

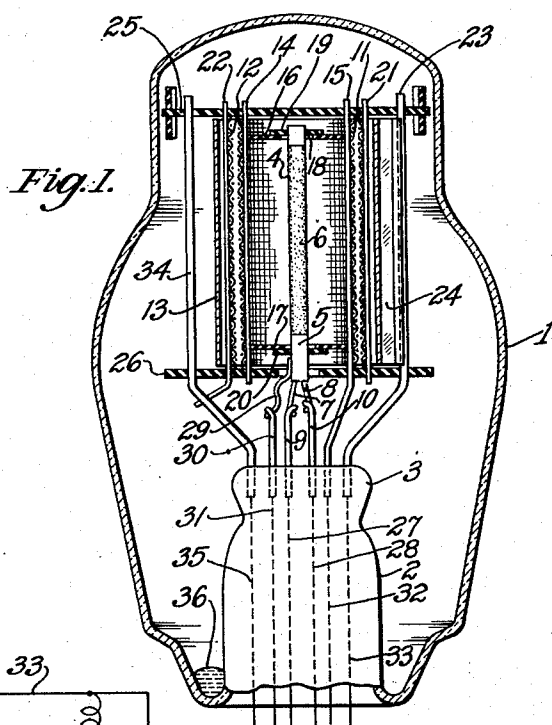
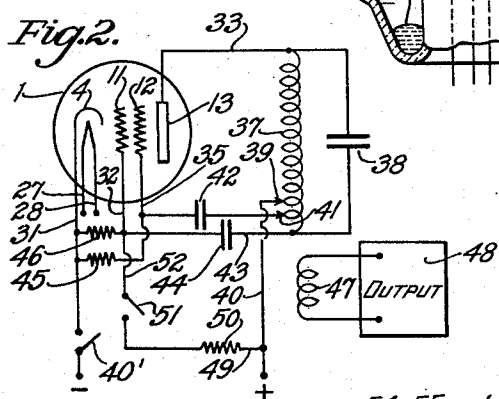
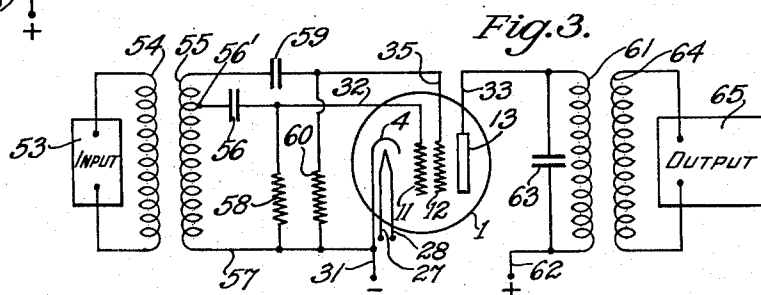
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CATHANODE TUBE OSCILLATOR

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CATHANODE TUBE OSCILLATOR

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This invention relates to systems which utilize gas-filled discharge tubes of the type described and claimed in the patents to Charles G. Smith, No. 1,962,158, and James D. Le Van, No. 1,962,159. Tubes of this type I shall refer to in this specification and claims as cathanode tubes.

In cathanode tubes there is provided an auxiliary discharge space in which, due to the passage of current therethrough, a region in which positive ions and electrons exist is created. This region serves as a supply from which the electrons pass into a space controlled by a grid, and this controlled current flows to an output anode. The efficiency of such tubes has been somewhat low, due to the necessity for having the current flowing through the auxiliary discharge space throughout the operation of the tube. Also such tubes require the provision of a separate source of potential for the auxiliary discharge space. An additional problem which has arisen in these tubes is that of an uncontrollable arc forming from the cathode, through the auxiliary discharge space and the controlled discharge space to the anode. The formation of such uncontrollable arcs has been called "spotting through", due to the fact that often such an uncontrollable arc localizes in one or more openings in the anode of the auxiliary discharge space, which anode is termed the cathanode.

My present invention contemplates substantially eliminating each of the foregoing defects, and therefore one of the objects of this invention is to eliminate the necessity for a separate potential supply for the auxiliary discharge space.

Another object is to decrease the total losses in the auxiliary discharge space.

A further object is to reduce the probability of uncontrollable arcs forming between the cathode and the output anode.

A still further object is to devise an oscillator using a cathanode tube which has the foregoing advantages.

The foregoing and other objects of my invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawing, wherein:

Fig. 1 is a cross-sectional view of a cathanode tube with which my invention may be practised;

Fig. 2 is a diagram illustrating one embodiment of my novel system; and

Fig. 3 is another diagram illustrating another embodiment of my invention.

In Fig. 1 the gaseous discharge tube which I prefer to utilize consists of a gas-filled envelope

1, preferably of glass, having a reentrant stem 2, the upper end of which carries a press 3 in which are sealed a number of lead-in electrode supporting wires. Above the press and within the envelope 1 are supported a number of electrodes. One of these electrodes consists of a cathode 4. This cathode is of the usual type of indirectly-heated cathode ordinarily used in vacuum tubes, and consists of a hollow metal cylinder 5 coated on the exterior thereof with electron-emitting material 6, such as, for example, the oxides of alkali earth metals. The coating is heated to thermionic emission by means of an internal heater consisting usually of a coil of fine wire. The two ends of the heating filament 7 and 8 are connected to the two wires 9 and 10 sealed in the press 3. Surrounding the cathode 4 is the cathanode 11. This electrode is called a cathanode because it acts as an anode with respect to the cathode 4, and is a virtual cathode with respect to the anode 13. Thus it performs both the function of a cathode and an anode. This cathanode consists of an extended electrode having perforations over its surface, and preferably is in the form of a fine wire grid. Surrounding the cathanode 11 and substantially concentric therewith is the control element 12 which likewise consists of an electrode of substantial area having perforations over its surface and which is preferably in the form of a fine wire grid. Surrounding all of the other electrodes and substantially concentric therewith is the anode 13 which is preferably formed of a thin solid metal plate. The cathanode is preferably supported in position by means of supporting standards 14 and 15. Two plates 16 and 17 close the upper and lower open ends of the cylindrical cathanode 11. The plates 16 and 17 have an opening 18 in the center thereof through which the cathode 4 passes freely. The cathode 4 is supported from the two plates 16 and 17 by means of insulators 19 and 20. The control electrode 12 is supported by supporting standards 21 and 22 while the anode 13 is supported from a supporting standard 23 by having a radial member 24 extending from said anode 13 and engaging said supporting standard 23. All of said electrodes are maintained in a definite relative position by the two insulating plates 25 and 26, which have small openings which receive the upper and lower ends respectively of the various supporting standards. External connections to the heating filament are made through wires 27 and 28 connected to the lead-in wires 9 and 10, respectively. An external connection is made to the cathode 4 by means of a cathode lead 29

welded to the lead-in wire 30 to which an external conductor 31 is connected. The supporting standard 15 for the cathanode 11 has its lower end sealed in the press 3, and has an external conductor 32 connected thereto, thereby establishing an external connection to said cathanode. The supporting standard 23 for the anode 13 also has its lower end sealed in the press 3, and an external conductor 33 connected thereto establishes an external connection for said anode. An additional supporting standard 34 whose lower end is sealed in the press 3 passes through openings in the upper and lower insulating members 25 and 26, respectively, and serves as an additional support for the electrode structure. The lower end of the supporting standard 22 of the control electrode 12 is welded to the supporting standard 34. An external conductor 35 connected thereto establishes an external connection to the control element 12. The envelope 1 is evacuated in accordance with the usual vacuum technique. After the tube has been evacuated, it is filled with a gas filling, such as helium or mercury vapor. The gas pressure of the filling may vary over a relatively wide range. However, this gas pressure is sufficiently high so that ionization can be produced therein to the degree as will be described below. When a vapor is used, such as mercury vapor, a quantity of mercury 36 is introduced into the tube. I have operated tubes in accordance with this invention at mercury vapor pressures of the order of ten microns and noble gas pressures of the order of 100 to 300 microns. It is to be understood that any gas pressure which will produce the results herein described could be used.

The tube as described above may be made to operate substantially in accordance with the principles as set forth in said patents to Smith and Le Van. By initially establishing a discharge between the cathode 4 and the cathanode 11, the space between the cathode and the cathanode is filled with electrons and positive ions. A large number of the electrons which pass into the gaseous discharge space between the cathode and cathanode and flow toward the cathanode, will pass through the screen openings in said cathanode, and thereupon will come under the influence of the control electrode 12. The spacing between the anode 13 and the cathanode 11 is such that under the pressure conditions existing in the tube, the distance between the opposing electrode surfaces is of the order of magnitude of the mean free path of the molecules in the gas. Due to this spacing, a comparatively large voltage can be impressed across these electrodes without producing a self-sustaining independent ionizing discharge therebetween. The spacing between the cathanode 11 and the cathode 4, however, is greater than the above order of magnitude so that substantial ionization can occur in the space between said cathode and cathanode. Further, it will be noted that due to the presence of the blocking surfaces at each end of the structure described above, electrons from the cathode 4 cannot pass out of the region between the cathode and the cathanode except through the openings in the cathanode. Under these conditions, any discharges which occur between the anode 13 and the cathanode 11 are directly the result of electrons which pass from the gaseous discharge space through the openings in the cathanode 11. Therefore, a complete control of this discharge can be secured by a potential on the control member 12.

In order to eliminate the various difficulties which might arise in connection with the use of such a tube, it may be connected in the type of circuit as illustrated in Fig. 2. I have applied the same reference numerals as appear in Fig. 1 to corresponding elements in Fig. 2. In Fig. 2 there is shown an oscillating circuit consisting of an induction coil 37 across which is connected a condenser 38. The circuit 37—38 comprises a tank circuit in which oscillations may be set up by means of the circuit connected thereto. The induction coil 37 is provided with a tap 39 from which a lead 40 extends to the positive terminal of a suitable source of direct current voltage. One end of the induction coil 37 is connected by means of the conductor 33 to the anode 13 of such a tube structure as described in connection with Fig. 1. The cathode 4 is connected by means of its conductor 31 to the negative terminal of the voltage supply source. The two leads 27 and 28 extending from the cathode heater may be connected to any suitable source of heating current, whereby the coated surface of the cathode may be raised to temperature of thermionic emission.

The induction coil 37 is also provided with a tap 41 from which a conductor extends through the condenser 42 to the conductor 35, and thus to the control electrode 12. As will be seen, the tap 41 is preferably on the opposite side of the tap 39 from the end of the coil 37 which is connected to the anode 13. The opposite end of the coil 37 is connected by means of a conductor 43 through the condenser 44 to the lead 32, and thus to the cathanode 11. A leakage resistance 45 is connected between the control element 12 and the cathode 4, while another leakage resistance 46 is connected between the cathanode 11 and the cathode 4. When the system is energized from the source of direct current and oscillations are set up in the circuit, such oscillations may be taken from the system by means of a coil 47 coupled to the coil 37. The coil 47 may be connected to a suitable output device 48 wherein the oscillations generated by the circuit may be utilized. In some instances the sudden application of the voltage to the conductors 40 and 31, for example, by closing a switch 40', is sufficient to start the circuit oscillating. However, in order to insure the starting of oscillations, I provide a conductor 49 connected to the lead 40 and extending through a current-limiting resistance 50 and a switch 51 to the conductor 52 which is connected to the lead 32, and thus to the cathanode 11. The switch 51 is normally in its open position. However, if the switch 51 is closed, the starting of oscillations in the system is insured, whereupon the switch 51 may be reopened. These oscillations will then continue until switch 40' is opened.

The system which I have described above operates substantially in the following manner. When the switches 40' and 51 are closed, a positive potential is impressed upon the cathanode 11 with respect to the cathode 4, and electrons will flow from the cathode 4 to the cathanode 11 through the intervening gaseous space, whereupon ionization occurs and the space between the cathode 4 and the cathanode 11 becomes filled with electrons and positive ions. The resistance 50 will limit this flow of current to a reasonable value. As soon as the space between the cathode and the cathanode becomes filled with positive ions and electrons, some of the electrons pass through the openings in the

cathanode 11, whereupon the cathanode 11 acts as a virtual cathode for the space between the cathanode and the anode 13. This space is under complete control of the voltage impressed upon the control electrode 12. The anode 13 has impressed upon it a positive potential through the lead 40, the coil 37, and the conductor 33, and the control electrode 12 has impressed upon it the proper voltage from the tap 41, whereby oscillations are produced in the tank circuit consisting of the coil 37 and the condenser 38. The oscillating circuit itself is a Hartley oscillator which is well recognized in the art, and therefore the theory of operation thereof need not be more fully explained in the present application.

Once the oscillations have started, as described above, the switch 51 may be opened, whereupon the operation of the circuit will continue. The theory as to why such oscillations continue is substantially as follows. Due to the periodic reversal of the voltage across the coil 37, the electrodes 11 and 12 are made periodically positive with respect to the cathode 4. Since electrons can flow only from the cathode to the electrodes 11 and 12, the voltage impressed between the electrodes 11 and 12 and the cathode 4 is rectified. The current which flows when the electrodes 11 and 12 become positive tends to charge the condensers 42 and 44 so as to impose a negative bias upon the electrodes 11 and 12. Due to the presence of the resistors 45 and 46, this negative bias is somewhat less than the peak value of the positive voltage which is impressed upon the electrodes 11 and 12, respectively. Therefore, as the tank circuit swings the electrodes 11 and 12 in a positive direction, the positive voltage will exceed the bias on these electrodes only at the peaks of the positive voltage swings, and therefore pulses of current consisting of flow of electrons from the cathode to the electrodes 11 and 12 will occur at these positive voltage peaks. The steady value of voltage impressed on the anode 13 from the direct current source will maintain the anode positive with respect to the cathode 4 throughout the operation. However, the alternating voltages impressed on the anode 13 by the tank circuit will make the anode periodically more and less positive with respect to the cathode 4. Since the anode 13 is connected substantially at the opposite end of the coil 37 from the electrodes 11 and 12, the voltage impressed on the anode 13, due to the tank circuit, will vary in the opposite direction from the voltage on the electrodes 11 and 12. Therefore, when the pulse of current flows to the electrodes 11 and 12, the anode 13 is least positive with respect to the cathode 4. However, since it is positive with respect to the cathode, the pulse of current to the electrodes 11 and 12 will cause electrons to pass through the openings in the cathanode 11 and be accelerated to the anode 13 by means of the control electrode 12, whereupon a pulse of current will flow to the anode 13. As the voltage impressed upon the electrodes due to the tank circuit reverses, the anode 13 becomes more positive with respect to the cathode 4. However, the electrodes 11 and 12 become less positive with respect to the cathode, and the voltage upon the electrodes 11 and 12 reverses so that it becomes negative with respect to the cathode. Due to the fact that the control electrode 12 can control the flow of electrons between the cathanode 11 and the anode 13 by its electrostatic potential, the negative voltage impressed on the con-

trol electrode 12 cuts off the flow of current to the anode 13 despite the fact that it has become more positive. The result, therefore, is that a pulse of current flows in the anode circuit, which pulse occurs for a short interval at the peak of the negative voltage swing upon the anode 13. This operation repeats itself as the voltage continues to reverse across the coil 37 so that a series of current pulses are supplied to the tank circuit, thus maintaining said circuit in its oscillating condition and supplying the requisite power thereto.

From the foregoing it will be seen that the energy which was supplied to the cathode-cath-anode discharge space from the direct current source when the switch 51 was closed is now supplied by alternating current energy fed through the condenser 44 to the cathode-cath-anode discharge space. This alternating current energy is rectified by the rectifying discharge path between the cathode and the cath-anode, and thus in effect a direct discharge current flows between the cathode and cath-anode analogous to the direct discharge current which flowed between said electrodes when the voltage of the direct current source was impressed thereon through the switch 51. However, instead of this discharge current flowing continuously, it flows only at the instant that it is needed, namely at the time when it is desired to supply a pulse of current to the anode circuit. This limitation of the cathanode current to short pulses greatly decreases the losses of energy in the tube inasmuch as the current in the cath-anode circuit is no longer flowing continuously and is no longer consuming energy throughout the period of operation but only for the short intervals described.

The limitation of the current to the cathanode to short pulses also decreases the possibility of an uncontrollable arc forming from the cathode 4 to the anode 13 through openings in the cath-anode 11. As previously indicated, the occurrence of such uncontrollable arcs is termed "spotting through." It has been found that spotting through is somewhat a haphazard occurrence whose probability of occurrence varies in accordance with several factors. Some of these factors are the total losses in the tube, the total time of ionization in the cathode-cath-anode circuit, and the maximum value of anode voltage during the occurrence of ionization between the cathode and the cathanode. It will be seen that each of these factors is decreased substantially in the present arrangement. As indicated above, the total losses in the tube are greatly decreased. Due to the fact that the time of flow of current between the cathode and cathanode is decreased, likewise the time during which ionization occurs between the cathode and cathanode is greatly decreased. Further, as pointed out above, current flows to the cath-anode 11 and to the anode 13 only at the point when the anode voltage is a minimum with respect to the cathode. When, however, the anode voltage is a maximum with respect to the cathode, no current is flowing in the cathode-cath-anode circuit, and therefore a relatively high voltage can be impressed on the anode without increasing the probability of spotting through.

Instead of having the circuit to which the tube is connected generate the alternating voltage impressed between the cathode and the cath-anode, this alternating voltage may be supplied from an external source, for example in such a

system as that illustrated in Fig. 3. In this figure the same reference numerals as appear in Fig. 1 are applied to corresponding elements. In Fig. 3 there is shown an input device 53 which constitutes a source of alternating voltage. This alternating voltage may be, for example, the output of an oscillator. The alternating voltage from the input device 53 is impressed upon the primary 54 of a coupling transformer which is likewise provided with a secondary 55. The secondary 55 may be provided with a tap 56' near one end thereof. This tap is connected through a condenser 56 to the cathanode 11. A conductor 57 connects the other end of the primary 55 to the conductor 31, and thus to the cathode 4. A leakage resistance 58 is connected from the cathanode 11 to the cathode 4. In this way an alternating voltage from the input device 53 is impressed between the cathode 4 and the cathanode 11.

In order that the device may be made to operate as an amplifier, the upper end of the primary 55 is connected through a condenser 59 to the control electrode 12. The control electrode 12 likewise is connected back to the cathode 4 through a leakage resistance 60.

The anode 13 is connected through a conductor 33 to the upper end of the primary 61 of an output transformer. The lower end of the primary 61 is connected by means of a conductor 62 to the positive terminal of a suitable source of direct current. The conductor 31 from the cathode 4 is connected to the negative terminal of said source. The primary 61 is tuned to the frequency of the voltage supplied from the input device 53 by means of a condenser 63 connected across said primary. To the primary 61 is coupled a secondary 64 connected in turn to a suitable output device 65 in which the amplified alternating voltage supplied from the input device 53 is utilized in some suitable manner.

The theory of operation of the device shown in Fig. 3 is substantially the same as that described in connection with Fig. 2. The combination of the condenser 56 and the leakage resistance 58 imposes a negative bias on the cathanode 11 which causes pulses of current to flow at the positive peaks of the voltage impressed upon the cathanode 11 by means of the primary 55. The combination of the condenser 59 and the leakage resistance 60 likewise imposes a negative bias on the control electrode 12 which also causes a pulse of current to flow to it at the positive peak of the voltage impressed upon the control electrode 12 by the primary 55. Since the anode 13 is maintained positive with respect to the cathode by the voltage of the direct current source, pulses of current will flow to the anode 13 whenever the control electrode 12 becomes positive. Due to the presence of the condenser 63, the pulses of current supplied to the coil 61 and the condenser 63 result in a substantially pure sine wave current flowing in the primary winding 61 and likewise in the output device 65. The presence of the condenser 63, however, does not perform exactly the same function as that of the condenser 38 in Fig. 2. In Fig. 2 the coil 37 and the condenser 38 have a flywheel effect so as to maintain current flowing in the tank circuit during the period when no current flows through the tube, so that voltage is available to re-initiate discharge in the tube when the next pulse of current is to be delivered to the tank circuit. In Fig. 3, however, the pulses of voltage are supplied independently to the

cathanode 11 and the control electrode 12 from the input device 53, and such a flywheel effect, therefore, is not necessary to insure the continuance of the operation of the device. It is for this reason that there is not provided any starting arrangement, such as, for example, the resistance 50 and switch 51, as is shown in Fig. 2.

Of course it is to be understood that this invention is not limited to the particular details of construction and operation as described above, as many equivalents will suggest themselves to those skilled in the art. For example, although I have illustrated a Hartley oscillator in Fig. 2, any other type of oscillating circuit may be utilized, provided the principles of my invention as defined in the appended claims are present. Also other types of amplifying circuit may be used than that illustrated in Fig. 3. Furthermore, other tube structures of the general type as defined in the claims may likewise be utilized. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, an electron permeable cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and said electrodes being immersed in a gaseous medium within said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing an alternating voltage between said cathode and cathanode to produce an electrical gaseous discharge in the space between said cathode and cathanode, means for impressing a variable control voltage on said control electrode, and means for impressing a power supply voltage to said anode.

2. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing an alternating voltage between said cathode and cathanode to produce an electrical gaseous discharge in the space between said cathode and cathanode, means for impressing upon said control electrode an alternating voltage substantially in phase with said first-named voltage, and means for impressing upon said anode a variable voltage substantially 180 degrees out of phase with said alternating voltages.

3. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing an alternating voltage between said cathode and cathanode to produce an electrical gaseous discharge in the space between said cathode and cathanode, means for impressing upon said control electrode an alternating voltage substantially in phase with said first-named voltage, means for impressing a power supply voltage to said anode, and means

for superimposing upon said supply voltage an alternating voltage substantially 180 degrees out of phase with said alternating voltages.

4. A system comprising an electrical gaseous discharge device comprising an envelope containing electrodes including a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing a power supply voltage to said anode, an alternating current network supplied with energizing current from said anode, and means for maintaining an electrical gaseous discharge in the cathode-cathanode discharge space comprising means for feeding energy from said alternating current network to the cathanode, and means for connecting said control electrode to another one of said electrodes.

5. A system comprising an electrical gaseous discharge device comprising an envelope containing electrodes including a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing a power supply voltage to said anode, an alternating current network supplied with energizing current from said anode, means for maintaining an electrical gaseous discharge in the cathode-cathanode discharge space comprising means for feeding energy from said alternating current network to the cathanode, means for connecting said control electrode to another one of said electrodes, and means for initially supplying energy to said cathanode to start the operation of said system.

6. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing a power supply voltage to said anode, an alternating current network supplied with energizing current from said anode, means for impressing upon said control electrode a voltage appearing across spaced points in said network to cause periodic pulses of current to flow to said anode, and means for feeding energy from said alternating current network to the cathanode to produce an electrical gaseous discharge in the cathode-cathanode discharge space.

7. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing a power supply voltage to said anode, an alternating current network supplied with energizing current from said anode, means for impressing upon said control electrode a voltage appearing across spaced points in said network to cause periodic pulses of current to flow to said anode, means

for feeding energy from said alternating current network to the cathanode to produce an electrical gaseous discharge in the cathode-cathanode discharge space, and means for initially supplying energy to said cathanode to start the operation of said system.

8. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, a tank circuit comprising inductance and capacity elements, said anode being connected to one end of said tank circuit, means for connecting a positive direct current potential upon said anode, means for impressing an alternating voltage between said cathode and cathanode to produce an electrical gaseous discharge in the space between said cathode and cathanode, and means for impressing upon said control electrode an alternating voltage substantially in phase with said first-named voltage.

9. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, a tank circuit comprising inductance and capacity elements, said anode being connected to one end of said tank circuit, means for connecting a positive direct current potential upon said anode, means for feeding energy from said tank circuit to the cathanode to produce an electrical gaseous discharge in the cathode-cathanode discharge space, and means for impressing upon said control electrode a voltage appearing across spaced points in said tank circuit to cause periodic pulses of current to flow to said anode.

10. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, a tank circuit comprising inductance and capacity elements, said anode being connected to one end of said tank circuit, means for connecting a positive direct current potential upon said anode, means for feeding energy from said tank circuit to the cathanode to produce an electrical gaseous discharge in the cathode-cathanode discharge space, means for impressing upon said control electrode a voltage appearing across spaced points in said tank circuit to cause periodic pulses of current to flow to said anode, and means for initially supplying energy to said cathanode to start the operation of said system.

11. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium

may be produced, a tank circuit comprising inductance and capacity elements, said anode being connected to one end of said tank circuit, means for connecting a positive direct current potential upon said anode, means for feeding energy from said tank circuit to the cathanode to produce an electrical gaseous discharge in the cathode-cathanode discharge space, means for impressing upon said control electrode a voltage appearing across spaced points in said tank circuit to cause periodic pulses of current to flow to said anode, said cathanode being connected to the positive side of said direct current potential through an impedance and a starting switch.

12. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, an electron permeable cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and said electrodes being immersed in a gaseous medium within said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing a negative bias on said cathanode, means for superimposing on said bias voltage an alternating voltage to produce an electrical gaseous discharge in the space between said cathode and cathanode, means for impressing a control voltage on said control electrode, and means for impressing a power supply voltage to said anode.

13. A system comprising an electrical gaseous discharge device comprising an envelope containing a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, means for impressing a negative bias on said cathanode, means for superimposing on said bias voltage an alternating voltage to produce an electrical gaseous discharge in the space between said cathode and cathanode, means for impressing a negative bias on said control electrode, means for superimposing upon said anode an alternating voltage substantially 180 degrees out of phase with said alternating voltages, and means for impressing a power supply voltage to said anode.

14. An oscillating system comprising an electrical gaseous discharge device comprising an envelope containing electrodes including a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, an oscillating circuit connected between the anode and another of said electrodes and adapted to be maintained in oscillation by said discharge device, means for impressing a voltage upon said anode for supplying energy to said system, means for feeding energy from said oscillating circuit to the cathanode for producing a gaseous discharge in the cathode-cathanode space, additional means for supplying energy to said cathanode to start a gaseous discharge in said cathode-cathanode space for initiating the production of oscillations in said oscillating circuit, and means for stopping said gaseous discharge between said cathode and cathanode for stopping said oscillations.

15. An oscillating system comprising an electrical gaseous discharge device comprising an envelope containing electrodes including a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, an oscillating circuit connected between the anode and another electrode and adapted to be maintained in oscillation by said discharge device, means for impressing a voltage upon said anode for supplying energy to said system, means for feeding energy from said oscillating circuit to the cathanode for producing a gaseous discharge in the cathode-cathanode space, additional means for supplying a pulse of energy to said cathanode to start a gaseous discharge in said cathode-cathanode space for initiating the production of oscillations in said oscillating circuit, and means for stopping said gaseous discharge between said cathode and cathanode for stopping said oscillations.

16. An oscillating system comprising an electrical gaseous discharge device comprising an envelope containing electrodes including a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, an oscillating circuit connected between the anode and another electrode and adapted to be maintained in oscillation by said discharge device, means for impressing a voltage upon said anode for supplying energy to said system, means for feeding energy from said oscillating circuit to the cathanode for producing a gaseous discharge in the cathode-cathanode space, additional means for supplying energy to said cathanode to start a gaseous discharge in said cathode-cathanode space for initiating the production of oscillations in said oscillating circuit, and means for removing said anode voltage for stopping said oscillations.

17. An oscillating system comprising an electrical gaseous discharge device comprising an envelope containing electrodes including a cathode, a cathanode spaced from said cathode, an anode spaced from said cathanode, a control electrode for controlling a discharge between said cathanode and said anode, and a gaseous medium in said envelope at a pressure at which substantial ionization of said medium may be produced, an oscillating circuit connected between the anode and another electrode and adapted to be maintained in oscillation by said discharge device, means for impressing a voltage upon said anode for supplying energy to said system, means for feeding energy from said oscillating circuit to the cathanode for producing a gaseous discharge in the cathode-cathanode space, additional means for supplying energy to said cathanode to start a gaseous discharge in said cathode-cathanode space for initiating the production of oscillations in said oscillating circuit, and means for removing and reapplying said anode voltage for stopping said oscillations and then putting said system into a condition wherein said additional means may restart said oscillations upon actuation thereof.

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