

July 27, 1948.

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2,445,784

CAVITY RESONATOR ELECTRIC WAVE GENERATOR

Filed June 10, 1943

2 Sheets-Sheet 1

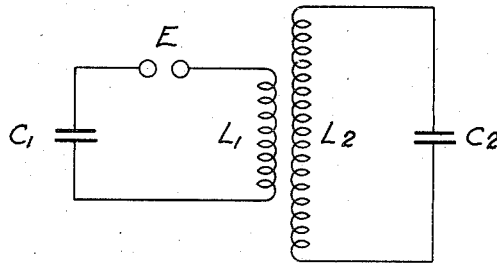


Fig. 1.

Fig. 2.

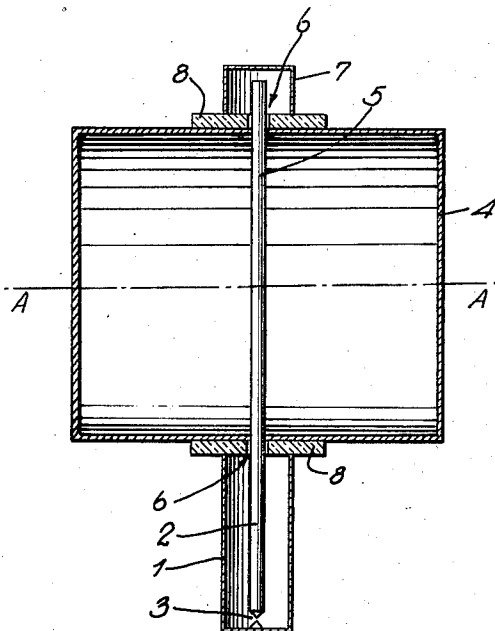
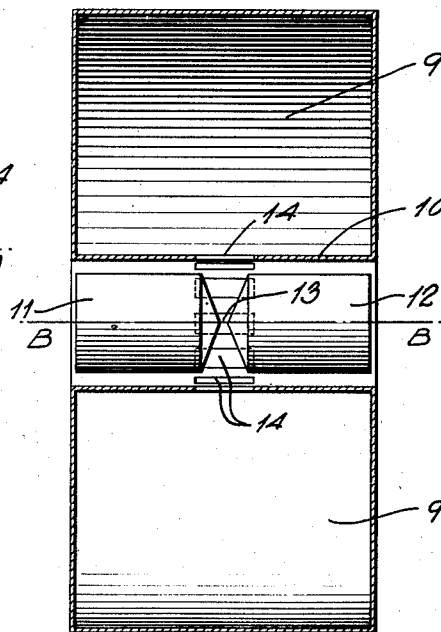


Fig. 3.



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2 Sheets-Sheet 2

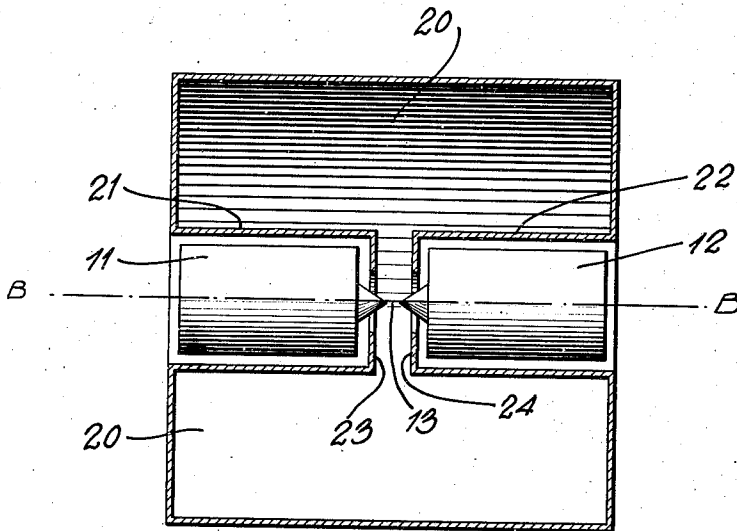
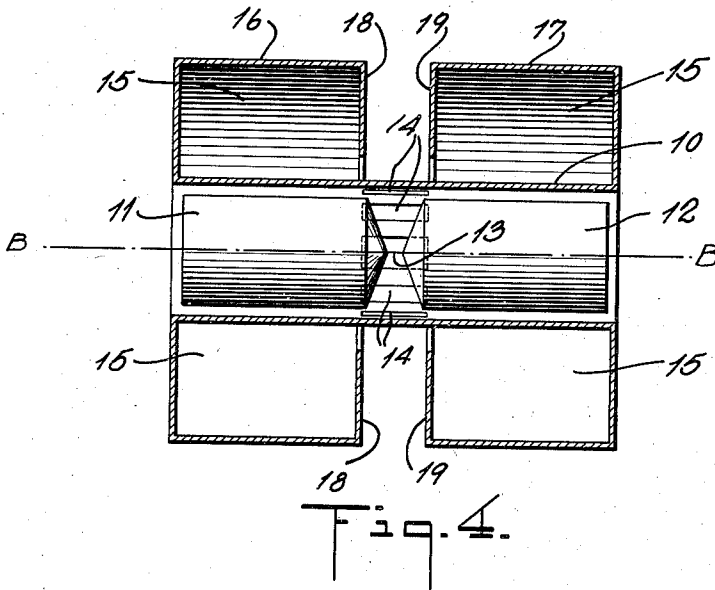


Fig. 5.

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CAVITY RESONATOR ELECTRIC WAVE GENERATOR

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The present invention relates to systems of secondary oscillators for radio electric transmitters of the spark type with indirect excitation. The invention is characterized, on the one hand, by an extremely high Q circuit, permitting the prolongation of the duration of each train of oscillations appreciably beyond the limits heretofore attained, particularly as concerns transmitters functioning at very short wave lengths, and on the other hand by the absence of constrained dielectrics which have the disadvantage of preventing the employment of very high exciting voltages.

Even where the intermittent character of the emission does not present any inconveniences in itself, it is known that the major defect in spark transmitters is the very short duration of each train of oscillations emitted; the duration diminishing with the wave length of the oscillation. Indeed, in one type of construction with a given circuit, this duration is inversely proportional to the linear resistance of the circuit, which, taking into account the radiation resistance, increases faster than the square root of the frequency. On the other hand, in circuits with lumped constants, it is hardly possible to utilize at very short wave lengths a type of construction and employing the most desirable circuit with relatively great kinetic energy. Finally for this kind of circuit the duration of the oscillation train diminishes excessively fast with the wave length so that all traffic then becomes impracticable.

An appreciable improvement of this condition is provided by employing circuits with distributed constants such as transmission lines with parallel conductors whose axes do not coincide, or better still with concentric conductors. One can thus obtain a relatively high ratio between the kinetic energy stored in the inductance and the energy dissipated in the resistance, a ratio which furnishes the above-mentioned high circuit Q and the desired duration of the train of oscillations. However, in spite of this undeniable advantage, the value of the circuit Q is still not sufficient to give, in the majority of applications, an acceptable train-duration, especially at very short wave lengths. Furthermore, the relatively high dielectric strain which is produced between conductors renders difficult the use of high voltages at the primary and impedes the utilization of one of the inherent advantages of spark transmitters.

According to the characteristics of the present invention, there is utilized for the secondary circuit of the spark emitter, a circuit of the so-called chamber type, or otherwise known as resonant

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cavity. This type of circuit recently discovered as a result of other uses, presents in the instant case particular advantages which have already been indicated at the beginning hereof but which will however be recalled because of their importance.

(a) It lengthens the duration of each train of oscillations because of the exceptional high peak voltage factor, especially at very short wave lengths.

(b) It permits in spite of this peak voltage factor, the utilization of very high tensions on the primary because of the absence of strained dielectrics in the interior of the secondary. It offers thus a means of forming in association, for example, with the type of primary circuit described in the application of Stanislas Teszner, Serial No. 477,654, filed on March 1, 1943, under the title "System of spark gaps for radio electric emitters," radio electric spark emitters of relatively high energy and efficiency. Application Serial No. 477,654 has become abandoned.

The description which follows, of some examples of embodiments, will produce a better understanding of the characteristics and advantages of the invention. Reference will therefore be successively made to the adjoining drawings in which,

Fig. 1 serves to illustrate the schematic equivalent of the oscillating circuits of a spark emitter of the indirect excitation type.

Figs. 2 to 5 represent in cross-section, different forms of embodiment of the secondary circuit according to the invention, coupled with the corresponding primaries by coaxial lines.

In Fig. 1, it will be observed that the circuit constants are represented as lumped. The schematic of the primary circuit comprises a capacity $C1$, an inductance $L1$ and a spark gap E . Represented in the same fashion, the secondary comprises an inductance $L2$ and a capacity $C2$. The indicated coupling, for purposes of illustration, between the primary and secondary, is electromagnetic, but it can equally well be of any other kind, such as electrostatic or even mixed.

In the ensuing description, the primary will be represented in the form of a line with distributed constants, of which a coaxial line will be taken particularly as an example.

In Fig. 2, such a line comprises an exterior conductor 1, a central conductor 2, closed at one extremity by a spark gap 3 inserted between the two conductors. The line oscillating in fact as a quarter wave line, is coupled with a secondary circuit 4 constituted by a resonant cavity in the

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form of a cylinder of revolution around the axis A—A. The coupling between the two circuits therefore is effected by an antenna 5 forming a spindle diametrically through the cavity 4 and traversing the openings 6 and formed by a prolongation of the central conductor 2 (the said coupling being by half wave). A cap 7 forms a reflector for the energy at the extremity of the antenna. Finally, the insulating tie member or washer 8 insulates the external conductor 1 and the cap 7 from the wall of cavity 4. It should be noted that the latter will be constituted preferably of as good an electrical conductor as possible, for example copper, and that it can be made in other shapes such as those hereinafter described.

In Fig. 3, the resonant cavity constituting the secondary circuit is in the form of a surrounding toroid 9 of rectangular cross-section and surrounding the axis B—B of the primary circuit. The latter is represented, as hereinabove, by a coaxial line which however, in this case, oscillates at half wave length. It is formed of an external tube 10 which constitutes at the same time the interior wall of the toroidal enclosure 9, and of a central conductor composed of two truncated sections 11 and 12 of equal length separated by spark gap 13. The coupling between the primary and secondary is effected through the openings 14 provided in the wall 10 opposite the spark gap, that is to say, at its middle portion. The coupling is then almost purely electromagnetic. The amount of coupling is a function of the dimensions and of the number of openings 14.

In Fig. 4, the primary circuit is constituted in the same way as in Fig. 3 (the reference numerals remaining the same for like parts). The cavity constituting the secondary circuit 15 is however in a more complex form. It is given a surrounding toroidal form, the toroid being one of revolution around the axis B—B of the primary, but the exterior cylindrical wall of which is cut away at its middle portion, the two sections 16 and 17 are prolongations respectively of the annular discs 18 and 19 which are parallel to each other and form what one may call the capacitive part of the cavity. The coupling between the primary and the secondary is effected as in Fig. 3, through the openings 14 which are situated preferably in the space between the two discs 18 and 19. The coupling is almost purely electromagnetic and the amount of coupling is likewise determined by the dimensions of the openings 14.

In Fig. 5, finally, the secondary cavity 20 is formed of a surrounding toroid (toroid of revolution around the axis B—B of the primary) but whose interior wall is separated at its middle part into two sections 21, 22. The free extremities of these sections are extended respectively by two annular parallel discs 23, 24, which form, likewise, the capacitive part of the circuit. The primary circuit is constituted as in Figs. 3 and 4 by a coaxial line; however the exterior conductor of this line forms also the interior wall of the toroidal cavity, and is interrupted at its middle portion as indicated in the figure. The coupling between the primary and the secondary is effected in the space between 23, 24, common in part to the two circuits. The coupling is principally, but not exclusively, electromagnetic and its value is a function of the length of the said space between 23, 24.

The functioning of the embodiments represented will be easily understood. The primary circuit being charged by a source of energization, not indicated in the drawing (the voltage being

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applied in Fig. 2 between the conductors 1 and 2, in Figs. 3, 4 and 5, between the sections 11 and 12 of the central conductor), when the spark gap is fired, there is provoked an oscillation of the primary circuit which excites in its turn that of the secondary cavity. The oscillation of the primary being then rapidly extinguished by an appropriate arrangement, such for example as that disclosed in the said application of Stanislas Teszner referred to hereinabove; the secondary circuit will thereafter continue to oscillate by itself. It is then that the inherent quality of the resonant cavities intervenes, namely their exceptionally high Q circuit. This is of a particular interest because it insures a relatively long duration of the secondary oscillation. In order to fix the orders of dimensions, it can be said that with resonant cavities one can easily attain a circuit Q value of the order of 10,000, and even more for wavelengths of the order of a meter. Assuming then a utilization coefficient in the emitting antenna (which is excited from the secondary for example, in a manner well known by means of a loop introduced into the interior of the cavity, which loop is not represented in the drawings) of the order of 0.9, it is easy to see that the duration of the oscillation until there is a reduction of amplitude of 40 decibels, will correspond to about 1,500 alternations. It is evident besides that one will be able without any special disadvantage at the secondary, to utilize at the primary, charging voltages which are very high and with relatively valuable useful energies in the antenna.

With respect to the choice of the form of the secondary cavity, it will be a function of the particular conditions applying to each particular species, notably, the high circuit Q, the wave length of the oscillation, the loading of the circuit, ease of operation, conditions of installation, etc., as well as the constitution of the primary circuit.

It will be understood, of course, that the above-described forms have been given only by way of example and not by way of limitation, and that they can be varied without departing from the spirit and scope of the invention.

What is claimed is:

1. An oscillation generator for very short wave lengths comprising a conductive resonant cylindrical cavity, an antenna-like member passing through said cavity substantially diametrically therein but conductively insulated therefrom, an integral prolongation of said member extending outwardly beyond said cavity, a concentric transmission line conductor surrounding said prolongation and forming therewith a quarter-wave concentric transmission line, and a spark gap interposed between the two conductors of said line exterior to said cavity space.

2. An oscillation generator according to claim 1 in which both ends of the antenna-like member extend beyond the cavity member and each end is enclosed by a metal cap spaced therefrom to form a concentric line, and a spark gap member is carried by the end wall of one cap and faces a cooperating spark gap member carried by the adjacent end of the antenna-like member.

3. An oscillation generator for use at very short wave lengths, comprising a primary circuit which includes a linear conductor in series with a spark gap, and a secondary circuit formed by a cavity resonator, of generally rectangular cross section centered on said linear conductor, which is coupled to said primary circuit but galvanically insulated from said conductor, the extent of the

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resonator in the direction of said conductor being of the order of half a wave length at the operating frequency.

4. An oscillation generator according to claim 3, wherein the resonator is of toroidal form and coaxial with said linear conductor.

5. An oscillation generator according to claim 3, wherein the resonator is in the form of a hollow cylinder having its axis at right angles to said linear conductor.

6. An oscillation generator according to claim 5, wherein a portion of said linear conductor passing diametrically through said hollow cylinder is extended externally thereof for a distance corresponding to one-quarter the wave length at the operating frequency, the said spark gap being provided at the end of said extension.

7. An oscillation generator according to claim 6, further comprising a tubular conductor surrounding said extension and forming a quarter-wave concentric transmission line therewith, the spark gap being provided between said extension and said tubular conductor.

8. An oscillation generator for use at very short wave lengths, comprising a primary circuit which includes a linear conductor, said conductor having a discontinuity forming a spark gap, and a secondary circuit formed by a toroidal cavity resonator coaxial with said conductor, the extent of said resonator in axial direction on each side of said spark gap being of the order of a quarter wave length at the operating frequency.

9. An oscillation generator according to claim 8, wherein the toroidal resonator has an outer wall formed with axial reentrant portions surrounding respective portions of said linear conductor on each side of said spark gap, each of said reentrant portions extending almost to the center of the resonator.

10. An oscillation generator for use at very short wave lengths, comprising a primary circuit which includes a linear conductor, said conductor

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having a discontinuity forming a spark gap, and a secondary circuit formed by a toroidal cavity resonator an inner wall of which coaxially surrounds said linear conductor and has an air gap adjacent the said spark gap, the extent of said resonator in axial direction on each side of said spark gap being of the order of a quarter wave length at the operating frequency.

11. An oscillation generator for use at very short wave lengths, comprising a primary circuit which includes a linear conductor, said conductor having a discontinuity forming a spark gap, and a secondary circuit formed by a toroidal cavity resonator an inner wall of which coaxially surrounds said linear conductor and has a plurality of circumferentially spaced apertures substantially co-extensive with the said spark gap, the extent of said resonator in axial direction on each side of said spark gap being of the order of a quarter wave length at the operating frequency.

12. An oscillation generator according to claim 11, wherein the toroidal resonator comprises an outer wall having a gap aligned with said circumferentially spaced apertures, a pair of conductive annular members extending inwardly from said outer wall on each side of said gap.

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