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HIGH FREQUENCY OSCILLATION GENERATOR

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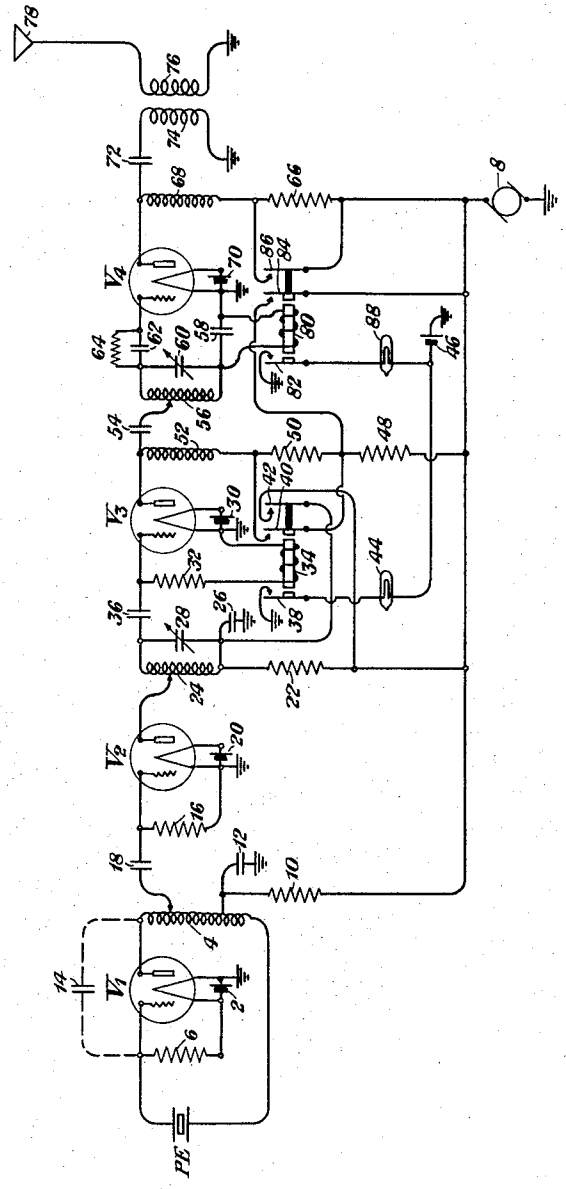

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HIGH-FREQUENCY-OSCILLATION GENERATOR

Application filed March 14, 1927. Serial No. 175,265.

This invention relates to oscillation generators, and particularly to arrangements for producing high frequency oscillations from the oscillations of a source of comparatively low frequency.

It is an object of this invention to provide means for producing high frequency oscillations from low frequency oscillations through the agency of a plurality of frequency multipliers or harmonic producers, the high frequency oscillations produced being controlled as to frequency by piezo-electric means.

It is another object of this invention to interconnect a source of low frequency oscillations and an antenna circuit by means of a plurality of harmonic producers each of which includes a three-element vacuum tube, a grid condenser and leak resistance being connected to the input circuit of each three-element vacuum tube to provide the distortion required for harmonic production.

It is a further object of this invention to connect a source of current of fundamental frequency to a plurality of harmonic producers so that the harmonic producers may be successively tuned to some harmonic of the fundamental frequency. Indicators may also be provided to show that the harmonic producers are properly multiplying the frequency of the source by some definite integer.

While this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, oscillations of comparatively low frequency are sustained by the circuits connected to the three-element vacuum tube V_1, the frequency of these oscillations being controlled by means of piezo-electric device PE. The vacuum tube V_1 is a space discharge device including a filament, a plate, and a grid electrode. The grid electrode of the vacuum tube V_1 is connected to the upper terminal of the piezo-electric device PE, while the lower terminal of the piezo-electric device is connected to the lower terminal of the inductance 4. A battery 2 heats the filament of the vacuum tube V_1 to an electron-emitting temperature. The inductance 4 connects the plate of the vacuum tube V_1 to the lower terminal of the piezo-electric device PE. A resistance 6 is connected between the grid electrode and the filament of the vacuum tube V_1. Resistance 6 acts as a grid leak to maintain the grid electrode at a suitable negative potential with respect to the filament. The necessary operating potential for the plate of the vacuum tube V_1 is derived from a direct current source 8 through a resistance 10 and part of the inductance 4. The alternating current output circuit of the vacuum tube V_1 includes the filament and plate of the vacuum tube V_1, the upper portion of the inductance 4, a condenser 12 and ground. A condenser 14, shown in dotted lines, represents the inherent capacity existing between the grid and the plate of the vacuum tube V_1, including the capacity between the leads connected thereto. The piezo-electric device PE may be a substance such as Rochelle salt, quartz, tourmaline, boracite, etc., which will produce an electromotive force from mechanical pressure and vice versa, this substance being placed between two metallic terminals or electrodes, as shown.

The principles underlying the operation of this oscillation generator are given in my copending application, Serial No. 50,336, filed August 14, 1925, entitled "Oscillation generator." This oscillation generator may obviously be arranged to set up oscillations of any frequency, the piezo-electric device acting to maintain the frequency of these oscillations constant within very narrow limits. It should be noted that the piezo-electric device is incorporated as an element in the input circuit of the vacuum tube V_1, this input circuit including the grid and filament of the vacuum tube V_1 and the piezo-electric device PE. In the particular form of oscillation generator shown herein for illustrative purposes, the piezo-electric device is vibrated at a frequency at which it exhibits an inductive reactance of a definite magnitude.

A harmonic producer, including a three-element vacuum tube V_2, is coupled to the output circuit of the vacuum tube V_1. A resistance 16 connects the grid of the vacuum tube V_2 to its filament. A condenser 18 serves first, to prevent the potential of direct current source 8 from being applied to the grid of the vacuum tube V_2, and second, to present a path of low impedance for current of the frequency generated by the oscillation generator which includes the vacuum tube V_1. The filament of the vacuum tube V_2 is heated to an electron-emitting temperature by means of a battery 20.

Oscillations sustained within the vacuum tube V_1 also flow in the circuit which includes the filament and plate of the vacuum tube V_1, a small portion of the inductance 4, the condenser 18, the resistance 16 and ground. Inasmuch as resistance 16 is connected between the grid and filament of the vacuum tube V_2, current of the fundamental frequency will also be impressed upon the grid and filament of this vacuum tube. The plate of the vacuum tube V_2 is supplied with the necessary operating potential by the direct current source 8 through a resistance 22 and an inductance 24. The output circuit of the vacuum tube V_2 includes the filament and plate of the vacuum tube V_2, the lower portion of the inductance 24, a condenser 26 and ground. The inductance 24 is bridged by a variable condenser 28, the inductance 24 and the condenser 28 together being tuned to a harmonic of the fundamental frequency sustained by the oscillator V_1.

Another harmonic producer, which also includes a three-element vacuum tube of the grid-leak type, is coupled to the output circuit of the vacuum tube V_2. Reference character V_3 represents the vacuum tube of this harmonic producer. A battery 30 heats the filament of the vacuum tube V_3 to an electron-emitting temperature. The grid of the vacuum tube V_3 is connected to the filament of this vacuum tube through a resistance 32 and through the winding of a relay 34. The condenser 36 prevents the potential of the direct current source 8 from being applied to the grid of the vacuum tube V_3. When the winding of the relay 34 becomes energized, three armatures, 38, 40 and 42, are simultaneously attracted, closing contacts associated with these armatures.

When the tuned circuit, including the inductance 24 and the condenser 28, is brought into resonance at some predetermined harmonic of the fundamental frequency, the grid of the vacuum tube V_3 will become greatly charged negatively, the charging circuit including the condenser 26, the inductance 24, the condenser 36, the grid and filament of the vacuum tube V_3 and ground. As the grid of the vacuum tube V_3 becomes impressed with current of the predetermined harmonic of the fundamental frequency, there will be a leakage of current through the resistance 32 and the winding of the relay 34, at a comparatively high rate. The relay 34 is so adjusted that when such a current flows therethrough, its winding will become energized sufficiently to attract its armatures, namely, armatures 38, 40 and 42.

Before the relay 34 operates, the plate current required by vacuum tube V_3 is supplied by source 8 through resistances 48 and 50 and inductance 52. Armature 38 controls the circuit of a lamp 44, this circuit including a battery 46, lamp 44, armature 38 and its contact, and ground. When relay 34 operates, resistance 22 will become shunted by armature 42 so that the impedance between the direct current source 8 and the plate of the vacuum tube V_2 will become decreased and the voltage impressed upon the plate of the vacuum tube V_2 will become correspondingly increased. The increased voltage impressed upon the plate of the vacuum tube V_2 will promptly increase the power output of the vacuum tube V_2 and will also increase the power supplied to the grid circuit of the vacuum tube V_3. Upon operation of the relay 34, armature 40 will also close its contact to shunt resistance 50. The impedance between the plate of the vacuum tube V_3 and the direct current source 8 will immediately be decreased, the potential applied to the plate of the vacuum tube V_3 will be increased, and the power output of the vacuum tube V_3 will be correspondingly increased.

It should be noted that the alternating current output circuit of the vacuum tube V_3 includes the filament and plate of the vacuum tube V_3, a condenser 54, an inductance 56, a condenser 58 and ground. A variable condenser 60 is connected between the terminals of the inductance 56 and may be employed to tune the output circuit of the vacuum tube V_3 to another predetermined harmonic of the frequency impressed upon the input circuit of the vacuum tube V_3. The condenser 54 prevents the potential of the direct current source 8 from being applied to the grid of the vacuum tube V_4, and at the same time presents a path of low impedance for current of the harmonic produced by the vacuum tube V_3.

Another harmonic producer, including a vacuum tube V_4 of the three-electrode type, is coupled to the output circuit of the vacuum tube V_3. The alternating current input circuit of this vacuum tube includes the filament and grid of the vacuum tube V_4, a condenser 62 and a resistance 64 in parallel relationship, the inductance 56 and the condenser 58. The plate of the vacuum tube V_4 is brought to the necessary operating potential by the direct current source 8, through a resistance 66 and an alternating current choke coil 68. The filament of the vacuum

tube V_4 is heated to an electron-emitting temperature by a battery 70. The alternating current output circuit of the vacuum tube V_4 includes the filament and plate of the vacuum tube V_4, a condenser 72, an inductance 74 and ground. The alternating current output circuit of the vacuum tube V_4 is coupled through inductances 74 and 76 to an antenna circuit, which includes an antenna 78, the inductance 76 and ground.

When the tuned circuit comprising the inductance 56 and the condenser 60 is brought into resonance at a frequency which is some predetermined harmonic of the frequency impressed upon the input circuit of the vacuum tube V_3, there will be a comparatively large leakage of current from the grid of the vacuum tube V_4 to the filament of that vacuum tube, this leakage taking place through the resistance 64, the inductance 56 and the winding of a relay 80. When the harmonic frequency is selected by the tuned circuit, as mentioned hereinabove, the flow of current through the winding of the relay 80 will ordinarily be sufficient to cause the attraction of its armatures, i. e., 82, 84 and 86, these armatures closing corresponding contacts. Yet, at frequencies substantially different from the selected harmonic frequency, the current flowing through the winding of the relay 80 will be insufficient to bring about the attraction of the armatures 82, 84 and 86. When the armature 82 becomes attracted, however, as is the case when relay 80 operates, a lamp 88 lights up and indicates to the operator that the predetermined harmonic is being produced by the harmonic producer having the vacuum tube V_4, current flowing through the lamp 88 in the circuit which includes battery 46, lamp 88, armature 82 and its contact and ground. At the instant armature 82 closes its contact, armature 84 will also close its contact in order to shunt more of the resistance, i. e., resistance 48, out of the path which is interposed between the plate of the vacuum tube V_3 and the direct current source 8. Accordingly the impedance between the plate of the vacuum tube V_3 and the direct current source 8 will be further decreased, the potential applied to the plate of the vacuum tube V_3 will be further increased, and the power output from the vacuum tube V_3 will be further increased. Therefore, the energy supplied to the input circuit of the vacuum tube V_4 will be correspondingly increased. The armature 86, operating in synchronism with armatures 82 and 84, shunts the resistance 66, and accordingly permits the potential applied to the plate of the vacuum tube V_4 to be increased in order that the power output from that vacuum tube may become correspondingly increased.

In practice, when adjustments are made to permit the filaments of the various vacuum tubes to be heated to electron-emitting temperatures, and when the plates of these vacuum tubes are supplied with suitable operating potentials, and when the piezo-electric device is connected between the grid and filament of the first vacuum tube V_1, oscillations of a definite fundamental frequency will be sustained. Condenser 28 shunting inductance 24 may then be adjusted to resonate at a predetermined harmonic of the fundamental frequency. The vacuum tube V_2 will then produce the latter harmonic, this harmonic being transmitted to vacuum tube V_3. As this harmonic frequency is being transmitted to vacuum tube V_3, the grid current of that vacuum tube arrangement will be sufficient to operate relay 34, thereby lighting indicating lamp 44. Instantly the resistance in the plate circuit of V_2 will become decreased and the level of the energy supplied to vacuum tube V_3 will be raised.

Condenser 60 shunting inductance 56 may then be adjusted to resonate at a still higher harmonic frequency. Relay 80 will be operated, thereby lighting indicating lamp 88, The power supplied to vacuum tube V_4 will similarly become increased and the power supplied to the antenna circuit will also be increased. Obviously, the principles of this invention may be applied to still other vacuum tube arrangements to produce any required harmonic of a fundamental frequency and at any desired energy level.

It is to be noted in this invention that a source of low frequency oscillations is connected to a plurality of harmonic producers, each producing some integral harmonic of the frequency of the source, and that a piezo-electric device is connected to the low frequency source to control and stabilize not only the frequency of oscillations sustained by the low frequency source but also the frequency of oscillations sustained by all of the harmonic producers.

It is also to be noted that a plurality of harmonic producers are coupled herein to a source of low frequency oscillations, and that these harmonic producers are successively brought into operation, an indicating device being connected to each harmonic producer to indicate when the harmonic producer to which it is connected is producing the desired harmonic of the fundamental frequency impressed upon its input terminals.

While this invention has been shown and described in one particular embodiment, merely for the purpose of illustration, it is to be distinctly understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a system for deriving current of a high frequency from current of a comparatively low frequency, the combination of an

oscillation generator of low frequency, a piezo-electric device for maintaining the constancy of the generated oscillations, a plurality of harmonic producers connected in tandem with respect to said oscillation generator each consisting of a three-element vacuum tube in the input circuit of which there is a grid condenser and leak, and means for preventing excessive discharges in the output circuits of said vacuum tubes when the biasing potentials impressed upon the input circuits of the respective tubes are below predetermined values.

2. In a system for producing oscillations of high frequency from a source of oscillations of low frequency, an oscillation generator of low frequency having a piezo-electric device associated therewith for controlling the frequency of sustained oscillations within narrow limits, a plurality of harmonic producers connected in tandem with respect to said oscillation generator each consisting of a three-element vacuum tube in the input circuit of which there is a grid condenser and a leak, and a plurality of relays one connected to the input circuit of each vacuum tube to prevent excessive discharges in the output circuit of that vacuum tube.

3. In a system for producing oscillations of high frequency from a source of oscillations of low frequency, the combination of an oscillation generator of low frequency to which a piezo-electric device is connected to control the frequency of the sustained oscillations within narrow limits, a plurality of harmonic producers connected in tandem with respect to said oscillation generator, each harmonic producer consisting of a three-element vacuum tube arrangement, a plurality of relays one associated with each vacuum tube arrangement, and a plurality of indicating devices one controlled by each relay, each relay and the corresponding indicating device becoming operated when the vacuum tube arrangement to which that relay is connected is producing a predetermined harmonic of the current supplied thereto.

4. In a system for producing oscillations of high frequency from the oscillations of a source of comparatively low frequency, the combination of means for generating oscillations of comparatively low frequency, a plurality of harmonic producers connected in tandem with respect to said low frequency source each comprising a three-electrode vacuum tube, and a plurality of relays one associated with each vacuum tube, each relay becoming operated when the grid current in the input circuit of the associated vacuum tube is above a predetermined value.

5. The combination of a vacuum tube having grid, filament and plate electrodes, an adjustable tuned circuit connected between the grid and filament electrodes of said vacuum tube, an output circuit connected to the plate and filament electrodes of said vacuum tube, a relay having a winding which is connected between the grid and filament electrodes through an impedance of a definite magnitude, and an indicating device, means whereby the grid current may operate the relay, and means whereby the relay may operate the indicating device when the tuned circuit is adjusted to resonate at a predetermined frequency.

6. The combination of an oscillation generator, a plurality of harmonic producers coupled thereto each including a three-electrode vacuum tube, and means associated with each vacuum tube to prevent excessive discharges therein when a predetermined harmonic is not being transmitted thereto and for increasing the power output of said vacuum tube when the predetermined harmonic is being transmitted thereto.

7. The combination of a source of current, a vacuum tube system coupled to said source to receive current of a predetermined frequency therefrom, and means for preventing excessive discharges in the vacuum tube system when said source is not transmitting current of the predetermined frequency to said vacuum tube system and for increasing the power output of said vacuum tube system when said source is transmitting current of the predetermined frequency thereto.

In testimony whereof, I have signed my name to this specification this 12th day of March, 1927.

RUSSELL S. OHL.