May 28, 1957 F. F. LEWIS, JR 2,794,153

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Filed Feb. 24, 1953 2 Sheets-Sheet 1

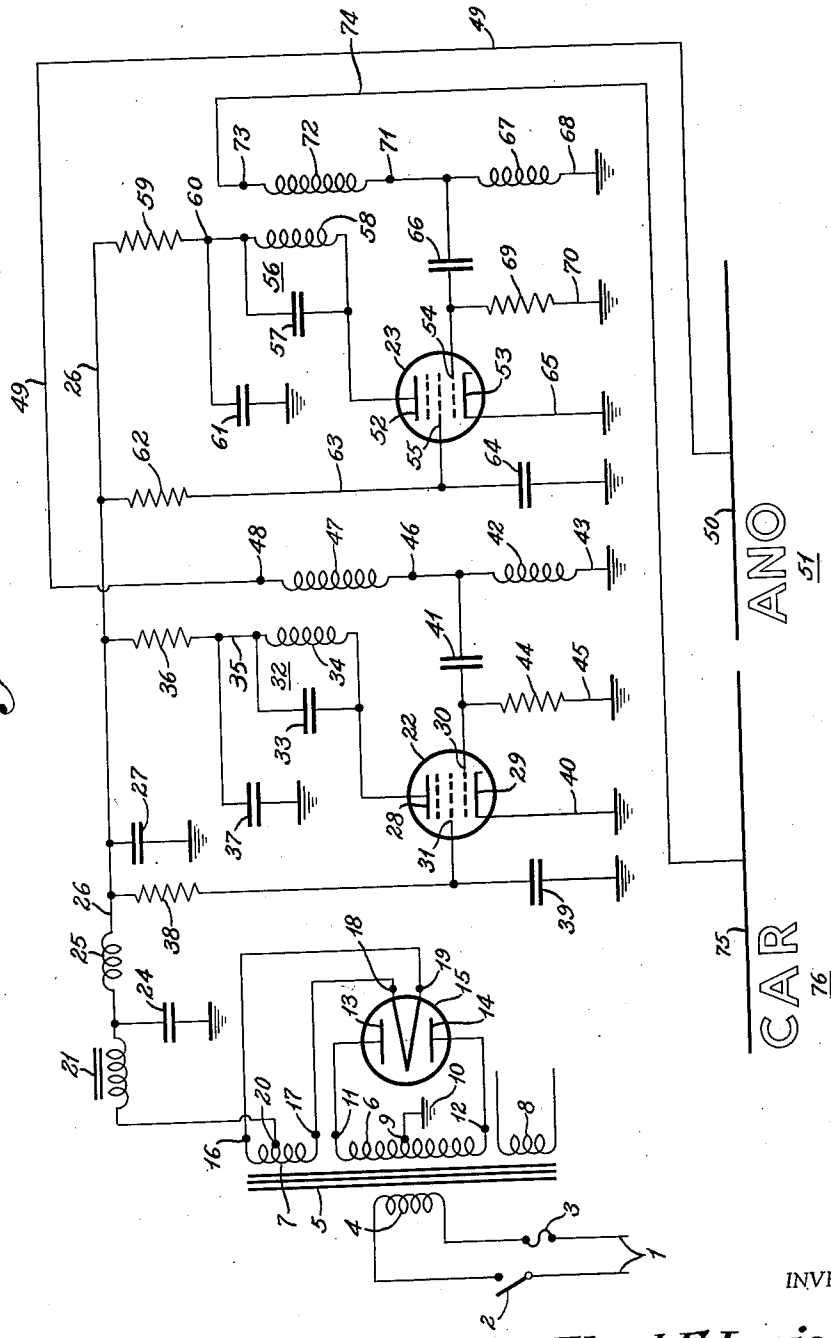


Fig. 1.

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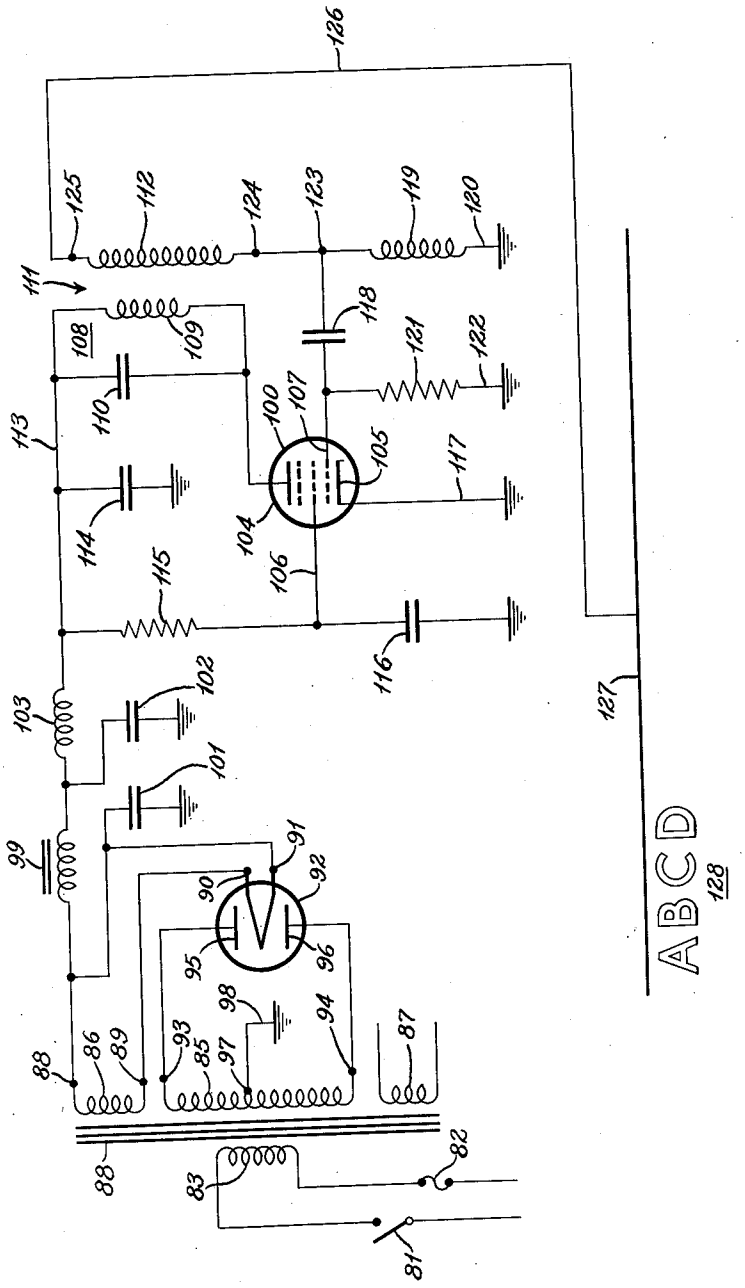


Fig. 2.

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DISPLAY SIGN

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8 Claims. (Cl. 315—248)

This invention relates to illuminated electric signs and more particularly relates to an improved means for exciting gas discharge tubes, particularly those having no internal electrodes. Such discharge tubes are commonly made in the form of letters or symbols and are assembled to form luminous signs for advertising purposes.

Signs of this type have the advantage that individual letters can be readily replaced when necessary and can be rearranged to spell out any desired message. A disadvantage of such signs has been the difficulty encountered in arranging the letters over extensive areas while maintaining uniform brilliance. A further disadvantage stems from the fact that the circuits heretofore used in exciting this type of fluorescent tubing have also radiated radio frequency energy in such a manner as to interfere with normal radio and television reception in the vicinity. This latter difficulty is more acute where the plate voltage is increased to insure starting and to insure uniformity in sign illumination. A further aggravating factor has been the use of self-rectifying oscillators which utilized 60 cycle alternating current power for the plate supply and thereby caused 60 cycle modulation or hum in nearby radio and television receivers.

It is an object of the present invention to provide an exciting means for illuminating gas-filled symbols which are not physically connected in the electrical circuit.

It is another object of this invention to provide a novel exciting means which will utilize rectified power in the plate supply circuit and which will eliminate 60 cycle hum or interference in nearby radio and television receivers.

It is another object of this invention to provide an exciting means which will minimize the radiation of radio frequency energy and will thereby minimize undesirable interference with the normal usage of radio and television receivers.

It is another object of this invention to provide an exciter means which will possess as an inherent feature thereof a switching means to cause intermittent excitation of the sign.

Further objects and advantages of the invention will become apparent upon reference to the following description and drawings, wherein:

Figure 1 shows one embodiment of the invention wherein two oscillator tubes are utilized, and

Figure 2 shows a second embodiment of the invention utilizing a single oscillator tube.

Referring particularly to Figure 1, there is shown at 1 a source of alternating current power connected to an energizing switch 2 and to a protective fuse 3. Switch 2 and fuse 3 are connected to the primary 4 of a supply transformer 5 having a center-tapped high voltage secondary 6, a first low voltage secondary 7 and a second low voltage secondary 8. The center-tap 9 of the high voltage secondary 6 of the transformer 5 is grounded to a chassis or other common connection at 10 while the outer terminals 11 and 12 of such winding are connected to the anodes 13 and 14 of a full wave rectifier tube 15. The first low voltage secondary 7 of the transformer 5 has its outer terminals 16 and 17 connected to the filament terminals 18 and 19 of rectifier tube 15 while the center-tap 20 of such winding 7 is connected to one terminal of a smoothing choke 21. The second low voltage secondary 8 of the transformer 5 is utilized to supply filament current to oscillator tubes 22 and 23 by means of connections which are not shown. The other terminal of the smoothing choke 21 is connected to one terminal of a grounded capacitor 24 to provide filtered direct current for the plates or anodes of tubes 22 and 23. A radio frequency choke 25 is located in series with the positive direct current supply lead 26 and this lead is also bypassed by a capacitor 27 in order to prevent radio frequency energy from reaching the power supply.

A high vacuum thermionic tube 22 of the pentode type having an anode 28, cathode 29, control electrode 30 and screen grid 31 has its anode 28 connected to a resonant circuit 32 consisting of a capacitor 33 and inductor 34. Capacitor 33 and inductor 34 are connected by means of lead 35 to a decoupling resistor 36 which is connected to the positive power supply lead 26. The resistor 36 and resonant circuit 32 are bypassed by means of a capacitor 37.

The screen grid 31 of tube 22 is connected to the positive supply lead 26 through a voltage dropping resistor 38 which is bypassed to ground by means of a capacitor 39. The cathode 29 of tube 22 is grounded by means of lead 40.

The control electrode 30 of tube 22 has connected thereto a capacitor 41 in series with a radio frequency choke 42 which is grounded at 43. Also connected to control electrode 30 is a resistor 44 which is grounded at 45. Connected to the interconnection between capacitor 41 and choke 42 is one terminal 46 of an inductor 47 which is inductively coupled to inductor 34 in resonant circuit 32. The other terminal 48 of inductor 47 is connected by means of a supply lead 49 to a letter supply line 50 for one group of sign letters 51.

A high vacuum thermionic tube 23 having an anode 52, cathode 53, control electrode 54 and screen grid 55 has its anode 52 connected to one terminal of a resonant circuit 56 consisting of a capacitor 57 and inductor 58. The resonant circuit 56 is fed with positive potential from supply line 26 through decoupling resistor 59 and lead 60. The lead 60 is bypassed to ground by means of a capacitor 61.

The screen grid 55 of tube 23 is fed with direct current from supply line 26 through a voltage dropping resistor 62 and connection 63. Such screen grid 55 is bypassed to ground by means of a capacitor 64. The cathode 53 of the tube 23 is grounded at 65.

Connected to the control electrode 54 of tube 23 is a capacitor 66 in series with a radio frequency choke 67 which is grounded at 68. The control electrode 54 is further connected to a resistor 69 which is connected to ground at 70. Connected to the interconnection between capacitor 66 and choke 67 is one terminal 71 of an inductor 72 which is inductively coupled to the inductor 58 in the resonant circuit 56. The other terminal 73 of inductor 72 is connected by means of a supply lead 74 to a letter supply line 75 which supplies power to a second group of letters 76.

The resonant circuits 32 and 56 resonate at approximately 100 kilocycles, the inductors 34 and 58 in said circuits forming the primaries of radio frequency transformers, the inductors 47 and 72 forming the secondaries of said transformers. These secondaries are primarily shunted by the capacitance to ground of the letters in groups 51 and 76, although there is also a certain amount of self-capacitance between the windings of such secondaries. Feed back energy is developed across radio fre-

quency choke **42** for the tube **22** and across the radio frequency choke **67** for the tube **23**. The two oscillator stages are identical and function as a type of blocking oscillator. That is, for a portion of each cycle the grid is driven positive and grid current flows causing a voltage drop across the grid resistors which serves as a bias. The greater the amplitude of oscillation, the more positive the grid swings, and the greater is the average grid current. Thus the bias builds up with oscillation amplitude, causing the transconductance to fall until equilibrium is established. Under equilibrium conditions grid current flows during only a small fraction of the cycle, and the grid bias is very nearly equal to the amplitude of the alternating grid voltage. After a number of cycles of oscillation the bias becomes so high that the circuit stops oscillating. Because oscillation starts at a lower bias than that at which it stops, some time elapses while the grid capacitor discharges through the bias resistor sufficiently to allow oscillation to recommence, and so periods of oscillation alternate with periods of rest. This phenomenon is termed "motor-boating" and the period of motor-boating depends upon the time required for the capacitor to discharge and this in turn is dependent upon the size of the capacitor and the grid leak resistance. The motor-boating phenomenon may be taken advantage of and used to cause intermittent excitation of the sign and for this purpose it may be desirable to make the resistors **44** and **69** variable.

The two oscillator stages, that is, the stage including tube **22** and the stage including tube **23**, each supply a group of letters such that uniform excitation of all of the letters in the sign is obtained even in situations where the entire sign is very large. Radiation interference with normal radio and television reception has not been experienced with the foregoing circuit, and it has even been found possible to operate radio and television receivers in the same room with the aforedescribed equipment.

In Figure 2 there is shown an embodiment of the invention wherein a single oscillator tube is used. This type device may be utilized where the size of the sign does not call for a plurality of stages of oscillators or where increased ratings of the oscillator tube makes it possible to excite a large sign through the use of a single stage oscillator.

A source of alternating current power **80** feeds an energizing switch **81** and fuse **82** in the supply lines of the primary **83** of a supply transformer **84** having a center-tapped secondary **85** and two low voltage secondaries **86** and **87**. The two terminals **88** and **89** of low voltage secondary **86** supply current to the filament terminals **90** and **91** of a full wave rectifier **92**. The terminals **93** and **94** of the high voltage center-tapped secondary **85** are connected to the plates **95** and **96** of the rectifier **92**, the center-tap **97** of said winding being grounded at **98**. The second low voltage winding **87** furnishes filament power for the high vacuum thermionic tube **100** by means of connections which are not shown. The terminal **88** of the low voltage winding **86** serves as the positive direct current supply terminal and has connected thereto a smoothing choke **99** and a filter condenser **101** which has its other terminal grounded. The other side of smoothing choke **99** has connected thereto a second grounded filter condenser **102** and a radio frequency choke **103** which serves to prevent radio frequency energy from reaching the power supply section.

The oscillator circuit is similar to those shown in the embodiment of Figure 1 and comprises an oscillator tube **100** having an anode **104**, cathode **105**, screen grid **106** and control electrode **107**. Connected to anode **104** is a resonant circuit **108** having an inductor **109** and a capacitor **110**, the inductor **109** forming the primary of a radio frequency transformer **111** which has a secondary consisting of inductor **112**. The tuned circuit **108** is connected by means of supply line **113** to the radio frequency choke **103** and is bypassed to ground by means of capacitor **114**.

The screen grid **106** is supplied with direct current voltage through a dropping resistor **115** which is bypassed to ground by means of a capacitor **116**. The cathode **105** is grounded at **117**.

Connected to control electrode **107** is a capacitor **118** in series with a radio frequency choke **119** which is grounded at **120**. Control electrode **107** is also connected to a resistor **121** which is grounded at **122**. At the interconnection **123** of capacitor **118** and choke **119** there is connected one terminal **124** of the inductor **112** which is the secondary of the radio frequency transformer **111**. The other terminal **125** of such inductor is connected by means of a lead **126** to a letter supply line **127** for exciting the letters **128** of the sign.

The operation of this embodiment of the invention is similar to that of the embodiment shown in Figure 1.

While the present invention has been described in connection with illuminated signs it will be understood that the oscillator described is useful in other environments where it is desired to produce controlled radio frequency power with a minimum of interference with radio and television receivers. The specific illustrations of the invention have been utilized by way of illustration only and are not to be deemed limiting in any sense, the invention being limited only by the scope and spirit of the appended claims.

I claim:

1. In combination, a gas-filled discharge tube constituting a display symbol and an oscillator for energizing said gas-filled discharge tube; said oscillator comprising an electron tube having a cathode, an anode having a series fed tuned anode circuit connected thereto, and at least one control electrode; a first series circuit including said control electrode, a capacitor means, a choke, and said cathode; a second series circuit including said control electrode, a resistor, and said cathode, said series circuits providing bias means for said control electrode, an inductor inductively coupled to said tuned circuit and connected in series with said control electrode and said capacitor, a series connected load circuit including said discharge tube, said choke and said inductor, whereby operation of the oscillator will excite said discharge tube; and said choke forming a part of said load circuit as well as a part of the bias means.

2. In combination, an electrically illuminated display sign and an oscillator for energizing said display sign; said oscillator comprising a thermionic tube having an anode, a cathode, and at least one control electrode; a series fed tuned anode circuit; a first series biasing circuit for said control electrode including a capacitor, a choke, and said cathode, a second series biasing circuit for said control element including a resistor connected between said control electrode and said cathode; an inductor coupled to said tuned anode circuit and having one end thereof connected to said second series circuit at the connection between said capacitor and said choke; and a load means connected to the other end of said inductor, said load means including in a series circuit said display sign, said choke and said inductor.

3. In combination, an electrically illuminated display sign and a radio frequency oscillator for exciting said sign; said sign comprising an ionizable gas-filled discharge tube; a source of substantially constant direct current; a vacuum tube having an anode, a cathode and at least one control electrode; a radio frequency transformer having a primary and a secondary; a resonant circuit connected in series between said source and said anode and including therein the primary of said transformer; blocking bias means for the control electrode, said bias means including a resistor connected in series between the control electrode and said cathode, and a capacitor and a choke connected in series between said control electrode and said cathode; and load means for the oscillator, said load means including in a series circuit said transformer sec-

ondary, said gas-filled discharge tube, and said choke, the values of the resistor and the capacitor being so chosen that intermittent operation of the oscillator with consequent intermittent excitation of said gas-filled discharge tube will take place.

4. In combination, an illuminated sign comprising a plurality of ionizable gas-containing discharge tubes constituting symbols and an oscillator for energizing said gas-filled tubes, said oscillator comprising an electron tube having an anode, a cathode and at least one control electrode; a source of potential for supplying said anode; a tuned anode circuit including a first inductive means and a first capacitor connected in parallel with said first inductive means; a first series circuit including said source of potential, said tuned anode circuit, and said anode; a resistor connected in a second series circuit between said cathode and said control electrode; a third series circuit including a second capacitor, said control electrode, a choke and said cathode; said second and third series circuits providing bias for said control electrode; a second inductive means having one terminal connected to the junction between said second capacitor and the choke; load means coupling the second inductive means to said gas-filled discharge tubes, said load means comprising a fourth series circuit including a supply line located in close spaced relation to the discharge tubes, a lead connecting said supply line to a second terminal of the second inductive means and said choke; said first and second inductive means being inductively coupled to each other.

5. In combination, an electric sign formed of groups of gas-filled discharge tubes constituting display symbols and at least two oscillators for energizing at least a pair of said groups, respectively; at least two feed means comprising conductors located in close proximity to each one of said pair of said groups of said gas-filled tubes; said oscillators each including a radio frequency transformer having a primary and a secondary winding and a tube having an anode, a cathode, and at least one control electrode; one terminal of each secondary winding being connected to a respective one of said feed means; the other terminal of each secondary winding being connected in a series circuit with a capacitor and with its respective control electrode; a resistor connected in series between each control electrode and each cathode; a choke connected in series with each of said capacitors and each respective cathode; and a series circuit comprising a series-fed tuned anode circuit connected to the anode of each of said tubes and the primaries of said transformers; said feed means, discharge tubes, transformer secondaries and chokes being series connected and constituting load means for the oscillators; and said resistors, capacitors and the chokes providing bias means for said oscillators.

6. In combination, an electric sign and energizing means therefor: said sign comprising a plurality of ionizable gas-filled tubes having a symbolic configuration; said groups of discharge tubes being arranged to constitute a display symbol; feed means comprising conductors which each extend along and in close proximity to a group of said symbols; a plurality of oscillators connected to said feed means for exciting said symbols, each oscillator comprising; a high vacuum thermionic tube having an anode, a cathode, and at least one control electrode; a series-fed tuned anode circuit for each of said oscillators; a first series circuit for each of said oscillators including said control electrode, a capacitor, a choke, and said cathode; a resistor connected in a second series circuit between said control electrode and said cathode; and a two-terminal inductor inductively coupled to said tuned anode circuit and connected in series with said first series circuit, said two-terminal inductor having one terminal connected between said capacitor and said choke and its other terminal connected to one of said feed means, said first series circuit and said second series circuit providing blocking bias for the tube whereby intermittent oscillator operation will be effected, and a load circuit for each of said oscillators, each of said load circuits comprising a series circuit including said choke, said inductor, said feed means and a group of said symbols.

7. In combination, an ionizable gas-filled discharge tube constituting a display symbol and an oscillator for energizing said gas-filled tube; said oscillator comprising an electron tube and a radio frequency transformer including a primary and a secondary; said electron tube having an anode, a cathode and a control electrode; a tuned anode circuit including in series the transformer primary and said anode; biasing means for the control electrode including a resistor connected in series between the control electrode and the cathode, and a capacitor and a choke connected in series with said cathode and control electrode, a load circuit including in series said choke, the transformer secondary and said discharge tube, a power source for the oscillator, connected to the tuned anode circuit, and means isolating the power source from radio frequency energy developed by the oscillator.

8. An oscillator as recited in claim 7, wherein the values of the resistor, the capacitor and said choke of said biasing means are so chosen as to provide intermittent operation of said oscillator.

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