

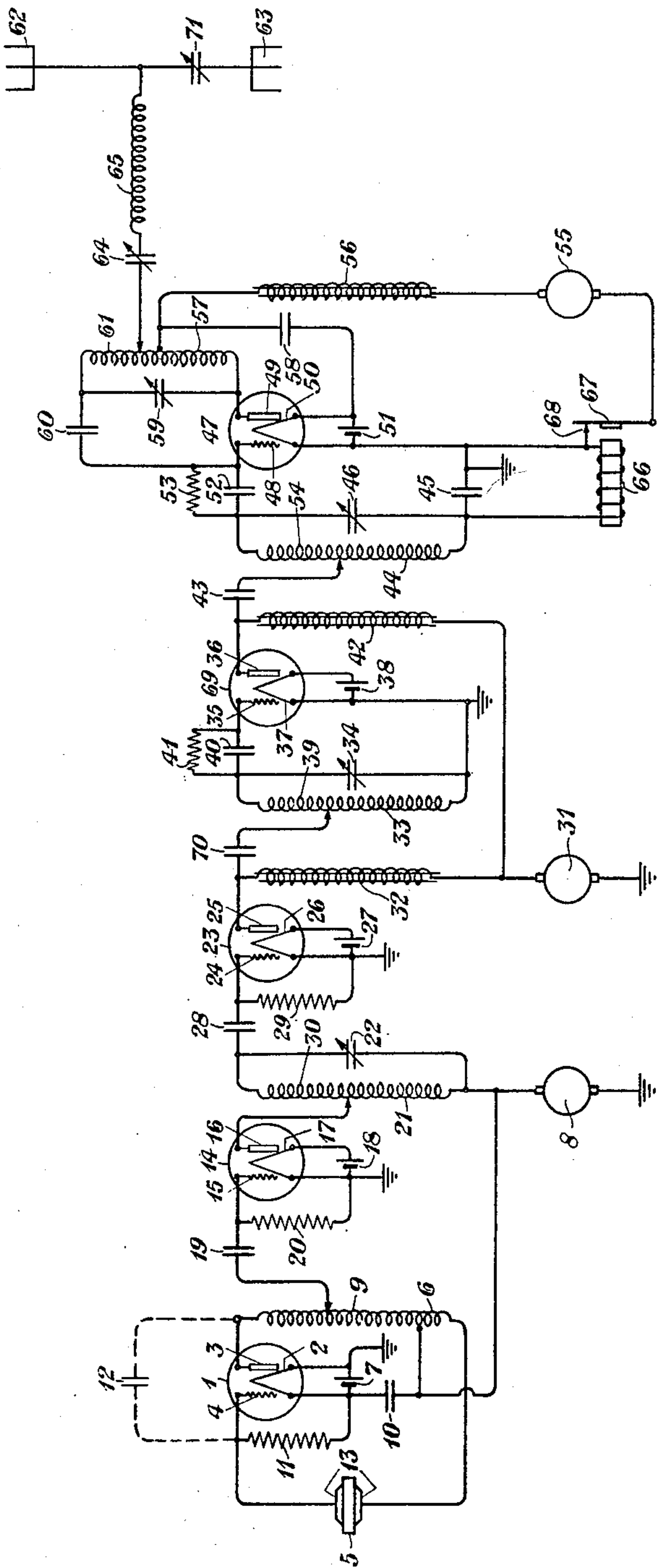
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R. S. OHL

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HIGH FREQUENCY OSCILLATION GENERATOR

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INVENTOR
R. S. Ohl
BY *g. f. 402*
ATTORNEY

UNITED STATES PATENT OFFICE

RUSSELL S. OHL, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

HIGH-FREQUENCY-OSCILLATION GENERATOR

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

It is an object of this invention to provide means for producing high frequency oscillations from a source of low frequency oscillations through the agency of a plurality of frequency multipliers.

It is another object of this invention to provide means for controlling the frequency of the oscillations in a high frequency oscillation generator within very narrow limits.

And it is a further object of this invention to interconnect a low frequency oscillation generator and an antenna circuit by means of a plurality of three-electrode vacuum tubes for producing high frequency oscillations, each vacuum tube being provided with a protective device for preventing excessive current from flowing in the circuits thereof.

While these objects and features, which are characteristic of the invention, will be described with particularity in the appended claims, the invention itself, both as to its objects and features, will be better understood from the following description when read in connection with the accompanying drawing showing one embodiment of the invention.

In this invention, a low frequency oscillation generator is described, the frequency of which is controlled by a piezo-electric device. It will be understood that any oscillation generator may be employed in place thereof, preferably a vacuum tube oscillation generator.

The reference character 1 is a space discharge tube working on the thermionic principle, including a cathode 2, an anode 3 and an input or grid electrode 4. The grid 4 is connected to one terminal of a piezo-electric device 5, while the other terminal of the piezo-electric device is connected to one terminal of the inductance 6. The battery 7 heats the cathode 2 to incandescence, and a source of potential 8 supplies space current to the anode 3 through the inductance 9. A condenser 10 is connected across the termi-

nals of the source of potential 8 to provide a path of low impedance for alternating currents. A resistance 11 is connected between the grid electrode 4 and the cathode 2, which acts as a grid leak in order to maintain grid electrode at a suitable negative potential with respect to the cathode. A condenser 12, shown in dotted lines, represents the inherent capacity between the grid electrode 4 and the anode 3, including the capacity between the leads connected thereto. The piezo-electric device 5 is preferably disk-shaped and has a pair of conductive plates 13 adjacent to the opposite sides thereof.

The principles underlying the operation of the low frequency oscillation generator shown in the drawing are given in my co-pending application, Serial No. 50,336, filed of even date, entitled "Oscillation generator." This low frequency oscillation generator may be arranged to set up oscillations of any frequency which is natural to the frequency of vibration of the piezo-electric device 5. For the purpose of illustration, a frequency of 1,000 kilocycles has been assigned to this low frequency oscillation generator.

A frequency multiplier is coupled to the low frequency oscillation generator. This frequency multiplier may be of any type, but is preferably a frequency multiplier employing a vacuum tube having a grid condenser and leak in the input circuit thereof. The three-electrode vacuum tube 14 of such a frequency multiplier has a grid electrode 15, an anode 16 and a cathode 17. A battery 18 heats the cathode 17 to incandescence. The condenser 19 serves, first, to prevent the potential of the source 8 from being impressed on the grid electrode 15 of the vacuum tube 14, and second, to form a grid condenser for the vacuum tube 14. The resistance 20 forms the grid leak in the input circuit of the vacuum tube 14. The output circuit of the vacuum tube 14 consists of the source of potential 8, the inductance 21, anode 16 and cathode 17. The variable condenser 22 is employed for tuning the output circuit of the vacuum tube 14 to any frequency, preferably a harmonic of the frequency in the input cir-

cuit of the vacuum tube 14, for example, 2,000 kilocycles.

Another frequency multiplier is coupled to the output circuit of the vacuum tube 14. This frequency multiplier may be of any type, but is preferably a frequency multiplier employing a three-electrode vacuum tube in which a grid condenser and leak are connected in the input circuit thereof. The vacuum tube 23 of such a frequency multiplier is shown having a grid electrode 24, an anode 25, and a cathode 26, which is heated to incandescence by the battery 27. The condenser 28 serves, first, to prevent the potential of the source 8 from being impressed upon the grid electrode 24 of the vacuum tube 23, and second, to form a grid condenser for the input circuit of the vacuum tube 23. The resistance 29 forms a leak for the input circuit of the vacuum tube 23. The inductance 30 is coupled to the inductance 21 so that the frequencies in the output circuit of the vacuum tube 14 and in the input circuit of the vacuum tube 23 are the same.

The source of potential 31 supplies the space current for the anode 25 through the alternating current choke coil 32, which prevents alternating current from flowing through the source of potential 31. The output circuit of the vacuum tube 23 for alternating current consists of the cathode 26, the anode 25, the condenser 70 and the inductance 33. The condenser 70 serves to confine direct current from the source of potential 31 to the anode 25 of the vacuum tube 23. The variable condenser 34 is employed for tuning the alternating current output circuit of the vacuum tube 23 to any frequency, preferably a harmonic of the frequency in the input circuit thereof, for example, 4,000 kilocycles.

Another frequency multiplier is coupled to the output circuit of the vacuum tube 23. This may be any frequency multiplier, preferably a frequency multiplier employing a vacuum tube in which a grid condenser and leak are connected in the input circuit thereof. The reference character 69 represents a vacuum tube of such a frequency multiplier having a grid electrode 35, an anode 36 and a cathode 37 which is heated to incandescence by battery 38. The inductance 39 is coupled to the inductance 33 so that the frequency in the input circuit of the vacuum tube 69 is the same as the frequency in the alternating current output circuit of the vacuum tube 23. The grid condenser 40 and leak 41 are in the input circuit of the vacuum tube 69 in order to permit rectification therein. The anode 36 is supplied with space current from a source of potential 31 through the alternating current choke coil 42, which prevents alternating current from flowing through the source of potential 31. The alternating current output circuit of the vacuum tube 69 consists of the anode 36, the condenser 43, the

inductance 44, the condenser 45 and the cathode 37. The variable condenser 46 is employed for tuning the alternating current output circuit of the vacuum tube 34 to any frequency, preferably a harmonic of the frequency of the input circuit thereof, for example, 8,000 kilocycles.

Another frequency multiplier is coupled to the output circuit of the vacuum tube 69. This frequency multiplier may be of any type, but is preferably a frequency multiplier employing a vacuum tube. The vacuum tube of such a frequency multiplier is represented by the reference character 47, having a grid electrode 48, an anode 49, and a cathode 50 which is heated to incandescence by battery 51. The input circuit of the vacuum tube 47 includes the grid condenser 52 and the leak 53. The inductance 54 is coupled to the inductance 44 so that the frequency in the input circuit of the vacuum tube 47 is the same as the frequency in the alternating current output circuit of the vacuum tube 69. The source of potential 55 supplies the anode 49 with space current through the alternating current choke coil 56 and inductance 57. The output circuit of the vacuum tube 47 for the alternating current consists of the anode 49, the inductance 57, the condenser 58 and the cathode 50. The variable condenser 59 is employed for tuning the output circuit of the vacuum tube 47 to any frequency, preferably a harmonic of the frequency in the input circuit of said tube, for example, 16,000 kilocycles. A condenser 60 is connected between the grid electrode 48 and the anode 49 through inductances 57 and 61 in order to neutralize the capacity between the anode 49 and the grid electrode 48. The current in the output circuit of the tube 47 is then transmitted to the antenna 62 having a counterpoise 63, through a variable condenser 64 and an inductance 65, the antenna and counterpoise having a variable condenser interconnecting them in order to obtain the proper capacity therebetween.

When a plurality of vacuum tube frequency multipliers are connected as shown herein, there is a possibility of a flow of an excessive current between the anode and the cathode of any vacuum tube in the system on account of the failure of the apparatus on either side of said vacuum tube. It has therefore been found desirable to provide means for preventing any excessive current from flowing between the cathode and anode when such a failure occurs.

Accordingly, an electro-magnetic relay is shown in connection with the vacuum tube 47 having a winding 66 and an armature 67. When sufficient potential is impressed between the grid electrode 48 and the cathode 50 in the circuit including the grid electrode 48, grid leak 53, inductances 54 and 44, the winding of the relay 66 and the cathode 50,

the armature 67 will close contact 68, and the source of potential 55 will be connected to the anode 49 through the alternating current choke coil 56 and inductance 57. But on failure of any of the apparatus outside of this vacuum tube, if thereupon there is not sufficient biasing potential impressed upon the cathode 50 by the grid electrode 48, then the armature 67 will open contact 68, and the source of potential 55 will be disconnected from the anode 49. An arrangement of this type is disclosed in my co-pending application, Serial No. 50,335, filed of even date, entitled "Control device for vacuum tubes."

The operation of these arrangements is as follows: Oscillations are produced in the oscillation generator having a vacuum tube 1 by reason of the inherent capacity of existing between the anode 3 and the grid electrode 4 of said vacuum tube. The periodicity of these oscillations is controlled by the vibration of the piezo-electric device 5. These oscillations are impressed upon the input circuit of the frequency multiplier, or harmonic producer, having a vacuum tube 14 associated therewith, and the output circuit is tuned by the condenser 22 to any frequency, preferably a harmonic of the frequency in the input circuit thereof.

Another frequency multiplier, or harmonic producer, which includes a vacuum tube 23, is coupled to the output circuit of the vacuum tube 14 by virtue of the mutual inductance of windings 30 and 21. Therefore, the same frequency is obtained in the input circuit of the vacuum tube 23 as there is in the output circuit of the vacuum tube 14. The output circuit of the vacuum tube 23 is tuned by the condenser 34 to any frequency, preferably a harmonic of the frequency in the input circuit of the vacuum tube 23.

Another frequency multiplier, or harmonic producer, including a vacuum tube 69, is coupled to the output circuit of the vacuum tube 23 by virtue of the mutual inductance existing between windings 39 and 33. The same frequency is therefore found in the input circuit of the vacuum tube 69 as there is in the output circuit of the vacuum tube 23. The output circuit of the vacuum tube 69 is then tuned by the condenser 46 to any frequency, preferably a harmonic of the frequency in the input circuit of the vacuum tube 69.

Another frequency multiplier, or harmonic producer, having a vacuum tube 47, is coupled to the output circuit of the vacuum tube 69 by virtue of the mutual inductance existing between windings 54 and 44. Thus the same frequency is present in the input circuit of the vacuum tube 47 as there is in the output circuit of the vacuum tube 69. The condenser 59 then tunes the output circuit of the vacuum tube 47 to any frequency, prefer-

ably a harmonic of the frequency in the input circuit thereof. A current having a frequency of the output circuit of the vacuum tube 47 is then transmitted to the antenna circuit to produce polarized oscillations for transmission to a distant station.

It will be understood that the frequencies mentioned herein are merely illustrative and that other frequencies may be employed as conditions necessitate. It will also be understood that while only one protective device has been shown to prevent excessive current from flowing in the output circuit of one tube in the system, similar protective devices may be provided for the other tubes to prevent similar occurrences.

While this invention has been disclosed in one particular arrangement, which is deemed desirable, it is to be understood that it is capable of embodiment in other and widely varied organizations without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. 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 the oscillations within narrow limits, a plurality of harmonic producers connected in tandem with respect to said low frequency source and interconnected by elements tuned to harmonics of said source each consisting of a tube of the three-electrode type having a grid condenser and leak in the input circuit, each harmonic producer serving to multiply the frequency of said oscillation generator by a constant, and means for preventing heavy discharges in the output circuit of the tube of the last harmonic producer when no biasing potential is impressed on its input circuit.

2. In a system for producing oscillations of high frequency, in combination, a source of oscillations, a piezo-electric device for stabilizing the frequency of the oscillations of said source, a frequency multiplier comprising a plurality of three-electrode vacuum tubes each having an input circuit and an output circuit, the output circuit of one tube being coupled with the input circuit of the succeeding tube, the output circuit of each tube being resonant at a harmonic of the frequency in the input circuit thereof, and a control device associated with the vacuum tube of the last harmonic producer for preventing excessive current from flowing in the output circuit thereof when current below a predetermined value flows in the input circuit.

3. In a system for producing high frequency oscillations from low frequency oscillations, in combination, a source of oscillations of low frequency, a plurality of three-

electrode vacuum tubes associated with said source of oscillations of low frequency in order to increase the frequency of oscillations, an input circuit for each of said vacuum tubes
5 in which a grid condenser and leak are associated to permit rectification therein, an output circuit for each of said vacuum tubes, the output circuit of one vacuum tube being coupled with the input circuit of the following
10 vacuum tube and being resonant at a harmonic of the frequency of said source, and a device associated with one of the vacuum tubes for preventing excessive current from flowing in the output circuit thereof when
15 the input circuit is not receiving sufficient biasing current.

4. Means for supplying high frequency oscillations to an antenna circuit comprising an oscillation generator of low frequency, an antenna circuit, a plurality of
20 frequency multipliers interconnecting said low frequency oscillation generator and said antenna circuit, each frequency multiplier consisting of a vacuum tube having an input circuit and an output circuit, the output
25 circuit of each vacuum tube being coupled with the input circuit of the succeeding vacuum tube so that the frequency in said circuits is the same, the output circuit
30 of each tube being tuned to a harmonic of the frequency in the input circuit thereof, and a protective device associated with one of the vacuum tubes for preventing excessive current from flowing in the output
35 circuit thereof.

5. A harmonic producer for producing a harmonic of the frequency of an alternating current source, comprising a vacuum tube having plate, filament and grid electrodes, a resistance and a condenser effectively
40 connected in parallel relationship between said grid and filament electrodes, and reactance elements included between the plate and filament electrodes resonant at a
45 predetermined harmonic of the frequency of the source, the resistance and the condenser providing rectification of the current of the source.

In testimony whereof, I have signed my
50 name to this specification this 13th day of August, 1925.

RUSSELL S. OHL.