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2,283,653

OSCILLATION GENERATOR CIRCUIT

Original Filed March 30, 1937

2 Sheets-Sheet 1

Fig. 1.

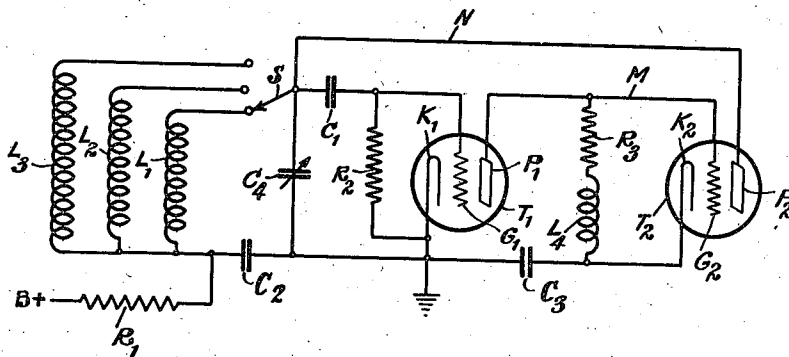
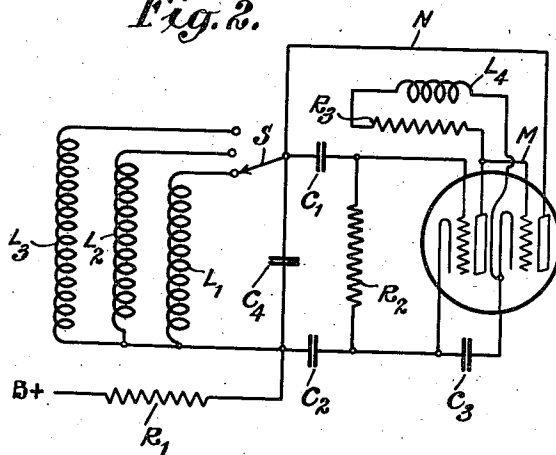


Fig. 2.



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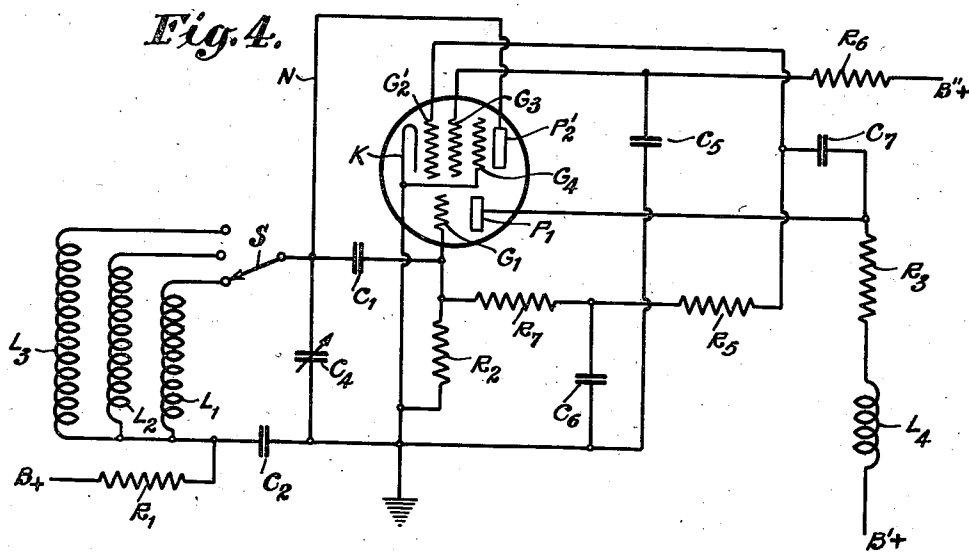
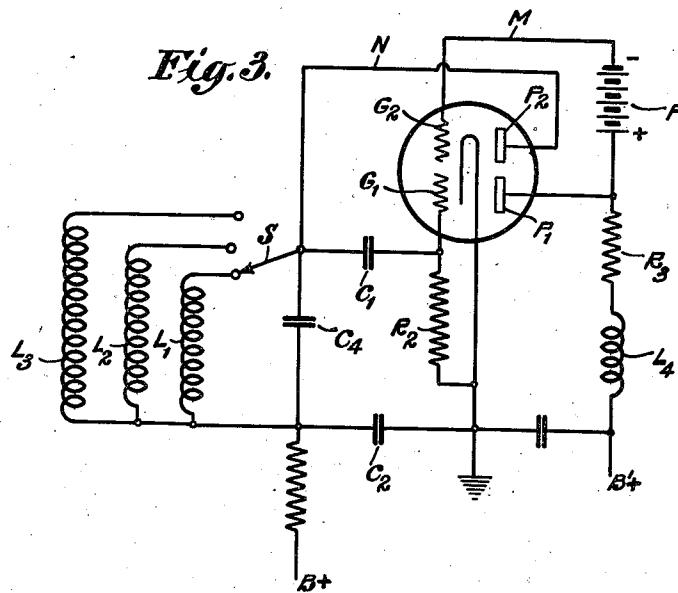
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UNITED STATES PATENT OFFICE

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OSCILLATION GENERATOR CIRCUIT

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Original application March 30, 1937, Serial No. 133,753, now Patent No. 2,192,205, dated March 5, 1940. Divided and this application January 5, 1940, Serial No. 312,479

4 Claims. (Cl. 250—36)

The present invention relates to oscillation generator circuits of the "two-terminal" type. By the expression "two-terminal" oscillator, as understood in engineering practice, is meant a generator employing only a single tuned circuit whose two terminals are required to be connected to the generator for producing an operative structure. This application is a division of my United States Patent No. 2,192,205, granted March 5, 1940, on an application Serial No. 133,753, filed March 30, 1937.

Heretofore, in oscillator circuits designed to cover various frequency ranges, it has been necessary to switch a plurality of contacts in order to change from one frequency range to another. Such arrangements, besides being relatively expensive and cumbersome, are rather complicated and introduce undesirable energy losses. The present invention, inter alia, overcomes the foregoing disadvantages and provides a relatively simplified oscillation circuit which requires that only one contact be changed in order to switch from one frequency range to another.

Accordingly, one of the objects of the present invention is to provide a simplified oscillator wherein a minimum of switching of tuned circuits is required for obtaining a number of different frequency ranges.

Another object is to provide a simplified regenerative type of two-terminal oscillator wherein a vacuum tube is employed to replace the usual feed-back coil.

A further object is to provide a multi-tube regenerative oscillator in which direct coupling is employed between the output electrode of one tube and the input electrode of the succeeding tube, and use is made of this direct coupling to provide bias for said input electrode.

A still further object is to provide a two-terminal oscillation generator which can function efficiently in the ultra high frequency range as well as at lower frequencies.

A feature of the invention resides in the use of an automatic amplitude regulator for providing a constant amplitude of oscillations over a desired range of frequencies.

According to one embodiment of the invention, the tubes of the oscillator may be operated over substantially linear portions of their respective grid-voltage-grid-current characteristics, thus producing oscillations which are substantially free from undesired harmonics.

Other objects, features and advantages will appear from a reading of the following description, taken in conjunction with the accompany-

ing drawings, wherein Figs. 1 to 4, inclusive, illustrate different embodiments of an oscillation generator circuit constructed in accordance with the principles of the present invention. In these figures, like parts are indicated by like reference numerals.

Referring to Fig. 1 in more detail, there is shown a two-terminal multi-tube high frequency oscillator comprising a pair of tubes T_1 and T_2 . Although tubes T_1 and T_2 are here shown as being of the triode type, it is to be distinctly understood that, if desired, such tubes may have additional electrodes. Vacuum tube T_1 includes, among its electrodes, a grid G_1 , a cathode K_1 and an anode P_1 . Coupled to the grid G_1 and cathode K_1 is a tuned oscillatory circuit comprising an inductance L_1 having in shunt therewith a variable condenser C_4 . A switch S is provided for enabling, alternatively, the selection of any one of a plurality of other coils L_2 , L_3 etc., for cooperating with the condenser C_4 for obtaining a change in the frequency range of the oscillator. The usual grid-leak and condenser combination here shown by the reference numerals R_2 and C_1 provide the automatic bias for the input electrode G_1 of the tube. Conductively coupled to the anode P_1 through a direct current path M is a grid G_2 of a vacuum tube T_2 whose anode P_2 is coupled back to the input circuit L_1 , C_4 through connection N , thus providing a feed-back circuit. The feed-back of energy from the output electrode of tube T_2 to the input electrode of tube T_1 is in such phase and of such magnitude as to overcome the losses in the circuit and produce oscillations. Putting it another way, it may be said that the voltage gain of the two tubes T_1 and T_2 is unity or greater between grid G_1 of tube T_1 , and the anode P_2 of tube T_2 .

Directly connected to the connection M , there is shown a resistance R_3 which acts as a load for the anode P_1 , and simultaneously provides grid bias for the grid G_2 . An inductance L_4 is arranged in series with R_3 and is of such value as to correct for the phase shift occurring in the load circuit R_3 . A radio frequency by-pass condenser C_3 connects the cathodes of the two tubes together, in the manner indicated in the drawings. The usual source of potential indicated as $B+$ is connected to the lower terminals of coils L_1 , L_2 , and L_3 for maintaining the anodes P_1 and P_2 of the tubes at a positive potential relative to their respective cathodes. The path of the positive source $B+$ for the anodes of the tubes may be traced through resistance R_1 , through induct-

ance L_1 , switch S , and feed-back path N to the anode P_2 . The positive polarizing potential for the anode P_1 is obtained through tube T_2 , over the cathode K_2 and its connection to the lower terminal of inductance L_4 , and resistance R_3 . It will be obvious that there will be a difference in the magnitude of the polarizing potentials applied to the anodes P_1 and P_2 due mainly to the voltage drop in the tube T_2 . In one embodiment actually used in practice, the voltage available from the source $B+$ was 250 volts. The magnitude of the voltage applied to the anode P_1 was less than that applied to the anode of tube T_2 , with respect to ground or the negative terminal of the anode supply, the difference varying in accordance with the amount of grid bias on the electrodes of the tubes. A radio frequency bypass and blocking condenser C_2 is connected between the anode source $B+$ and the cathode of the tube T_1 for preventing a direct path for the current from the positive source $B+$ to ground. Condenser C_2 also completes the tuned circuit between the lower end of C_4 and inductances L_1 , L_2 , and L_3 . This condenser C_2 in conjunction with resistor R_1 forms a filter isolating the oscillator circuit from other circuits which may be connected to the same power supply system.

The operation of the circuit is as follows. Any voltage appearing across the tuned circuit L_1 , C_4 is impressed across the grid G_1 and the cathode K_1 of the tube T_1 , whereupon it develops a voltage on the anode P_1 substantially 180° out of phase with the original voltage. The oppositely phased voltage is then transmitted to the grid G_2 by the connection M . The tube T_2 functions as an amplifier and produces on the anode P_2 a voltage which is again reversed substantially 180° with respect to the voltage on the grid G_2 , but now in phase with the original voltage on grid G_1 . It will thus be seen that the tube T_2 serves both as an amplifier and as a phase inverter. By suitably selecting the constants of the circuit, any desired degree of amplification of the original exciting impulse may be obtained.

Fig. 2 illustrates the same circuit arrangement as that shown in Fig. 1, the electrodes of both tubes being contained within a single envelope. Since the connections of Fig. 2 are similar in every respect with those of Fig. 1, and the operation of the oscillator is the same, it is not believed necessary to repeat what has been said before. In one oscillator actually constructed in accordance with the circuit of Fig. 2, there was used an RCA type 6C8 dual triode. With such a tube, oscillations as high as 38 megacycles were obtained. This frequency is given by way of example, merely to indicate the possibilities of the circuit, but it does not represent the limit to which the oscillator of the invention can be operated.

In the dual tube where a common cathode is employed for the two grids and their respective anodes, such as in the RCA type 6N7, a circuit such as shown in Fig. 3 may be used instead of that shown in Fig. 2. Besides using a common cathode, Fig. 3 differs from Fig. 2 mainly in the use of a bucking battery F inserted in the lead M , the battery being so polarized as to provide the correct operating bias for the grid shown in the upper section of the envelope of the tube. An additional source of anode supply $B'+$ is employed to supply potential to the anode of the lower portion of the tube, which anode corresponds to P_1 of Fig. 1. The reason why another anode battery is required for P_1 in this instance

is because the electron paths are no longer in series as is the case in Figs. 1 and 2. The bucking battery F is required to overcome the positive potential on anode P_1 , inasmuch as the grid G_2 must be maintained at a negative potential with respect to the common cathode. The operation of this circuit is substantially identical with that of Figs. 1 and 2.

Fig. 4 illustrates another embodiment of an oscillation generator in accordance with the principles of the present invention. The operation of this circuit is substantially the same as that of the other figures with the addition of an automatic amplitude regulator feature described hereinafter. The oscillator of this feature employs a single electron discharge device of the Radiotron type 6F7 consisting of a combination triode and variable mu pentode, although it will be appreciated that, if desired, two separate tubes may be employed. The automatic amplitude regulator feature consists of a connection from the grid G_1 of the triode portion of the tube to the grid G'_2 of the pentode portion. This connection includes a resistance-condenser filter network R_7 , C_6 and a resistor R_5 . The pentode screen grid portion of the tube is used in order to obtain a wide range of control of the voltage amplification in this portion of the circuit, because of the automatic amplitude regulator feature. It should be noted that the pentode portion of this tube includes a screen grid G_3 and a suppressor grid G_4 , the screen grid being supplied with a suitable positive potential from a source of supply B'' . The condenser C_7 serves to isolate the anode P_1 from the grid G'_2 for direct current.

The automatic amplitude regulator feature functions as follows: Assuming that the oscillation generator is generating oscillations of a certain amplitude, then a voltage will appear across the resistance R_2 due to the current drawn by the grid G_1 . This voltage will be polarized negatively with respect to the cathode K , and will charge a condenser C_6 to the peak value of this negative voltage through the resistor R_7 . This voltage appearing on condenser C_6 is then passed on to the grid G'_2 so that the potential appearing on this last grid is essentially the same as that on the grid G_1 . This amount of potential on the grid G'_2 will allow the tube to function with a certain voltage amplification. If the oscillator now tends to oscillate more strongly, a larger potential will be developed across the resistance R_2 which, in turn, is passed to the condenser C_6 charging it more negatively than before, and thus a more negative potential will in turn be passed on to grid G'_2 . Because of the action of the variable mu pentode portion of the tube, the gain of this portion of the circuit will be reduced from that formerly obtained when the oscillation generator was generating voltage of lower amplitude, thus lowering the amount of feed-back voltage transferred from the anode P'_2 back over connection N to the grid G_1 . This lowered feed-back potential will then result in a lower amplitude of oscillations which will be similar to that initially started in the circuit. Conversely, if the amplitude falls below the original assumed level, the gain of the pentode portion of the tube is increased, thus restoring the voltage amplitude of the energy on grid G_1 to the predetermined level. In this way, the oscillation generator functions to produce a constant amplitude of oscillations as the losses of the circuit vary.

An inspection of all the figures will show that

it is only necessary to move the single pole switch S to engage a single contact, in order to select any desired frequency range which may be characteristic of a particular coil L_1 , L_2 , or L_3 . This is possible because one terminal of each of these coils is permanently connected to the circuit while the other terminal is connected to a contact of the switching mechanism S.

Although the invention has been described with particular reference to circuits employing two separate electron discharge device paths, either in separate envelopes or combined in a single envelope, it is to be distinctly understood that the invention is not limited to such particular arrangements since, if desired, any even multiple of two electron discharge device paths may be employed.

What is claimed is:

1. A system for the generation of high frequency oscillations comprising first and second electron discharge paths, each path having an anode, a grid, and electron emitting means, a connection from the anode of said first path to the grid of said second path, and a feed-back circuit from the anode of said second path to the grid of said first path, means for applying a suitable bias to each of said grids and means for applying polarizing potentials to said anodes to cause the flow of current through said electron discharge paths, a condenser connected between one of said grids and said electron emitting means, a plurality of inductance coils of different values each having a terminal permanently connected electrically to one electrode of said condenser and another terminal to a contact, a switch connected to the other electrode of said condenser and adapted to engage any one of said contacts for selectively coupling any one of said inductance coils in parallel relation to said condenser, whereby said system may generate oscillations of a frequency range determined by said condenser and the selected coil, and an automatic amplitude regulator constituted as a filter network and comprising a resistive connection from the grid of said first electron discharge path to the grid of said second electron discharge path, and a shunt capacitor connected between said electron emitting means and an intermediate point on said resistive connection.

2. An oscillation generator comprising first and second electron space discharge paths, said first path including electron emitting means, a grid and an anode, said second path including electron emitting means, first and second grids and an anode; said second path having a variable μ characteristic, a connection between the electron emitting means of said two paths, a resistance connected between the grid of said first path and said electron emitting means an alternating current connection including a series ar-

ranged condenser from the anode of said first path to the first grid of said second path, a connection from the anode of said second path to the grid of said first path, a parallel tuned circuit coupled through connections of low impedance to energy of the operating frequency between the grid of one of said paths and said electron emitting means, and an amplitude regulator including at least a portion of a filter network connected between the grid of said first path, said electron emitting means and the first grid of said second path, connections from both of said anodes and from said second grid to suitable sources of positive polarizing potentials, said condenser serving to isolate the anode of said first path from the first grid of said second path for direct current.

3. An oscillation generator comprising a discharge tube of the triode-pentode type wherein the triode discharge path extends from a common cathode through a grid to an anode, and the pentode discharge path extends from said common cathode through a control grid, a screen grid and a suppressor grid to a second anode, said suppressor grid being connected to said common cathode, a grid resistor connected between the triode grid and the cathode, a capacitor connected between the triode anode and the control grid of the pentode path, a second capacitor connected between the pentode anode and the triode grid, a parallel tuned circuit coupled through connections of low impedance to energy of the operation frequency between the triode grid and the cathode, a T-filter network constituted as a series resistance and shunt capacitance where the resistance is connected between the triode grid and the pentode control grid and the capacitance is connected to said cathode, and operating potential sources applied between the cathode, the pentode screen grid and both anodes.

4. A system for the generation of high frequency oscillations comprising a vacuum tube having within a single evacuated envelope, first and second space discharge paths each having an anode and a grid; a common cathode for said space discharge paths; a connection from the anode of one path to the grid of the other path; and a feed-back connection from the other anode to the other grid; a parallel tuned circuit coupled through connections of low impedance to energy of the operating frequency between one of said grids and said cathode; means for applying a suitable bias to each of said grids; means for applying suitable polarizing potentials to said anodes; and an automatic amplitude regulator comprising a direct current connection between said two grids, said last connection including a resistor network and a condenser connecting a point on said network and said cathode.

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