F. K. VREELAND.

ELECTRICAL OSCILLATOR.

APPLICATION FILED MAY 15, 1919.

1,340,193. Patented May 18, 1920.

Fig. 1.

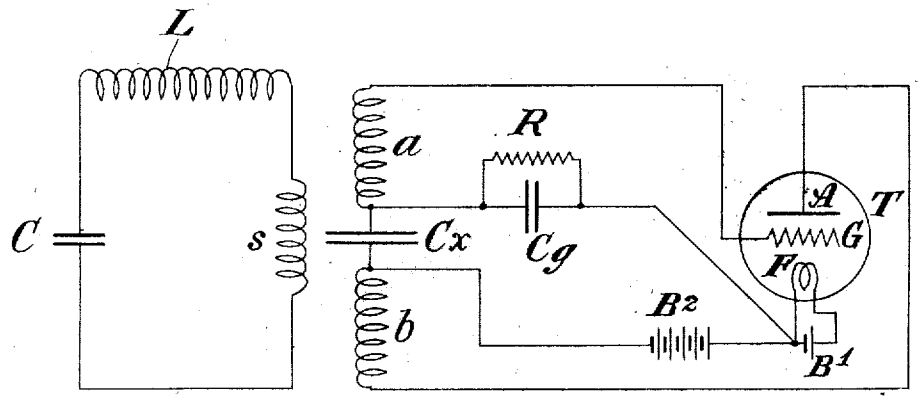
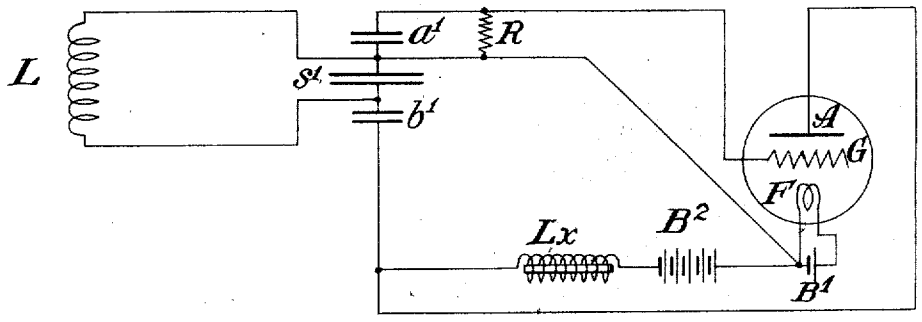


Fig. 2.



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ELECTRICAL OSCILLATOR.

1,340,193. Specification of Letters Patent. Patented May 18, 1920.

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To all whom it may concern:

Be it known that I, FREDERICK K. VREELAND, a citizen of the United States, residing at Montclair, in the county of Essex and State of New Jersey, (post-office address No. 55 Liberty street, New York city,) have invented certain new and useful Improvements in Electrical Oscillators, of which the following is a specification.

The invention herein described relates to an improvement in electrical oscillators of the vacuum tube or electron relay type, whereby greatly improved operation is secured, particularly in the matter of purity of the wave form.

In my U. S. Patents Nos. 829,447 and 829,934 I have described a method and apparatus for generating undamped or sustained electrical oscillations by utilizing an electrostatic or magnetic field excited by the oscillations to control the flow of energy in a vacuum tube or other sensitive gap, in such a manner that increments of energy are supplied to the oscillating circuit in synchronism with the oscillations. One form of the invention specifically described utilizes "the effect of an electrostatic field upon the discharge of cathode particles in a vacuum tube" as a means of electrically communicating energy in the tube in such manner as to add energy to the oscillating circuit in synchronism with the oscillations. (Patent No. 829,447, page 1, lines 56–81.)

In recent years great improvements have been made in thermionic tubes, whereby the effect of an electrostatic field, set up between the cathode and a third control electrode or grid controls in a highly efficient manner the flow of thermionic energy between the cathode and the anode. This apparatus is so associated with an oscillating circuit that the oscillations act through the control electrode to produce the electrostatic commutating field, and the variations in anode current thus produced supply energy to the oscillating circuit.

In the vacuum tube oscillator as ordinarily employed to-day, a three electrode thermionic tube, with its appropriate source of direct current energy, is coupled to an oscillating circuit with a feed-back connection, whereby the flow of energy through the tube is controlled by the oscillations and energy is supplied to the oscillating circuit in synchronism with the oscillations. Ordinarily the oscillating circuit is directly connected to the thermionic generator tube, the feed-back connection being associated with this circuit in any one of several well known ways.

The result of this arrangement is an oscillating current whose wave form is very far from sinusoidal. This is due to the fact that the wave form of the energy supply is not itself sinusoidal, and the disposition and the proportions of the oscillating circuit are such that it is incapable of smoothing out harmonics. As a consequence, when it is desired to secure an approximately pure wave form from such a device it is usual to employ filters or other equivalent devices to sift out the overtones.

The present invention provides means whereby a current wave of great purity can be secured directly without the use of filters or other extraneous means.

An oscillating circuit, when fed by a source of energy whose wave form is not sinusoidal, will execute approximately pure sinusoidal oscillations only if its inductance and capacity reactances are large with respect to the other impedances of the system with which it is associated.

The thermionic bulbs ordinarily employed possess usually a high, and sometime a very high impedance, and it is usually impracticable to construct an oscillating circuit of sufficient reactances to be a stiff oscillator when connected directly to such a tube.

By means of the present invention I am able to use an oscillating circuit of moderate capacity and inductance reactances which is nevertheless capable of oscillating with very pure wave form. The requisite stiffness of the oscillating system is secured by coupling the oscillating circuit to the tube and its associated circuits by a step down coupling whereby the effective impedances of the tube circuit, as affecting the oscillating circuit, are greatly reduced, and the distortions of wave form of the energy supply are minimized. This may be done in a variety of ways.

In the drawing, Figure 1 shows the circuit arrangements of one embodiment of the invention, in which the oscillating circuit is coupled to a generator circuit by an inductive coupling. Fig. 2 shows an arrangement in which an electrostatic coupling is employed.

In the arrangement of Fig. 1, T is a three electrode thermionic bulb having the usual hot filament F with heating battery B^1,

anode A, and grid or control electrode G. The tube- or generator-circuit includes the inductance coils *a*, *b*, the latter connected to the anode and the former to the grid, which by their mutual inductance accomplish the usual feed-back function, the anode and grid being connected to points of opposite potential and the filament to an intermediate point. The generator circuit is completed through a stopping condenser C_x, across which the anode battery B^2 is connected.

The oscillating circuit is connected to the generator circuit through inductive coupling of the coils *a* and *b* to a secondary coil *s*, having a relatively small number of turns, whose circuit is closed through the main capacity C and inductance L of the oscillating circuit. The coil *s* is preferably closely coupled to the coils *a*, *b*. By virtue of the step down action of the transformer *a*, *b*—*s*, the oscillating circuit may be made a stiff oscillator with moderate values of inductance and capacity reactances, while the close coupling of the transformer, *a*, *b*—*s* provides an efficient energy transfer.

By a close coupling I mean a coupling whereby the coil *s* embraces the major portion of the field of the coils *a* and *b*, thus making the generator circuit practically aperiodic and subject to the frequency control of the oscillating circuit. The effect on the oscillating circuit however is equivalent to a loose coupling, inasmuch as the inductance of the coil *s* is small compared to the inductance L. The oscillating circuit is therefore effective in selecting oscillations of its own frequency to the practical exclusion of other frequencies, notwithstanding the relatively small absolute values of its reactances, while the reactances of the coils *a*, *b*, may be made comparable to the tube impedance, thereby providing an efficient energy transfer.

The invention is not limited to the pure electromagnetic coupling shown in Fig. 1. Any one of several forms of coupling may be employed. For example, Fig. 2 shows a purely electrostatic coupling. Here the generator circuit includes condensers *a'*, *b'*, of reactances comparable to the tube impedance, and a third condenser *s'* of relatively small reactance, which serves as a step down electrostatic coupling between the generator circuit and the oscillating circuit, including the coil L. Suitable connections are employed for providing a conducting path from the power battery to the anode through the inductance L_x, and means, such as the leak resistance R, or a negative C battery, for preventing an accumulation of negative charge on the grid G.

Other arrangements embodying the invention will readily suggest themselves to those skilled in the art.

Having now described my invention, what I claim as new therein and desire to secure by Letters Patent is:

1. In an electrical oscillator, a generator tube, a power circuit associated therewith, and an oscillating circuit associated with the power circuit by a step down coupling, substantially as set forth.

2. In an electrical oscillator, a generator tube, a power circuit associated therewith, including the primary of a step down transformer, and an oscillating circuit in the secondary of this transformer, substantially as set forth.

3. In an electrical oscillator, a generator tube, a power circuit associated therewith, including the primary of a step down transformer, and an oscillating circuit in the secondary of this transformer, the primary and secondary coils being closely coupled, substantially as set forth.

4. In an electrical oscillator, a generator tube, a power circuit associated therewith, an oscillating circuit associated with the power circuit by a step down coupling, the impedance of the power circuit being comparable to the tube impedance and the secondary impedance being relatively small, the reactances of the oscillating circuit being large relative to the secondary impedance, substantially as set forth.

5. In an electrical oscillator, a generator tube, a power circuit associated therewith, including the primary of a step down transformer, an oscillating circuit in the secondary of this transformer, the primary coil having an impedance comparable to the tube impedance, the secondary having relatively low impedance, and the oscillating circuit having capacity and inductance reactances that are large compared to the secondary impedance, substantially as set forth.

6. In an electrical oscillator, a three electrode generator tube, a source of power connected between two of these electrodes, a power circuit including a feed-back connection between these electrodes and the third electrode, and an oscillating circuit associated with the power circuit by a step down coupling, substantially as set forth.

7. In an electrical oscillator, a three electrode generator tube, a source of power connected between two of these electrodes, and a power circuit including a feed-back connection between these electrodes and the third electrode, the impedance of the power circuit being comparable to the tube impedance, a secondary element of relatively low impedance associated with the power circuit, and an oscillating circuit including the secondary element whose reactances are large compared with the secondary impedance, substantially as set forth.

8. In an electrical oscillator, a three electrode generator tube, a source of power con-

nected between two of these electrodes, and a power circuit including a feed-back connection between these electrodes and the third electrode, and including a primary coil having an impedance comparable to the tube impedance, a secondary coil of relatively small impedance coupled thereto, and an oscillating circuit including the secondary coil having reactances that are large compared to the secondary impedance, substantially as set forth.

9. In an electrical oscillator, a generator tube, a source of power associated therewith, a stiff oscillating circuit receiving energy from the source of power by a step down coupling and means whereby the oscillations of the oscillating circuit affect the generator tube to control the supply of energy thereto from the source of power, substantially as set forth.

This specification signed and witnessed this 13th day of May, 1919.

FREDERICK K. VREELAND.

Witnesses:

FRANK L. DYER,

C. D. JORDAN.