Dec. 11, 1934. E. W. B. GILL 1,983,848

SHORT WAVE OSCILLATION GENERATOR

Filed Oct. 2, 1931

Fig. 1

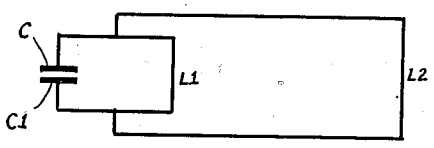


Fig. 2

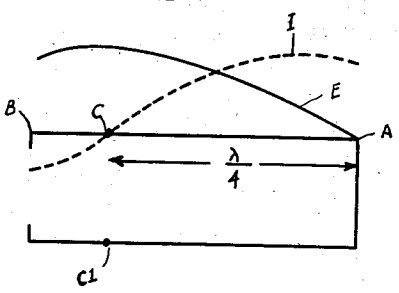


Fig. 3

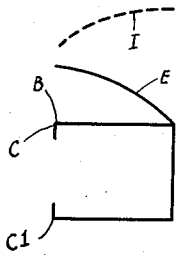


Fig. 4

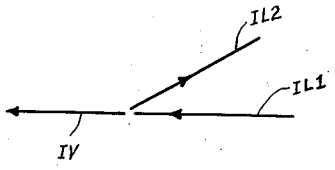


Fig. 5

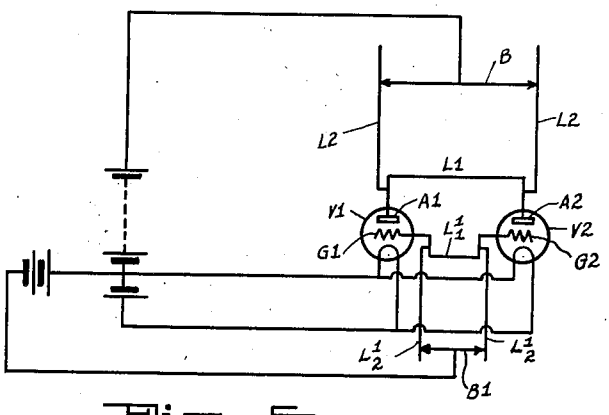
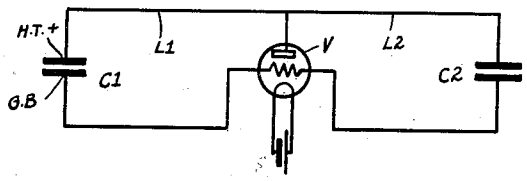


Fig. 6



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SHORT WAVE OSCILLATION GENERATOR

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Application October 2, 1931, Serial No. 566,441
In Great Britain October 8, 1930

9 Claims. (Cl. 250—36)

This invention relates to short wave oscillation generators and more particularly to valve generators adapted to generate wave lengths of the order of about 3 metres.

In valve generators as at present employed for frequencies of the order above referred to, it is common to employ as the only cencentrated capacity in the oscillatory circuit the self capacity between the grid and plate of the thermionic valve employed, the inductance of the usual coil or other inductance device employed being reduced as far as possible. There is however a limit to the extent to which the inductance value may be reduced. An essential condition if free oscillatons are to be maintained in the circuit is that the various electrical values be such that $4L>R^2C$ where L is the effective inductance, R the effective resistance and C the effective capacity of the circuit. If, however, the circuit is of the kind in which one side of the oscillatory condenser is connected to the anode and the other side to the grid and if the valve characteristic is given by the equation:

Anode current $= a \times$ (grid volts) $+ b \times$ (plate volts) $+$ C where

$\frac{a}{b}$ = the valve magnification and

$\frac{1}{b}$ = the valve impedance, then

$$\frac{L}{C}(a-b)>R$$

is the condition for oscillation.

If, for example, $(a-b)$ has a value of the order of

$$\frac{1}{1000}$$

then

$$\frac{L}{C}>1000R$$

may be a more severe condition than

$$\frac{L}{C}>\frac{R}{4}.$$

There is thus a theoretical critical value of minimum inductance below which oscillations are not maintained, and if the value of inductance is reduced so that it comes near to this theoretical value, the oscillations become very weak.

In order that the present invention may be the better understood, a theoretical explanation will now be given. It is to be understood, however, that this theoretical explanation is given merely for the purpose of exposition, and in order that the invention may be the better appreciated. While this theoretical explanation is believed to be correct, it is not of necessity complete, nor does the operation of the invention depend upon its accuracy or otherwise.

When the current in an oscillatory circuit reaches its maximum value, the energy can be regarded as substantially wholly electro-magnetic and assuming the inductance in the circuit to be of value L and the maximum current of value i the amount of energy may be written in the form $\frac{1}{2}Li^2$. Obviously, this energy is analogous to mechanical energy in a flywheel, and since it is that which maintains the oscillation in being during the change over from "growing" to "dying" current intensity, it is desirable that this energy be as large as possible.

According to this invention, there is placed in parallel with the inductance of an oscillatory circuit employed in a short wave oscillation valve generator a circuit whose natural wave length is larger than that of the original circuit but less than twice that of the original circuit.

The effect of providing the additional circuit in carrying out the present invention may be regarded as that obtained by so arranging an oscillatory circuit in which the concentrated capacity is a valve capacity that a large portion of the oscillatory current never reaches the valve capacity at all, so that for a comparatively small potential variation across the valve there are obtained large oscillatory currents and very large "electromagnetic flywheel" effects.

Referring to the drawing,

Fig. 1 illustrates schematically a circuit equivalent of an arrangement in accordance with the present invention,

Figs. 2 and 3 illustrate the theoretical distribution of currents and potentials along inductances L1 and L2 respectively, of Fig. 1,

Fig. 4 illustrates, diagrammatically, the magnitudes and directions of the various currents

Fig. 5 shows a preferred arrangement embodying the principles of the present invention and

Fig. 6 illustrates another embodiment in accordance with the present invention.

The circuit arrangement in accordance with the present invention may be represented theoretically as shown in Figure 1 of the drawing wherein the capacity between C C′ represents the grid anode capacity of the valve, L_1 the inductance connected between plate and grid of

the valve and ordinarily employed as the inductance of the oscillatory circuit and L_2 an added inductance, this added inductance being constituted by, for example, so called Lecher wires. These Lecher wires have been represented as connected between the points of connection between the capacity and inductance L_1 since owing to the presence of the valve leads the inductance L_2 cannot be applied directly across the terminals of the effective capacity but a little away along the leads. The effect of adding the larger inductance L_2 in parallel with L_1 is small so far as the wave length generated is concerned provided the capacity per centimetre of L_1 is large compared with the capacity per centimetre of L_2, and the wave length remains approximately that which would be obtained by the capacity and inductance L_1 alone. The distribution of currents and potential down the larger inductance L_2 is as shown in Figure 2 of the drawing, the full curve E representing the potential and the dotted curve I the current. It will be noted that the distance CA is a quarter of a wave length while on the two sides of the capacity the relation between direction of current and sign of potential is reversed. The corresponding curves for distribution of current and potential along the inductance L_1 (which is very short) is as shown in Figure 3 of the drawing, the dotted curve I being the curve of current and the full curve E the curve of potential.

Comparing the curves of the Figures 2 and 3, it will be noticed that the potentials at B due to the two circuits, must be the same, but the currents are in opposite directions. It will further be noted that if the length of the added inductance L_2 were less than the length AC the direction would be the same. Now the natural period of the circuit consisting of the inductance L_2 is twice the length of wire which in the critical case may be taken to be

$$2\left(\frac{\lambda}{4}+\frac{\lambda}{4}\right)=\lambda$$

so that the critical length for this circuit is λ where λ is the wave length. The result of the currents at B being in opposite directions may be represented as shown in Figure 4 of the drawing in which figure the line IV represents the current to the valve, the line IL_1 represents the current from the inductance L_1, and the oblique line IL_2 the current to the inductance L_2. From this representation it is evident that the current in L_1 is larger than the current to the capacity and it would appear therefore that the excess current merely oscillates into and out of the added inductance L_2. The value of this excess may be very considerable, and as moreover the inductance L_2 is considerably higher than L_1 the "flywheel" energy expression $\frac{1}{2}Li^2$ becomes of considerably increased value.

Figure 5 of the drawing shows a preferred arrangement in accordance with the present invention. In this figure there are two valves V_1 V_2 arranged in push-pull the anodes A_1 A_2 being connected together by a short wave coil L_1 and the grids G_1 G_2 by another short wave coil L'_1. The circuit which practically determines the oscillatory frequency is the circuit

$$G_1A_1L_1A_2G_2L'_1G_1.$$

Extra circuits are provided as shown, these circuits consisting of Lecher wires $L_2L_2L'_2L'_2$ upon which are arranged slidable adjusting bars B B'. The Lecher wires and bars constitute added inductances.

In practice, the sliding bars are moved until the optimum effect is obtained, and this is generally found to be obtained when the distance of the bar B from the anodes A_1A_2 is about $\frac{3}{8}$ths of a wave length. The position of the bar B' is of lesser importance, the arrangement operating substantially equally well over a fair length of adjustment. The bar B' may therefore serve as a fine adjustment for wave length. The added inductances should have as little coupling as possible with the other inductances.

An alternative arrangement is shown in Figure 6 of the drawing in which a single valve V is employed. The oscillatory frequency determining circuit comprises inductance L_1 connecting the anode to the grid through a blocking condenser C_1 to either side of which the high tension positive and grid bias supplies are connected. The added inductance L_2, comprising Lecher wires each of length equal to $\frac{3}{8}\lambda$ is also connected between anode and grid through a blocking condenser C_2. It should be noted, however, that L_2 need not consist of Lecher wires, but may be a coil whose natural wave length is preferably

$$\frac{3}{2}\lambda.$$

The cathode of the valve is connected to the negative terminal of the anode battery and to the end of the grid bias battery remote from the grid.

Having now particularly described and ascertained the nature of my invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In a short wave electron discharge device oscillation generator having an anode and a control electrode, the combination with an oscillatory circuit connected to said anode and control electrodes, of a second circuit in parallel with said oscillatory circuit, said second circuit having a natural wave length larger than that of said oscillatory circuit, but less than twice that of said oscillatory circuit.

2. An electron discharge device short wave oscillation generator having anode and control electrodes comprising an oscillatory circuit of capacity and inductance coupled to said anode and control electrodes, and a second circuit comprising capacity and inductance in parallel with said oscillatory circuit, said inductance of said second circuit having a value larger than the inductance of said first circuit and the capacity of said second circuit being appreciably smaller than the capacity of said first circuit.

3. In a short wave oscillation generator having an anode and a control electrode, the combination with an oscillatory circuit connected to said anode and control electrodes, of a second circuit comprising Lecher wires in parallel with at least a portion of said oscillatory circuit, said second circuit having a natural wave length larger than that of said oscillatory circuit, but less than twice that of said oscillatory circuit.

4. A short wave oscillation generator adapted to generate a substantially constant wave comprising two electron discharge devices connected in push-pull, each of said devices having anode and control electrodes, the corresponding anode and control electrodes of said devices being connected together by inductances in the form of linear wires to constitute respectively output and input oscillatory circuits, and an additional inductance in the form of a linear wire loop in each

of said output and input oscillatory circuits and directly connected thereto in parallel with said first mentioned inductances, said additional linear wires having inductance values respectively greater than the inductance values of said first mentioned linear wires.

5. In a short wave electron discharge device oscillation generator having an anode and a control electrode, the combination with an oscillatory circuit connected to said anode and control electrodes, said oscillatory circuit comprising an inductance and capacity in series, of a second circuit comprising an inductance and capacity in series in parallel with said oscillatory circuit, said second circuit having a natural wave length larger than that of said oscillatory circuit, but less than twice that of said oscillatory circuit.

6. An oscillation generator in accordance with claim 5 characterized in this, that said inductance in said second circuit consists of Lecher wires.

7. A short wave oscillation generator adapted to generate a substantially constant wave comprising two electron discharge devices connected in push-pull, each of said devices having anode and control electrodes, the corresponding anode and control electrodes of said devices being connected together by linear wires to constitute together with the inherent capacity of the devices output and input oscillatory circuits respectively, and additional linear wires having inductance values greater than the inductance of said first wires in each of said output and input oscillatory circuits in parallel with said first mentioned wires.

8. In an electron discharge device oscillation generator having input and output electrodes, the combination with an oscillatory circuit connected to said input and output electrodes, of a second circuit in parallel with said oscillatory circuit, said second circuit having a natural wave length larger than that of said oscillatory circuit, but less than twice that of said oscillatory circuit.

9. In a short wave electron discharge device oscillation generator having an anode and a control electrode, the combination with an oscillatory circuit connected to said anode and control electrode, said oscillatory circuit comprising an inductance and capacity in series, of a second circuit comprising an inductance and capacity in series in parallel with said oscillatory circuit, said inductance in said second circuit consisting of Lecher wires each of which has a length equal to $\frac{3}{8}\lambda$, where λ is the wave length of said oscillatory circuit.

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