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M. R. BOYD ET AL

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GASEOUS DISCHARGE CIRCUIT

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Fig. 1

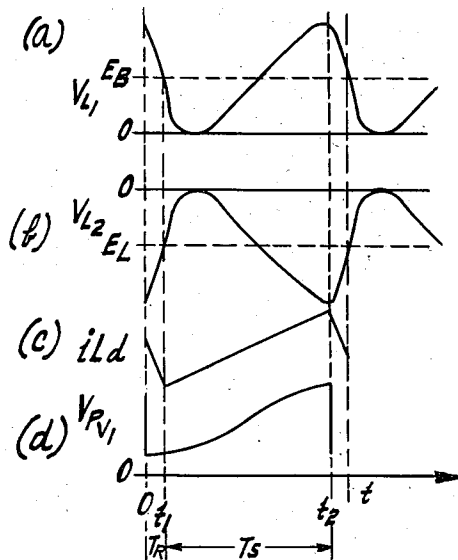
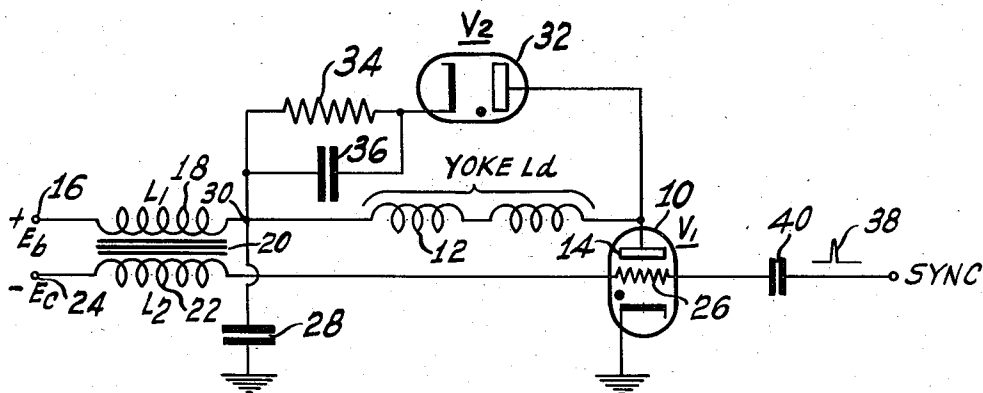


Fig. 2

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GASEOUS DISCHARGE CIRCUIT

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14 Claims. (Cl. 315-27)

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The present invention relates to gaseous discharge circuits and more particularly, although not necessarily exclusively, to a gaseous discharge oscillatory circuit wherein the highest operating frequency, otherwise restricted by the de-ionization time of the discharge tube, is greatly increased.

The present invention deals more directly with, although is in no way restricted to, television horizontal deflection circuits of a type employing gaseous discharge output tubes.

In electrical circuit arrangements, it is often-times desirable to provide self-excited oscillators or multivibrators of a type which may be easily synchronized. In the interest of simplicity and economy and where operating conditions permit, it is often convenient to utilize the well-known form of gaseous discharge tube commonly termed Thyatron. The basic elements of this tube are substantially the same as a triode vacuum tube. However, inasmuch as the elements are incorporated in an atmosphere of gas, the operating characteristics of the Thyatron are entirely different from vacuum triode types. In most respects, the Thyatron or controllable discharge tube characteristics, being of a virtually "on" or "off" nature, makes it eminently suited for such relaxation oscillator or multivibrator application. However, it is well recognized that due to the required de-ionization time of the gas in the Thyatron envelope, upon cessation of active excitation, the operating frequency limit of oscillators using Thyatron is severely limited.

This limitation is perhaps more severely felt in the television field wherein the interests of efficiency, it would be highly desirable to base horizontal electromagnetic deflection circuits solely on Thyatrons. The inherent low voltage drop across such gas tubes, as well as their relatively large peak current carrying capacities, make them ideally suited for such applications provided stable operation could be achieved at the higher frequencies required. It is because of this instability due to gas deionization time that Thyatron circuits have not been commonly employed for such deflection circuit applications.

It is therefore an object of the present invention to provide an improved form of oscillator circuit utilizing controllable gaseous discharge tubes.

It is another object of the present invention to provide a new and improved form of electromagnetic cathode ray beam deflection circuit particularly suited for television application in which the gaseous discharge tube or Thyatron is employed as the deflection output device.

It is a further object of the present invention to provide a novel form of control circuit for use with multi-electrode gaseous discharge tubes such that their application in oscillatory circuits is made more valuable due to an increase of the frequency limit normally imposed by gas de-ionization time.

In the realization of the above objects, the present invention in its more general form contemplates the use of a control voltage developing circuit which is synchronously operated in accordance with the oscillator action of the circuit involving the gaseous discharge tube. The output voltage of the control circuit is so polarized to cyclically drive the control electrode of the discharge tube highly negative relative to the discharge tube cathode for a suitable interval prior to the application of synchronizing firing stimulus to the discharge tube. The highly negative swing allows the control electrode of the discharge tube to regain control of the discharge path more quickly than in prior art systems thereby enhancing the effective recovery time of a gas tube to a degree permitting more stable operation of the oscillator circuit and its possible accuracy of synchronization.

In one of its more limited aspects, the present invention contemplates the use of a gaseous discharge tube in a horizontal deflection circuit for a television receiver. A suitable control signal transformer having a primary-to-secondary is connected in the output and input circuits of the gaseous deflection output tube with such polarity that required voltage variations in the output circuit produce highly negative-going pulses in the control circuit of the discharge tube and thereby provide more stable and more easily controllable deflection waveform generation.

Other objects and features of advantages in addition to those set forth hereinabove and hereinafter, as well as a more complete understanding of the mode of operation of the present invention will follow perusal of the following specification, especially when taken in connection with the accompanying drawing in which:

Figure 1 illustrates a form of synchronizable gaseous discharge oscillator eminently suited for application as an electromagnetic deflection generator in television receivers;

Figure 2 shows various operating waveforms peculiar to the operation of the embodiment of the present invention as illustrated in Figure 1.

In order to more fully understand the novel mode of operation of the present invention, as well as the many distinct benefits to be derived therefrom, reference is now made to Figure 1 in

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which there is shown a gaseous discharge tube 10 of the Thyatron variety adapted for excitation of a typical television electromagnetic deflection yoke 12. Positive biasing potential for the anode 14 of the discharge tube 10 is then supplied from the positive biasing supply terminal 16 through the primary winding 18 of a control transformer 20. The secondary winding 22 of the control transformer 20 is then connected between a negative biasing potential terminal 24 and the control electrode 26 of the gas discharge tube 10. A suitable capacitor 28 is connected from the terminal 30 of the transformer primary to ground to form a resonant circuit with the inductance L_1 of the primary winding 18. To properly damp the deflection yoke 12, a diode 32, in series combination with the parallel RC network comprising resistance 34 and capacitor 36, is placed in shunt with the yoke winding. Periodically recurrent sync signal 38 is then applied through capacitor 40 to the control grid 26 of the discharge tube with positive-going polarity to effect firing and synchronization of the deflection circuit.

In considering the operation of the deflection circuit and for convenience in labeling the curves in Figure 2, the gaseous discharge tube 10 will be designated as V_1 , diode 32 designated as V_2 , the inductance of the deflection 12 designated as L_d , the inductance of the transformer primary 18 as L_1 , and the inductance of the transformer secondary 22 as L_2 .

Inasmuch as the description of the operation of any oscillatory circuit demands the initial assumption of some arbitrary static condition, it shall be assumed that the capacitor 28 has been allowed to fully charge from the power supply terminal 16 through the inductance L_1 , and gas tube V_1 is in a quiescent condition. The arrival of positive-going sync pulse 38 will then cause discharge tube V_1 to fire and the potential of the anode 14 thereof will immediately drop to a potential only several volts above ground. This firing may be thought of as occurring at the time 0 in Figure 2 where it will be noted in curve 2d that the voltage

$$V_{P_{V_1}}$$

has dropped to a low value of several volts. Upon firing of tube V_1 a current will then start to flow through the yoke inductance L_d due to the then charged condition of capacitor 28. This current flow behaves sinusoidally, being based upon the resonant frequency of the yoke inductance L_d and the capacitor 28. After one-quarter cycle of a sinusoidal current flow, the voltage across the capacitor 28 will then reverse causing the cathode of the diode V_2 to become negative with respect to its associated anode. Diode V_2 then fires automatically and the voltage across inductance L_d is held substantially constant during the ensuing sweep interval t_1-t_2 or T_s . The constant voltage so produced across the yoke inductance L_d is a function of the time constant of the RC circuit comprising elements 34 and 36 and of the characteristics of the damping tube in accordance with well-known deflection circuit damping principles. Furthermore, with a substantially constant voltage across the inductance L_d , the current i_{L_d} through the yoke 12 will then begin to rise linearly as shown in curve 2c to form the linear rise portion of the required sawtooth deflection current.

The energy stored in inductance L_d then, taking the form of current flow, is dissipated through

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the diode V_2 , resistance 34 and partially stored in capacitor 36. The capacitor 36 is large and acts to hold the voltage constant during the deflection interval T_s while the resistance 34 dissipates the power initially stored in the inductance L_d . Resistance 34 is generally proportioned such that the current through the diode V_2 becomes substantially zero at or immediately following the end of the sweep interval T_s .

During the sweep interval T_s when tube V_2 has been conducting, it is desirable that the discharge tube V_1 be substantially cut off. Due to some residual de-ionization in the tube V_1 , there will however continue to be a small current flow through the tube from some time after the initiation of the sweep interval T_s . It will be seen, however, that upon further extinction of the discharge tube V_1 , the capacitor 28 will then begin to charge through the primary 18 of the control transformer 20. As it charges through the inductance L_1 , the current waveform will be substantially sinusoidal and the voltage appearing across the primary 18 (L_1) will be substantially that shown by curve 2a.

If now, according to the present invention, the secondary 22 of the control transformer 20 is properly poled with respect to the primary 18 so that the secondary voltage across L_2 is 180° out of phase with respect to the primary voltage across L_1 , the control voltage applied to the control electrode 26 will be substantially that shown by curve 2b. By inspecting the voltage variation on the anode of the discharge tube 10, as shown in curve 2d, in relation to the voltage applied to the control electrode 26, as shown in curve 2b, it will be seen that as the potential on the anode 14 of the discharge tube 10 increases (curve 2d), the control electrode voltage (curve 2b) swings highly negative thereby tending to discourage refiring of the discharge tube due to any residual gas ionization in the tube envelope. Furthermore, this negative-going control voltage will provide a degree of noise immunity against incoming positive-going signals other than sync. Thus, the noise immunity of the circuit against mis-synchronization by unwanted noise signals during the deflection cycle T_s is greatly enhanced while the high negative voltage applied to the control electrode greatly decreases the effective grid recover time of the discharge tube.

In general, the inductance L_1 and the capacitor 28 are so chosen that approximately one-half wave is completed during the interval T_s . This waveform must have as its A. C. axis the value of the D. C. input voltage appearing at the power supply terminal 16. The voltage across capacitor 28 therefore swings as far above this axis as it does below so that the capacitor 28 acquires a peak voltage approximately twice that of the power supply. Inductance L_1 and capacitor 28 may be so chosen that more than one-half cycle transpires during this interval T_s which makes the current through the inductance L_1 appreciably negative-going at the end of time T_s . By adjusting saturated characteristics of the transformer 20, the input charging current may be made quite non-linear so that during the early portion of the charging interval the current will remain low thus allowing further time for deionization of the Thyatron.

It will be apparent from the above that the utility of the present invention is in no way limited to the specific transformer arrangement shown nor to the utilization of a gaseous diode in the position of V_2 . V_2 may, under certain con-

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ditions, be replaced by a vacuum diode if desired while other methods may be employed to derive the negative-going control signal for the control electrode of the discharge tube in accordance with electrical variations in the discharge tube output circuit.

In the practice of the present invention, it may be desired to adjust the turns ratio of the transformer 20 to be approximately equal to the ratio of the D. C. voltage appearing at the positive power supply terminal E_b to the biasing voltage E_c appearing at terminal 24. This allows maximum swing to be obtained without driving the control electrode 26 positive during the early part of the deflection cycle.

We claim:

1. In an electrical circuit the combination comprising a gaseous discharge tube having at least an anode, a cathode and control electrode, an output circuit connected between the anode and cathode of said discharge tube, an input circuit connected between the control electrode and cathode of said discharge tube, an inductive element connected in the output circuit of said discharge tube, a unilaterally conductive damping circuit connected in shunt with said inductive element, means for applying timing pulses to the input circuit of said discharge tube for effecting periodic control thereof, means responsive to output circuit current variations upon conduction of said discharge tube to develop a control signal having positive and negative extremities, and means for applying said control signal to the control electrode of said discharge tube such that the negative extremity of said control signal is active to swing said control grid negatively with respect to the cathode of said discharge tube just prior to conduction of said discharge tube.

2. Apparatus according to claim 1 wherein said unilaterally conductive damping circuit comprises a diode having an anode and cathode in series with a parallel resistance-capacity network.

3. Apparatus according to claim 2 wherein said unilaterally conductive damping circuit diode is a gaseous discharge tube.

4. In an electrical circuit, the combination of, a gaseous discharge tube having an anode, a cathode, and control electrode, an output circuit connected between the anode and cathode of said discharge tube, an input circuit connected between the control electrode and cathode of said discharge tube, a transformer having a primary and secondary, an inductive element connected in series with said transformer primary to form a combination, connections placing said combination in said discharge tube output circuit, a unilaterally conductive damping path in shunt with said inductance, means for applying periodically recurrent timing pulses to said input circuit in such polarity to swing said discharge tube control electrode in a positive direction with respect to said cathode, and connections placing said transformer secondary in the input circuit of said discharge tube, the phasing of said transformer secondary relative to said transformer primary being such that said control electrode is swung negatively with respect to said cathode just prior to conduction of said discharge tube.

5. Apparatus according to claim 4 wherein a unidirectional anode biasing polarizing potential of E_1 is imposed in series with said output circuit and a control electrode biasing potential of $-E_2$ is imposed in series with said input circuit,

and wherein the primary to secondary turns ratio of said transformer is approximately equal to:

$$\frac{E_1}{E_2}$$

6. Apparatus according to claim 5 wherein a capacitor is placed in shunt with the primary of said transformer to form a resonant circuit whose resonant frequency is approximately equal to the periodic recurrence of said timing pulses.

7. Apparatus according to claim 5 wherein said unilaterally conductive damping path comprises a gaseous discharge diode connected in series with a resistance-capacity time constant circuit.

8. An electromagnetic deflection generator for a cathode ray deflection system employing a deflection yoke having an input winding, said circuit comprising in combination, a gaseous discharge tube having an anode, cathode and control electrode, a positive power supply terminal, an output circuit including said discharge tube anode, said positive power supply terminal and said discharge tube cathode, connections placing the deflection yoke input winding in series with said output circuit, a unilaterally conductive damping circuit connected in shunt with said deflection yoke input winding, an input circuit connected between said discharge tube control electrode and cathode, means for applying periodically recurrent timing pulses to said input circuit in such polarity to fire said gaseous discharge tube, means connected with said output circuit responsive to electrical variations in said output circuit following firing of said discharge tube to derive an alternating current control signal, and means for applying said control signal to said input circuit with such polarity and amplitude to swing said control electrode negatively with respect to said discharge tube cathode for disabling thereof.

9. Apparatus according to claim 8 wherein said unilaterally conductive damping circuit comprises a diode serially connected with a parallel resistance-capacity network.

10. Apparatus according to claim 9 wherein said damping circuit diode is of the gaseous discharge variety.

11. An electromagnetic deflection generator for a cathode ray system employing a deflection yoke having an input winding, said circuit comprising in combination, a gaseous discharge tube having an anode, cathode and control electrode, a positive power supply terminal, an output circuit including said discharge tube anode, said positive power supply terminal, and discharge tube cathode, connections placing the deflection yoke input winding in series with said output circuit, a unilaterally conductive damping circuit connected in shunt with said deflection yoke input winding, an input circuit connected between said discharge tube control electrode and cathode, means for applying periodically recurrent timing pulses to said input circuit in such polarity to fire said gaseous discharge tube, a transformer having a primary and secondary winding, connections placing the primary and secondary of said transformer respectively in series with the output and input circuits of said discharge tube, the phasing of said transformer secondary relative to its primary being such to swing said discharge tube control electrode highly negative relative to its cathode subsequent to firing of said discharge tube.

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12. Apparatus according to claim 11 wherein said transformer primary has in shunt therewith a capacitor to form a resonant circuit with said primary inductance whose resonant frequency is approximately integrally related to the recurrence frequency of said timing pulses.

13. Apparatus according to claim 12 wherein said one terminal of said deflection yoke input winding is connected with the anode of said discharge tube and wherein said transformer primary is connected between said positive power supply terminal and the other terminal of said deflection yoke input winding.

14. Apparatus according to claim 13 wherein said input circuit incorporates a source of negative biasing potential for said discharge tube con-

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trol electrode and wherein the primary-to-secondary turns ratio of said transformer is equal to the numerical ratio of said positive power supply terminal potential to said negative control electrode biasing potential.

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