circuit, the grid will become sufficiently negative with respect to the cathode to extinguish the plate current. The oscillations in said tuned circuit, nevertheless, continue and during the next succeeding positive half cycle will cause the grid to flash the tube, thus repeating the cycle of operations.

From this it appears that the cathode-anode circuit in this oscillating system, merely performs the function of providing an electron stream from which the grid draws its supply. In other words, the presence of current in the plate circuit permits the grid circuit to be conductive during periods of positive grid potential, there being apparently no other interaction between the grid and plate circuits of the tube.

The action of the oscillator is rendered more stable by the insertion of a resistance at R₂ where it is common to the cathode, grid and plate circuits. In this arrangement the grid circuit containing the oscillatory unit, is given a pulse of energy to excite the tuned circuit and then instantly thereafter all damping is removed therefrom. When the plate circuit of the tube T is closed at the switch S, a voltage due to the flow of electrons is set up in the grid circuit which initiates an oscillatory condition in the tuned circuit. Immediately the flow of plate current produces an IR drop across the cathode resistance R₂ which causes the grid to become highly negative with respect to the cathode. This negative potential on the grid assists the negative half of the first oscillation to extinguish the tube and thus performs the desired function of reducing the damping of the grid circuit, by leaving the tuned circuit to oscillate freely. Now as the plate current was interrupted and became zero, the IR drop across the resistance also became

zero and hence the full plate potential is restored, so that on the next succeeding positive half cycle across the tuned circuit, the tube is in condition to instantly flash, thereby repeating the cycle of operations.

It will be observed, therefore, that the elements in our oscillatory system are so correlated that there are two effects which coact to extinguish the tube and there are also two effects which supplement each other at the instant of starting. Thus the negative half cycle of the oscillatory voltage is assisted by the IR drop of the plate current across the cathode resistance R_2 to extinguish the tube, while the restoration of the plate potential, by the removal of the IR drop grid bias, coacts with the next succeeding positive half cycle from the oscillatory circuit to start the tube. The resistance R_2 thus assists greatly in stabilizing the action of the oscillator and the frequency is readily controllable over a wide range.

In the circuit arrangement above described, approximately the full potential of the plate battery is impressed during the course of an oscillation, under some circuit conditions, upon the space path between the cathode and the anode while the tube is in a conducting condition. This high voltage imparts an excessive velocity to the gas molecules, thus making them highly destructive to the active coating of the cathode as well as to the grid material.

Our present invention is designed to overcome this defect in prior oscillators of this type and eliminate the cause of the excessive voltage applied to the conducting space path while maintaining the frequency stability of the oscillator.

Referring again to Fig. 1, we have found that by connecting a condenser c_1 in shunt between the anode and cathode, the conjoint action of the condenser c_1 with the resistance R_1 in series with the anode or plate battery serves to reduce the peak of the voltage at the instant of its maximum value and thereby reduces the transient voltage impressed upon the gaseous path. The frequency stability of the oscillator is modified to the extent that the oscillating condition is critical as to the value of the condenser c_1 . We have found that this critical condition is due to the presence of two types of oscillation; (1) a sinusoidal voltage in the tuned grid circuit Lc_2 ; and (2) a relaxation oscillation in the plate circuit.

Instead of connecting the condenser c_1 as a direct shunt between the anode and cathode, the condenser may be connected across the plate circuit as shown in Fig. 2, so that the condenser discharge is impressed directly upon the grid circuit.

The combination of a resistance and a condenser in the anode circuit which acts as a transient voltage reducer might be regarded as analogous in effect to a reduced plate voltage. It is evident, however, that the results obtained are quite different from that which would occur by merely reducing the voltage of the anode battery.

In the circuit arrangement shown in Fig. 1, the oscillator exhibits characteristics of both the impulse and relaxation types as previously described. In the arrangement shown in Fig. 2, however, the oscillator appears to be purely of the impulse type and possesses great frequency stability and general ease of handling coupled with normal life of the tube.

In the prior patent of one of the applicants, Keith B. Eller, No. 2,080,411, granted May 18, 1937,

there is disclosed a circuit arrangement whereby a power consuming circuit may be connected to an oscillatory system, such as herein disclosed, by means of an auxiliary circuit coupled by a high impedance to the oscillatory grid circuit. The grid circuit of the amplifier, which may be a high vacuum tube, consumes only a negligible amount of energy but oscillatory power in any desired amount may be secured from the work circuit of the amplifier.

It will be evident to engineers that our invention is not limited to the specific arrangements shown and described, but that its scope is defined in the appended claims.

We claim:

1. An oscillation generating system having an oscillatory circuit and a gaseous arc discharge device provided with anode and cathode elements and a grid or cathode element for starting and stopping the anode-cathode current, said oscillatory circuit forming a part of and being confined to the grid cathode circuit of said discharge device, a current source for supplying energy to the anode-cathode circuit, a resistance element connected in said anode cathode circuit and a condenser connected between said anode and cathode.

2. An oscillation generating system as set forth in claim 1 and including a resistance element common to the anode-cathode and grid-control circuits.

3. An oscillation generating system having an oscillatory circuit and a gaseous arc discharge device provided with anode and cathode elements and a grid or control element for starting and stopping the anode-cathode current, said oscillatory circuit forming a part of and being confined to the grid cathode circuit of said discharge device, a current source for supplying energy to the anode-cathode circuit, a resistance element common to the anode-cathode and grid-cathode circuits and a condenser connected between said anode and cathode.

4. An oscillation generating system having an oscillatory circuit and a gaseous arc discharge device provided with anode and cathode elements and a grid or control element for starting and stopping the anode-cathode current, said oscillatory circuit forming a part of and being confined to the grid-cathode circuit of said discharge device, a circuit between said anode and said cathode, a current source for supplying energy to the anode-cathode circuit, a resistance element common to the anode-cathode and grid-cathode circuits, a resistance in series with said anode and said current source and a condenser connected between the anode and the negative terminal of said current source.

5. An oscillation generating system having an oscillatory circuit and a gaseous arc discharge device provided with anode and cathode elements and a grid or control element for starting and stopping the anode-cathode current, said oscillatory circuit forming a part of and being confined to the grid cathode circuit of said discharge device, a current source for supplying energy to the anode-cathode circuit, to normally cause the flow of current therein, said oscillatory circuit receiving energy from the cathode electron stream, the resulting cyclic potentials causing the grid to alternately stop and start the anode-cathode currents and means to reduce the peak voltage at the instant of coincidence of high voltage from said source and positive grid

potential comprising a condenser connected between said anode and said cathode.

6. An oscillation generating system having an oscillatory circuit and a gaseous arc discharge device provided with anode and cathode elements and a grid or control element for starting and stopping the anode-cathode current, said oscillatory circuit forming a part of and being confined to the grid cathode circuit of said discharge device, a current source for supplying energy to the anode-cathode circuit, to normally cause the flow of current therein, said oscillatory circuit receiving energy from the cathode electron stream, the resulting cyclic potentials causing the grid to alternately stop and start the anode-cathode currents and means to reduce the transient voltage impressed upon the gaseous path of said discharge device at the instant of coincidence of high voltage from said source and positive grid potential comprising a resistance element connected between said anode and said current source and a condenser shunting the anode-cathode circuit.

7. An oscillatory generating system, comprising a gaseous arc discharge tube having anode and cathode elements and a grid element operating to control the starting and stopping of the

anode-cathode current, a resonant oscillatory circuit included in the grid cathode circuit of the tube, a current source for supplying the anode-cathode current, said oscillatory circuit being actuated by said current source through conduction within the tube and means to reduce the transient voltage impressed upon the gaseous path of said discharge device at the instant of coincidence of high voltage from said source and positive grid potential comprising a resistance element connected between said anode and said current source and a condenser shunting the anode-cathode circuit.

8. An oscillation generating system comprising a gaseous arc discharge tube provided with anode and cathode elements and a grid or control element for starting and stopping the anode-cathode current, means in said grid cathode circuit operating to produce impulse oscillations, and means in said anode cathode circuit operating to produce relaxation oscillations.

9. An oscillation generator as in claim 8 in which the grid cathode circuit and plate cathode circuit oscillations are of the same frequency.

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