June 6, 1950 M. J. O. STRUTT ET AL 2,510,842

DEVICE FOR GENERATING ULTRA HIGH FREQUENCY OSCILLATIONS

Filed May 9, 1946

Fig. 1.

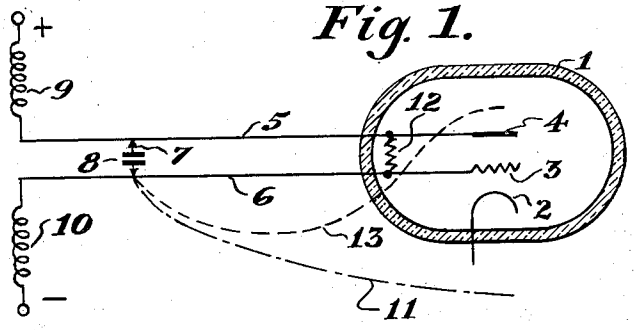


Fig. 2.

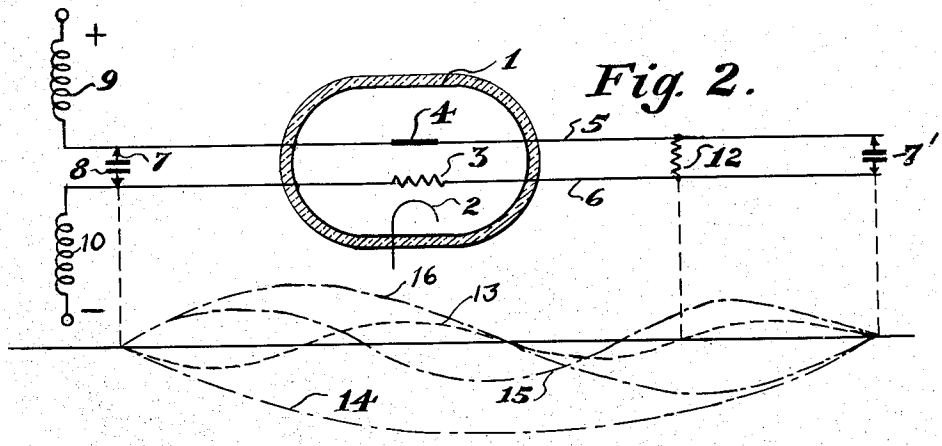


Fig. 3.

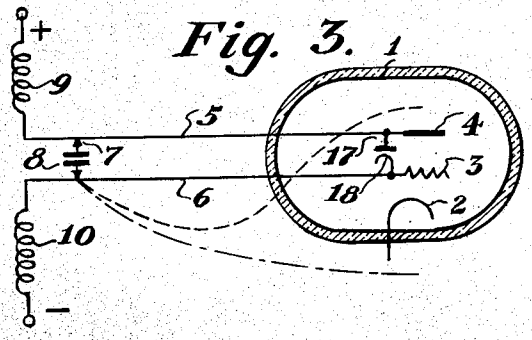
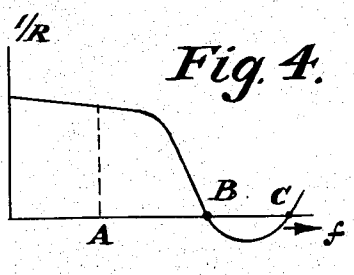


Fig. 4.



INVENTORS

MAXIMILIAAN JULIUS OTTO STRUTT & ALBERT VAN DER ZIEL

BY Lee B. Sloan

ATTORNEY

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DEVICE FOR GENERATING ULTRA HIGH FREQUENCY OSCILLATIONS

Maximiliaan Julius Otto Strutt and Aldert van der Ziel, Eindhoven, Netherlands, assignors, by mesne assignments, to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

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9 Claims. (Cl. 250—27.5)

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The present invention relates to circuit-arrangements for generating oscillations in the ultra-high frequency region and more particularly to apparatus in conjunction with such circuits for suppressing the production of subharmonics therein without at the same time damping oscillations of the desired frequency.

According to the invention, a device comprising a discharge tube at least two electrodes of which form part of the parallel conductors, extending on one side or on either side respectively of the electrodes, of the frequency-governing oscillatory circuit is made to generate oscillations having a predetermined wavelength, a quarter or half-wavelength of which is shorter than the electric length of that part of the conductors which is arranged internally of the tube by tuning the total electric length of the conductors to a whole number of quarter-wavelengths of the oscillations to be generated and by so arranging or connecting respectively a damping resistance that while subharmonics of the oscillations to be generated are damped the oscillations to be generated themselves are not damped.

The conductors of the frequency-governing circuit are preferably shunted, at a point at which a potential node occurs for the desired frequency, by a damping resistance whose value is independent of the frequency.

In order that the invention may be clearly understood and readily carried into effect it will now be described more fully with reference to the accompanying drawing in which three embodiments of the circuit according to the invention are illustrated.

In the drawing:

Fig. 1 is a schematic diagram of one preferred embodiment of an ultra-high frequency generator in accordance with the invention,

Fig. 2 is a schematic diagram of a second preferred embodiment of the invention,

Fig. 3 is a schematic diagram of a third preferred embodiment of the invention, and

Fig. 4 is a curve illustrative of the principles underlying the invention.

The circuit shown in Fig. 1 comprises a discharge tube 1 which within an exhausted envelope contains a cathode 2, a grid 3 and an anode 4. The two last-mentioned electrodes are connected respectively to one of the conductors 5 and 6 of an oscillatory circuit which is constituted by two parallel conductors and which by means of a short-circuit bridge 7 can be tuned to the desired frequency. The short-circuit bridge 7 includes a condenser 8 for the separation of the direct voltages fed to the anode 4 and the grid 3. Preferably, the anode 4 has supplied to it via a choke coil 9 a voltage which is highly positive with respect to the cathode 2 and the grid 3 has supplied to it likewise via a choke coil 10 a voltage which is negative or slightly positive with respect to the cathode. For the sake of clearness the sources of supply voltage are not shown in the figure.

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If no particular precautions are untertaken the device described generates oscillations whose wavelength is equal to four times the electric length of the conductors 5 and 6 of which the electrodes 3 and 4 form part. The voltage distribution then occurring along the conductors 5 and 6 is designated by the dot-and-dash line 11. From this it is clear that at the position of the electrodes 3 and 4 there is a potential antinode and at the position of the tuning bridge 7 a potential node. If, however, it is desired that the device described generates oscillations a quarter wavelength of which is smaller than the electric length of that part of the conductors which is arranged internally of the tube 1, the total electric length of the conductors 5 and 6 is, according to the invention, tuned to a whole number viz, three quarter wavelengths of the oscillations to be generated and at a point located at an electric distance of a quarter wavelength from the open end of the transmission line formed by the conductors 5 and 6 the conductors 5 and 6 are shunted by a resistance 12. The resistance 12 is thus arranged at a point at which, for the oscillations to be generated, a potential node occurs as is shown by the dotted line 13 which denotes the voltage distribution occurring along the conductors if oscillations of the desired frequency are generated. Since the resistance 12 is located at a potential node the damping of the circuit for the oscillations to be generated is not influenced. On the other hand the resistance 12 is located for the subharmonic to be suppressed, of the frequency to be generated at a point adjacent the potential antinode, as is apparent from the curve 11, so that for this harmonic frequency the resistance 12 brings about a considerable damping which in the case of correct proportioning of this resistance suppresses the occurrence of the undesired harmonic.

In the practical embodiment of the invention shown in Figure 2 the conductors 5 and 6 of the frequency-governing circuit extend on either side of the grid 3 and the anode 4 and these electrodes are therefore provided with two oppositely

arranged terminals. At a point external to the tube of the oscillatory circuit the conductors 5 and 6 are shunted by a damping resistance 12 and the total electric length of the conductors is tuned by means of two short-circuit bridges 7 and 7' to a whole number viz eight quarter wavelengths of the oscillations to be generated. The arrangement of the damping resistance 12 at a point external to the tube has the advantage that the device permits of generating oscillations of a frequency capable of being adjusted throughout a wide frequency band, by displacement of the resistance 12 and the short-circuit bridges 7 and 7'.

The voltage distribution along the conductors for oscillations of the desired frequency being generated is denoted by a dotted line 13, whereas the voltage distribution along the conductors for the harmonics to be suppressed is denoted by the dot-and-dash lines 14, 15 and 16. As shown in the figure, the damping resistance 12 is again located at a potential node for the oscillations to be generated and adjacent a potential antinode for the harmonics to be suppressed.

In this practical embodiment in which the conductors 5 and 6 which constitute the frequency governing oscillatory circuit extend on either side of the electrodes of the discharge tube 1, the electric length of that part of the conductors which is located inside the tube exceeds a half-wavelength of the oscillations to be generated.

In the embodiments hitherto described the damping resistance was constituted by a resistance whose value is independent of the frequency and whose value preferably corresponds to the surge impedance of the transmission line. If a resistance interconnected between the conductors is used this resistance must be located at a potential node and, if a resistance included in the conductors is used, at a potential antinode for the oscillations to be generated and this is responsible for the fact that the resistance is not exactly located at a potential antinode or potential node respectively for the harmonics to be suppressed.

Fig. 3 shows a practical form in which a damping resistance may be arranged at any point of the conductors, notably at a potential antinode for the subharmonics to be suppressed. For this purpose, the damping resistance is constituted by a resistance whose value is dependent on the frequency and which has a high impedance for the frequency to be generated and a low impedance for the frequency of the subharmonics to be suppressed. The resistance whose value is dependent on the frequency may be constituted for example by a diode whose anode and cathode designated 17 and 18 respectively in Fig. 3 are connected respectively to the conductors 5 and 6. The damping dependent on the frequency is brought about by this diode due to the transit time of the electrons between the cathode and the anode. The curve that denotes the damping, i. e. the reciprocal value of the internal resistance of a diode, as a function of the frequency is shown in Fig. 4. This figure shows that if the frequency of the oscillations to be generated is adjacent the point B or C the damping for these oscillations has a low positive value or a negative value and, for the frequency of the subharmonic to be suppressed which is located adjacent the point A, a high positive value.

The variation in the damping as a function of the frequency is dependent on the distance between the cathode and the anode of the diode and can be influenced by the choice of the supply voltages applied.

If desired, the diode may be interconnected between the grid 3 or the anode 4 respectively and the cathode 2 of the oscillator valve 1 and in this case the conductors 5 and 6 are shunted by the series combination of the anode-cathode capacity or grid-cathode capacity respectively of the oscillator valve 1 and the damping resistance of the diode.

The desired damping for the subharmonic of harmonics to be suppressed may also be obtained by such a choice of the spacing of the electrodes of the oscillator valve 1 and of the supply voltages of this valve that the damping for the subharmonic or harmonics to be suppressed is constituted by the transit time damping of the valve 1.

We claim:

1. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having internal electrodes, a pair of parallel conductors extending into said tube and connected to said electrodes and forming a resonant line therewith, the section of said line contained within said tube having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, adjustable tuning means shunting said line for high-frequency oscillations for effectively adjusting the length of said line to a multiple of a quarter wavelength, and a damping resistance shunted across said line at a point therein between said tuning means and said electrodes and having a value at which only subharmonics of said oscillations are suppressed.

2. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having internal electrodes, a pair of parallel conductors extending into said tube and connected to said electrodes and forming a resonant line therewith, the section of said line contained within said tube having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, adjustable tuning means shunting said line for high-frequency oscillations for effectively adjusting the length of said line to a multiple of a quarter wavelength, and a damping resistance shunted across said line at a point therein between said tuning means and said electrodes and located within said tube and having a value at which only subharmonics of said oscillations are suppressed.

3. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having internal electrodes, a pair of parallel conductors extending into said tube and connected to said electrodes and forming a resonant line therewith, the section of said line contained within said tube having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, adjustable tuning means shunting said line for high-frequency oscillations for effectively adjusting the length of said line to a multiple of a quarter wavelength, and a damping resistance shunted across said line at a point therein between said tuning means and said electrodes and located external of said tube and having a value

at which only subharmonics of said oscillations are suppressed.

4. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having internal electrodes, a pair of parallel conductors extending into said tube and connected to said electrodes and forming a resonant line therewith, the section of said line contained within said tube having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, adjustable tuning means shunting said line for high-frequency oscillations for effectively adjusting the length of said line to a multiple of a quarter wavelength, and a damping resistance shunted across said line at a point therein between said tuning means and said electrodes at which a potential node occurs for said predetermined frequency, said damping resistance having a value which is independent of frequency.

5. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having internal electrodes, a pair of parallel conductors extending into said tube and connected to said electrodes and forming a resonant line therewith, the section of said line contained within said tube having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, adjustable tuning means shunting said line for high-frequency oscillations for effectively adjusting the length of said line to a multiple of a quarter wavelength, and a damping resistance shunted across said line at a point therein between said tuning means and said electrodes at which a potential node occurs for said predetermined frequency, said damping resistance having a value which is substantially equal to the surge impedance of said line.

6. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having internal electrodes, a pair of parallel conductors extending into said tube and connected to said electrodes and forming a resonant line therewith, the section of said line contained within said tube having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, adjustable tuning means shunting said line for high-frequency oscillations for effectively adjusting the length of said line to a multiple of a quarter wavelength, and a damping resistance shunted across said line at a point therein between said tuning means and said electrodes at which a potential node occurs for said predetermined frequency, said damping resistance having a value which depends on frequency.

7. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having internal electrodes, a pair of parallel conductors extending into said tube and connected to said electrodes and forming a resonant line therewith, the section of said line contained within said tube having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, adjustable

tuning means shunting said line for high-frequency oscillations for effectively adjusting the length of said line to a multiple of a quarter wavelength, and a damping resistance shunted across said line at a point therein between said tuning means and said electrodes at which a potential node occurs for said predetermined frequency, said resistance being constituted by a diode discharge device.

8. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having an envelope and grid and anode electrodes enclosed therein, a pair of parallel conductors extending into said envelope and connected to said electrodes and forming a resonant line therewith, the portion of said line contained within said envelope having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, a high-frequency shorting bridge connected across said line at a point therein at which the effective length of the line is equal to an odd multiple of a quarter wavelength, and a damping resistance shunted across said line at a point therein between said bridge and said electrodes at which a potential node occurs for said predetermined frequency.

9. Apparatus for generating high-frequency oscillations of a predetermined frequency comprising an electron discharge tube having an envelope and grid and anode electrodes enclosed therein, a pair of parallel conductors extending into said envelope and connected to said electrodes and forming a resonant line therewith, the portion of said line contained within said envelope having a length which exceeds one quarter wavelength of the oscillations to be generated by a fraction of a quarter wavelength, a high-frequency shorting bridge connected across said line at a point therein at which the effective length of the line is equal to an odd multiple of a quarter wavelength, and a diode having an anode and a cathode, said diode shunted across said line at a point therein between said bridge and said electrodes, the anode of said diode being connected to the conductor of said line connected to the anode of said tube and the cathode of said diode being connected to the conductor of said line connected to the grid of said tube, said diode having a transit time characteristic resulting in a relatively low impedance at a subharmonic of said predetermined frequency and a high impedance at said predetermined frequency.

MAXIMILIAAN JULIUS OTTO STRUTT.
ALDERT VAN DER ZIEL.

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