June 24, 1941. A. M. BRAATEN 2,247,216

RESONANT LINE CONTROLLED OSCILLATION GENERATOR

Filed April 27, 1938

Fig. 2

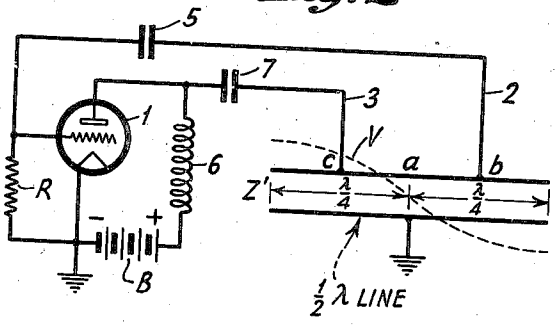


Fig. 1

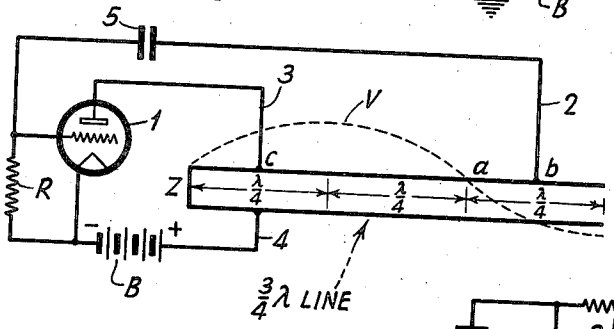


Fig. 4

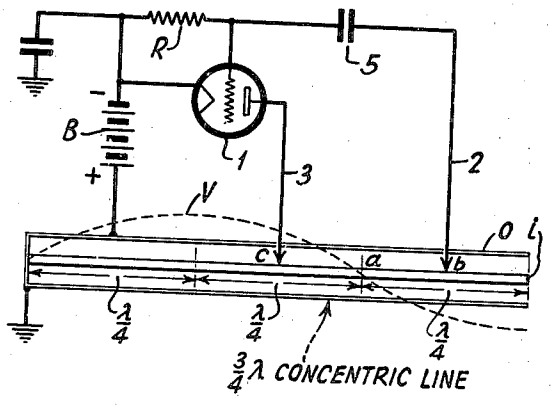
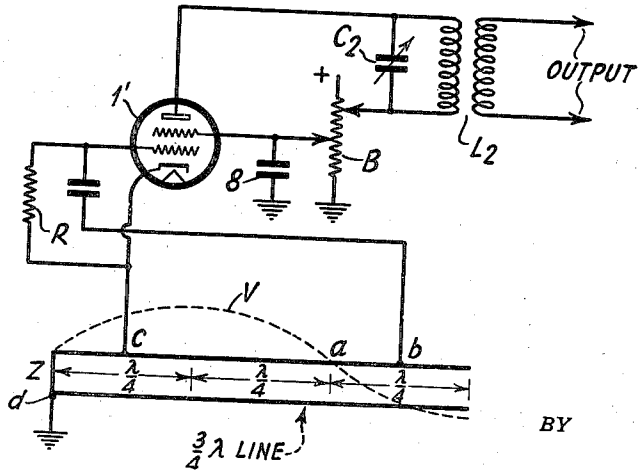


Fig. 3



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RESONANT LINE CONTROL OSCILLATION GENERATOR

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Application April 27, 1938, Serial No. 204,589

9 Claims. (Cl. 250—36)

The present invention relates to electron discharge device oscillation generators, and particularly to such generators which are stabilized as to frequency by a resonant line.

It is known to employ a quarter wavelength resonant line connected between the grid and cathode of a vacuum tube oscillator to control the frequency of oscillations generated by said tube. In such case, the feed-back coupling between the grid and anode of the tube is usually the interelectrode capacity between the grid and anode.

The present invention provides an improved type of resonant line controlled oscillation generator, wherein, among other things, a single resonant line functions both as a frequency stabilizing element and as a feed-back means to supply the grid with alternating voltage of instantaneous opposite phase to that on the anode in order to sustain oscillations.

A better understanding of the invention may be had by referring to the following description, which is accompanied by a drawing, wherein:

Figs. 1, 2 and 3 show different embodiments of the invention using a two-wire type of resonant line, and

Fig. 4 is a further embodiment using a concentric conductor type of resonant line.

Referring to Fig. 1, there is shown a conventional type of electron discharge device 1, having a cathode, a grid, and an anode. A resonant line Z consisting of two parallel wires three-quarters of a wavelength long, open at one end, and short circuited at its other end, serves the dual purpose of stabilizing the frequency of oscillations and of providing a feed-back circuit to sustain oscillations. The voltage distribution along the resonant line Z is indicated by the dotted line V. Connections 2 and 3 from the grid and anode, respectively, of the electron discharge device 1 extend to points *b* and *c* on the resonant line which are oppositely disposed with respect to the voltage nodal point *a*. The cathode of the electron discharge device is connected through a suitable polarizing battery B and a lead 4 to another point, suitably selected, on the resonant line Z. A condenser 5 serially placed in the connection 2, extending to the grid, serves to block the direct current voltage from the positive terminal of battery B from flowing to the grid circuit. A resistance R serves to suitably bias the grid of the oscillator.

Due to the fact that the resonant line Z has low losses, and a high Q (low power factor), the line serves as an extremely efficient frequency control element. Because the connections 2 and 3 from the grid and anode have instantaneous opposite polarities impressed thereon by the line, the circuit will sustain oscillations.

Fig. 2 illustrates a different modification of my oscillation generator wherein the resonant line here indicated as Z', is one-half wavelength long and open at both ends. The connections 2 and 3 from the grid and anode of the electron discharge device 1, extend to points *b* and *c* which are oppositely disposed with respect to the voltage nodal point *a*, and located on one of the wires of the line. The other wire of the resonant line Z' is grounded and connected back to the cathode of the device. Although a ground connection has been shown diagrammatically, it is to be distinctly understood that this ground connection in this figure, as well as in the other figures, need not be an actual earthed connection, but rather a point of relatively fixed radio frequency potential. Since the polarizing voltage for the anode is here supplied through a choke coil 6, there is provided a blocking condenser 7 in connection 3.

Fig. 3 illustrates the application of the principle of my invention to an electron coupled oscillation generator. In this figure, the electron discharge device 1' is a four electrode tube, having an oscillation circuit constituted by the first three electrodes; namely the cathode, grid, and the screen electrode, these three electrodes being isolated from a reaction standpoint from the outer electrode which surrounds the screen. In effect, the screen is the anode for the oscillation generator, while the outer surrounding electrode is merely an electron collecting circuit for the output of the electron discharge device. Any suitable tuned circuit may be coupled between the outer electrode and the cathode to derive output energy for utilization purposes. In the present case, condenser C_2 serves to tune the output circuit. The reference numeral L_2 designates the transformer coupling the oscillation generator to a utilization circuit, here labeled "Output."

In Fig. 3 the first or control grid is connected to a point *b* on the resonant line Z on one side of the voltage nodal point *a*, while the cathode is connected to point *c* on the other side of the voltage nodal point. Since the screen grid is grounded through a radio frequency by-pass condenser 8, and the resonant line Z is also grounded at point *d*, it will be evident that in effect the screen grid is also connected to point *d*. Inasmuch as points *b* and *c* have instantaneous opposite polarities impressed thereon (note the voltage distribution curve V), the line serves both to control and to sustain oscillations generated by the electron discharge device 1'.

Fig. 4 shows an arrangement similar to that of Fig. 1, except that in this case the resonant line is a concentric affair having an outer conductor *o* and an inner conductor *i*. Both the outer and inner conductors are three-quarters of a wave-length long, open at one end and short circuited and grounded at their other ends. Since in a concentric line the projection of the inner

conductor on the outer conductor determines the effective length and the frequency of the resonant line, it will be evident that if desired the outer conductor may be made longer than the inner conductor without appreciably effecting the resonant frequency of the line. It should be noted that connections 2 and 3 from the grid and anode of the electron discharge device 1, in this Fig. 4, extend to points *b* and *c* on the inner conductor *i*, which are on opposite sides of the voltage nodal point *a*.

Although points *c* and *b* have been shown in all figures as being on opposite sides of the voltage nodal point, it should be distinctly understood that they are not necessarily symmetrically disposed with respect to the voltage nodal point, inasmuch as these points are carefully selected with a view to matching, as close as reasonably possible, the impedance of the line to the impedances of the vacuum tube electrodes. It should be noted that the resonant line of the present invention has a length which gives both a high impedance and also at least one phase reversal. Other lengths of resonant line than those illustrated in the drawing may be used, provided that the principles outlined above are adhered to. Greater lengths than those illustrated, however, are not preferred in the interest of simplicity and compactness.

What is claimed is:

1. An oscillation generator comprising an electron discharge device having a grid, a cathode, and an anode, a resonant line having uniformly distributed inductance and capacity and being in the form of two, straight, parallel and continuous wires at least one-half wavelength long, the conductors of said line being insulatingly spaced from each other at all points intermediate the ends, connections from said grid and anode to points on one of said wires of said line intermediate the ends thereof which are oppositely disposed with respect to a voltage nodal point thereon, and a connection from said cathode to the other wire of said line.

2. An oscillation generator comprising an electron discharge device having a grid, a cathode, and an anode, a two-conductor resonant line three-quarters of a wavelength long, said line being open at one end and short circuited at one end, connections from said grid and anode to points on said line intermediate the ends thereof which are oppositely disposed with respect to a voltage nodal point thereon, and a connection from said cathode to said line.

3. An oscillation generator comprising an electron discharge device having a grid, a cathode, and an anode, a two-conductor resonant line having uniformly distributed inductance and capacity, said line having straight parallel and continuous conductors and being at least one-half wavelength long, the conductors of said line being insulatingly spaced from each other at all points intermediate the ends, connections from said grid and anode to points of opposite polarities on one of the conductors of said line, at least one of said points being intermediate the ends of said resonant line, and a connection from said cathode to said line.

4. An oscillation generator comprising an electron discharge device having a grid, a cathode, and an anode, a concentric conductor resonant line at least one-half wavelength long and having a straight continuous inner conductor, a path of low impedance to energy of the operating frequency connecting together the conductors of said resonant line solely at one end, connections from said grid and anode to points of opposite polarities on the inner conductor of said line, a connection of low impedance to energy of the operating frequency from ground to the outer conductor of said line, at least one of said points being intermediate the ends of said line, and a connection from said cathode to said line.

5. An oscillation generator system in accordance with claim 2, characterized in this that said anode contains apertures for enabling electrons to pass therethrough, there being an electron collecting electrode outside said anode and an output circuit coupled to said electron collecting electrode, whereby said oscillation generator is isolated from said output circuit to avoid reaction from said output circuit onto said oscillation generator.

6. An oscillation generator comprising an electron discharge device having a grid, a cathode, and an anode, a concentric conductor resonant line three-quarters of a wavelength long, said line being open at one end and short circuited at its other end, connections from said grid and anode to points on the inner conductor of said line intermediate the ends thereof which are oppositely disposed with respect to a voltage nodal point thereon, and a connection from said cathode to said line.

7. An oscillation generator comprising an electron discharge device having a grid, a cathode, and an anode, a concentric conductor resonant line at least one-half wavelength long and having straight continuous conductors, a path of low impedance to energy of the operating frequency connecting together the conductors of said resonant line solely at one end, connections from said grid and anode to points of opposite polarities on the inner conductor of said lines, both of said points being intermediate the ends of said line, and a connection from said cathode to the outer conductor of said line.

8. An oscillation generator comprising an electron discharge device having a grid, a cathode, and an anode, a two-conductor resonant line having uniformly distributed inductance and capacity, said line having straight parallel and continuous conductors and being at least one-half wavelength long, a path of low impedance to energy of the operating frequency connecting the conductors of said line together solely at one end, connections from said grid and anode to points of opposite polarities on one of the conductors of said line, at least one of said points being intermediate the ends of said resonant line, and a connection from said cathode to said line.

9. An oscillation generator comprising an electron discharge device having a grid, a cathode, and an anode, a concentric conductor resonant line at least one-half wavelength long and having a straight continuous inner conductor, the conductors of said line being insulatingly spaced from each other at all points intermediate the ends, connections from said grid and anode to points of opposite polarities on the inner conductor of said line, a connection of low impedance to energy of the operating frequency from ground to the outer conductor of said line, at least one of said points being intermediate the ends of said line, and a connection from said cathode to said line.

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