Oct. 1, 1946. H. BENIOFF 2,408,407

HIGH FREQUENCY APPARATUS

Filed July 10, 1942

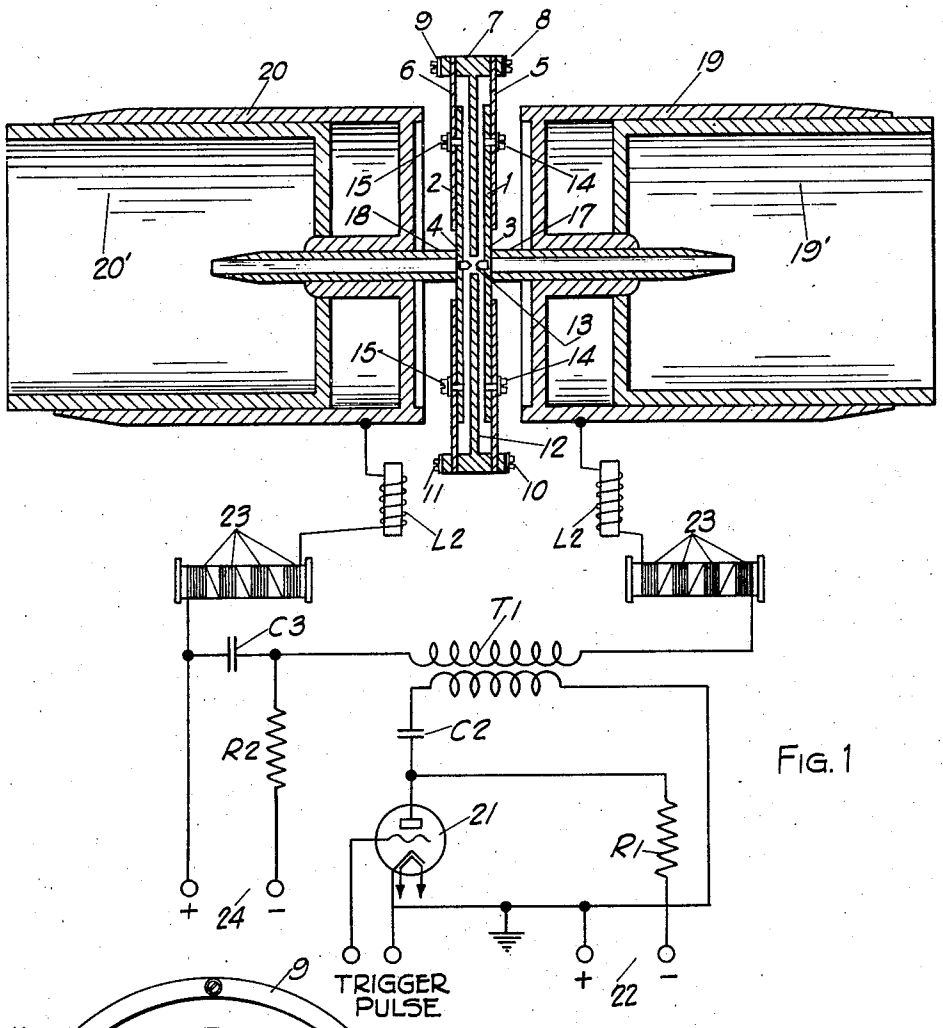


FIG. 1

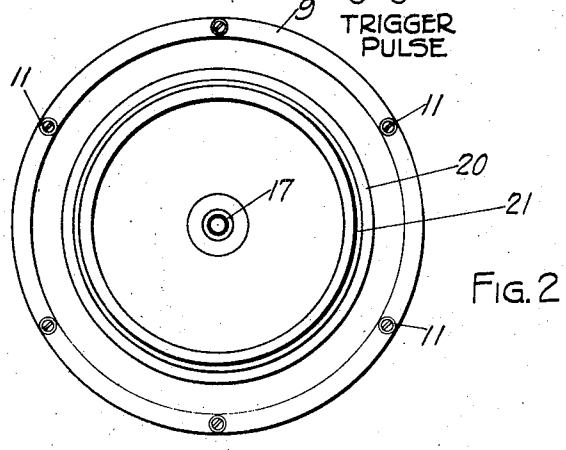


FIG. 2

INVENTOR
HUGO BENIOFF
BY Ezekiel Wolf
ATTORNEY

Patented Oct. 1, 1946

2,408,407

UNITED STATES PATENT OFFICE

2,408,407

HIGH-FREQUENCY APPARATUS

Hugo Benioff, La Canada, Calif., assignor, by mesne assignments, to Submarine Signal Company, Boston, Mass., a corporation of Delaware

Application July 10, 1942, Serial No. 450,451

11 Claims. (Cl. 315—39)

1

The present invention relates to apparatus for producing ultra high-frequency electromagnetic waves and relates more particularly to short-wave radio transmitters in a frequency range of 150 megacycles and higher.

The present invention is an improvement of my copending applications Serial No. 362,434, filed October 23, 1940, Serial No. 391,153, filed April 30, 1941, and Serial No. 432,293, filed February 25, 1942. In the last of these applications a spark tank circuit is shown in which there is used two closely spaced plates with the sparking electrodes centrally located therein.

The present invention relates to the same general apparatus and finds its chief improvement and advantage in that a greater amount of power can be more readily handled than in the former embodiment. In the present application a direct current polarizing voltage is employed which, it appears, prevents a premature discharge across the sparking electrodes and permits the voltage between plates to rise to a higher value before breakdown of the gap with a resulting storage of increased amount of energy for liberation during the discharge of the gap.

The present invention is further simplified in that in this form it is unnecessary to provide auxiliary sparking electrodes.

A further advantage obtained in the present invention is that the resonant oscillatory circuit is coupled more efficiently to the radiator and that the radiator functions more efficiently in the radiation of electromagnetic power.

The applicant believes, but he is not certain, from studies and tests of the present invention that after the discharge across the spark gap, the oscillatory circuit establishes itself with the opposed plates as a capacity and the radiators extending therefrom as resonant quarter wave length elements forming a one-half wave length radiating system.

Other constructional features and advantages will be more fully appreciated and understood from the description contained in the specification below when taken in connection with the drawing in which Fig. 1 shows a central section through the apparatus and the operating wiring diagram connected therewith, and Fig. 2 shows an end view of the apparatus shown in Fig. 1.

In Fig. 1 the apparatus comprises two opposed conductive plate members 1 and 2 with centrally located electrodes preferably of tungsten or other suitable material 3 and 4 mounted and projecting from the opposing surfaces of the plates 1 and 2 with the points of the electrodes in actual alignment. The plates 1 and 2 are supported by insulating discs 5 and 6, respectively, which at their peripheries are held against the clamping cylinders 7 by means of the clamping rings 8 and 9 which may be held by screws 10 and 11 to the clamping cylinder, which screws may be spaced around the rings. Centrally located and supported by the cylindrical ring 7 is a thin insulating disc 12. The elements 5 and 6 and 16 may all be of mica or some other suitable material having high insulating qualities. The disc 12, which is centrally spaced between the inner surfaces of the plates 1 and 2, has a centrally located perforation 13 into which the points of the electrodes 3 and 4 may slightly project. The plates 1 and 2 may be mounted and held to the mica discs 5 and 6 by means of suitable short screws 14, 14 and 15, 15, although any other suitable means for attaching the plates to the discs 5 and 6 may be employed. The plates 1 and 2 make good electrical contact with rearwardly projecting members 17 and 18 which may be formed as a part of the conducting cylinders 19 and 20, respectively. The elements 17 and 18 are also of highly conductive material. The whole system, comprising the cylinders 19 and 20, the connecting elements 17 and 18, the plates 1 and 2 with their projecting electrodes 3 and 4, forms both the spark tank circuit and the radiating circuit.

Within the cylinders 19 and 20, respectively, are telescopic cylindrical elements 19' and 20' which may be extended beyond the edge of the cylinders 19 and 20 to increase the effective antenna length and adjust for tuning of the system. These telescopic cylinders 19' and 20' may be omitted where the antenna length is definitely determined and no tuning adjustment is required.

Initially the voltage is built up between the plates 1 and 2 until a breakdown occurs in the region between the electrodes 3 and 4 and the perforation 13 in the disc 12. The electrodes are spaced apart a distance determined by the maximum available potential at breakdown. As an illustration in one case with breakdown occurring with 21,000 volts between plates, the spacing was .050 of an inch for the point electrodes. Before the breakdown occurs, the energy is stored up in the tank circuit with extreme stresses occurring between the plates 1 and 2. Breakdown of the spark releases energy stored in the capacity of the tank circuit and sets up oscillations in the tank circuit which is coupled with the antenna, thus providing means for radiating power.

Under normal conditions there is present in the gap enough ions to bring about a breakdown

between the sparking electrodes 3 and 4 at relatively low voltages. By the use of a direct current polarizing voltage the free ions remaining in the gap after discharge are cleaned out, thus increasing the potential at which discharge occurs. This polarizing potential must be direct current or timed low frequency pulses of a sufficient value to effect the desired cleaning out of the space between the electrodes. Where the impulse potential is built up to a peak in the neighborhood of 20,000 volts between the plates, an initial application of 500 to 2500 volts D. C. will sweep the space between electrodes free of such ions. By this means a voltage considerably higher than that which could normally be maintained may be reached between the electrodes before a breakdown occurs. The mica disc 12 which is centrally located between plates 1 and 2 prevents breakdown at points other than the gap in the space between the plates due to stray ions not removed by the direct current potential. The thickness of the mica plate should preferably be small compared to the spacing between plates.

The circuit for operating the oscillator includes an impulse transformer T_1 the primary of which is energized by a gaseous tube 21 which has a cathode, anode and control electrode. A triggering impulse may be impressed between the cathode and the control electrode in a manner similar to that described in my copending application Serial No. 432,293 referred to above. The condenser C_2 is charged from a source 22 through a resistor R_1 when the thyratron 21 is in a non-conducting condition. When the gaseous tube 21 is rendered conducting by the action of the trigger pulse on its grid, the charge on C_2 passes through the primary of the transformer T_1 in the form of a short pulse. The output of the secondary is impressed upon the plates of the tank circuit. The constants of the circuit are so chosen as to charge the plates in a few microseconds. Chokes L_2L_2 are effective at the oscillator frequency (which may, for instance, be 600 megacycles). Chokes 23 are of higher inductance and are effective at charging impulse frequencies. In order to be effective at ultra high frequencies the windings of L_2 are wound of very fine wire on a core of small diameter and with appreciably spaced turns. There is also in the circuit with the transformer a condenser C_3 across the terminals of which the direct polarizing voltage 24 is applied. This polarizing voltage is applied through a high resistance R_2.

The source 24 may be applied through the whole period of operation as desired and the impulse voltage generated by the transformer T_1 will be superimposed upon this polarizing voltage during the charge of the tank circuit. The action of the polarizing voltage is such that upon discharge of the tank circuit a normal uniform voltage is quickly provided across the space between the plates, thus causing the positive ions remaining in the space to travel to the negative plate and the negative ions to travel to the positive plate. This reduces the number of ions in this space.

Having now described my invention, I claim:

1. In an ultra short wave oscillatory spark circuit, in combination, two flat plates spaced with their face surfaces in closely opposed relationship with each other, electrodes centrally positioned in opposing relationship on said plates and facing each other, means insulatingly supporting said plates in said position and an insulating sheet positioned midway between the faces of said two plates, said insulating sheet having a perforation in alignment with said electrodes.

2. In an ultra short wave oscillatory spark circuit, in combination, two flat plates spaced with their face surfaces in closely opposed relationship with each other, electrodes centrally positioned in opposing relationship on said plates and facing each other, means comprising insulating discs attached to the backs of said plates, an insulating sheet positioned midway between the faces of said two plates, said insulating sheet having a perforation in alignment with said electrodes and means supporting said insulating discs and sheets in parallel positions with each other.

3. An ultra short wave oscillatory spark circuit comprising two flat plates spaced with their face surfaces in closely opposed relationship with each other, electrodes centrally positioned in opposing relationship on said plates and facing each other, means insulatingly supporting said plates in said position and a conducting shell supported to the back of each of said plates in conducting relationship therewith, said conducting shell having a longitudinal dimension adjusted for the desired resonance in the oscillator circuit.

4. In an ultra short wave oscillatory spark circuit, in combination, two flat plates spaced with their face surfaces in closely opposed relationship with each other, electrodes centrally positioned in opposing relationship on said plates and facing each other, means insulatingly supporting said plates in said position, an insulating sheet positioned midway between the faces of said two plates, said insulating sheet having a perforation in alignment with said electrodes, and means providing a direct current potential between said plates for sweeping out the free ions to prevent a premature discharge between said electrodes.

5. In an ultra short wave oscillatory spark circuit, in combination, two flat plates spaced with their face surfaces in closely opposed relationship with each other, electrodes centrally positioned in opposing relationship on said plates and facing each other, means insulatingly supporting said plates in said position and means providing a direct current potential between said plates for removing ions to prevent a premature discharge between said electrodes.

6. An ultra short wave oscillatory spark circuit comprising two flat plates spaced with their face surfaces in closely opposed relationship with each other, electrodes centrally positioned in opposing relationship on said plates and facing each other, means insulatingly supporting said plates in said position, a conducting shell supported to the back of each of said plates in conducing relationship therewith, said conducting shell having a longitudinal dimension adjusted for the desired resonance in the oscillator circuit, and means providing a direct current potential between said plates for sweeping out the free ions after a discharge has occurred between said electrodes.

7. An ultra short wave oscillatory spark circuit comprising two flat plates spaced with their face surfaces in closely opposed relationship with each other, electrodes centrally positioned in opposing relationship on said plates and facing each other, means insulatingly supporting said plates in said position, a conducting shell supported to the back of each of said plates in conducting relationship therewith, said conducting shell having a longitudinal dimension adjusted

for the desired resonance in the oscillator circuit, said conducting shell having a diameter substantially as large as the diameter of said plates.

8. An ultra short wave oscillatory spark circuit comprising two flat plates spaced with their face surfaces in closely opposed relationship with each other, electrodes centrally positioned in opposing relationship on said plates and facing each other, means insulatingly supporting said plates in said position and a conducting shell supported to the back of each of said plates in conducting relationship therewith, said conducting shell having a longitudinal dimension adjusted for the desired resonance in the oscillator circuit, said conducting shell having a diameter substantially as large as the diameter of said plates, said shell being supported to said plates at the central section of said plates.

9. In an ultra short wave oscillatory spark circuit, in combination, means providing two closely spaced surfaces in opposed relation with each other, electrodes centrally positioned on and projecting towards each other from said opposing surfaces, means insulatingly supporting said plates in said position and a mica sheet positioned in the space midway between said surfaces and extending parallel to the same, said mica sheet

having a perforation in alignment with said electrodes.

10. An ultra short wave oscillatory spark circuit comprising elements providing two closely spaced surfaces in opposed relation to each other, electrodes centrally located on and projecting towards one another from said surfaces, means insulatingly supporting said elements in said position and a conducting shell supported to the back of each of said elements in conducting relationship therewith, said conducting shell having a longitudinal dimension adjusted for the desired resonance in the oscillatory circuit.

11. An ultra short wave oscillatory spark circuit comprising elements providing two closely spaced surfaces in opposed relation to each other, electrodes centrally located on and projecting towards one another from said surfaces, means insulatingly supporting said elements in said position and a conducting shell supported to the back of each of said elements in conducting relationship therewith, said conducting shell having a longitudinal dimension adjusted for the desired resonance in the oscillatory circuit, said shell having a diameter of substantially the same size as said elements.

HUGO BENIOFF.