No. 706,741. Patented Aug. 12, 1902.

R. A. FESSENDEN.

APPARATUS FOR WIRELESS TELEGRAPHY.

(Application filed Nov. 5, 1901.)

(No Model.)

FIG. 1.

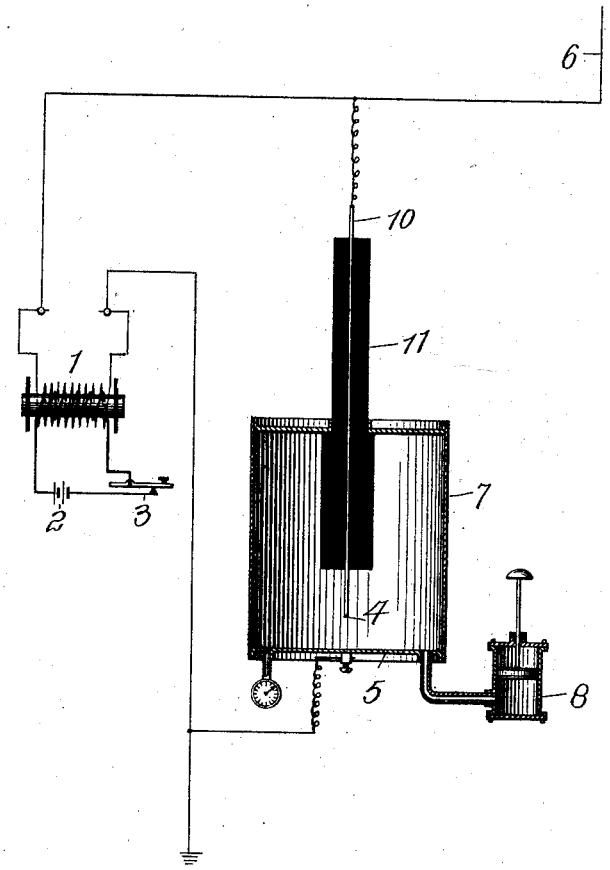
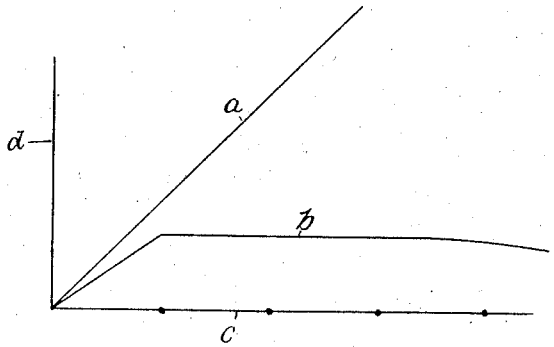


FIG. 2.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 706,741, dated August 12, 1902.

Application filed November 5, 1901. Serial No. 81,215. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSENDEN, a citizen of the United States, residing at Manteo, in the county of Dare and State of North Carolina, have invented or discovered certain new and useful Improvements in Apparatus for Wireless Signaling, of which improvements the following is a specification.

As is well known to the skilled in the art the efficient range of electromagnetic waves or impulses produced by oscillations in a conductor connected to a suitable generator, as an induction-coil, is up to a certain length of spark—*i. e.*, one inch—approximately proportional to the length of the spark. Any material increase in the length of the spark beyond this point results in practically no increase in radiation. I have found that this decrease is due in part to increased resistance in the gap between the sparking terminals and in part to causes whose nature and the theory of which are not at present understood, but which I have devised means for overcoming.

The object of the invention described herein is to provide for the maintenance of a certain definite relation between the resistance and the self-inductance and capacity of the sending mechanism regardless of the potential employed and securing such a relation between sparking potential and radiation that the curve showing this relation shall not as at present be flattened at and beyond the point corresponding to a sparking potential of one inch, but shall continue to ascend.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings, forming a part of this specification, Figure 1 is a diagrammatic view illustrating a form of sending apparatus embodying my improvement, and Fig. 2 is a graphic diagram illustrative of the relative efficiencies of my improved and old forms of sending apparatus.

In the practice of my invention I employ a suitable generator, as the induction-coil 1, having its primary coil in circuit with the battery 2 and key 3, while its secondary coil is connected to the terminals 4 and 5, forming the sparking gap. The terminals 4 and 5 are connected, respectively, to the radiating portion of the sending-conductor 6 and to the ground. By the terms "sending-conductor" and "receiving-conductor" as herein employed are included all of the circuits from the top to ground, if grounded, or, if not grounded, from one extreme end to the other extreme end of the circuits, including all apparatus in series with the circuits, while under the term "radiating portion" is included all of the sending-conductor from top or extreme end of same to point of junction with apparatus for effecting the oscillatory charging and discharging thereof, such as sparking terminals, transformer-coils, armature-windings, &c.

It is well known that the resistance should bear a certain relation to the capacity and self-inductance, such relation being expressed by the formula R^2 not greater, than $4\frac{L}{C}$, where R is the resistance, L the self-inductance, and C the capacity. When a spark longer than an inch is formed under conditions heretofore existent in the art, the distance between the sparking terminals is such that the ohmic resistance of the spark renders a total resistance of the circuit greater than that specified in the formula, and the discharge between the terminals is not oscillatory. In order to increase the radiations of the sending mechanism beyond the limit above pointed out, I employ suitable means for increasing the potential of the spark without increasing the spark length or the ohmic resistance of the spark as distinguished from the dielectric strength of the medium in the gap. A convenient means to this end consists in subjecting the medium interposed between the terminals to pressure, and thereby increasing the dielectric strength of the medium in the gap and rendering it possible to increase the potential of the spark for a given distance between the terminals; but the fact that the ohmic resistance of the spark for a given gap has not been increased with the increase of potential the total resistance of the circuit hence is still within the limits of the formula and is not of itself sufficient to produce increased radiation. An entirely new phenomenon will also occur, for if in the apparatus shown the sparking distance in the bulb is, for example, four inches for a given potential when the pressure therein is that of the atmosphere

on gradually increasing the pressure up to fifty pounds per square inch above atmospheric pressure the corresponding sparking distance (the potential of the source remaining the same as before) is correspondingly shortened down to about one-fourth of an inch, and yet there is no marked increase in radiation, though the ohmic resistance of the spark is now presumably not more than one-sixteenth of what it was originally, this being based on the assumption that the ohmic resistance of the spark is approximately proportional to its length and does not increase with the pressure; but when the pressure reaches sixty pounds the radiation begins to increase and at eighty pounds is about three and one-half times what it was at fifty pounds and radiation becomes substantially proportional to the potential of the source. If, however, under these conditions the applied potential is doubled, the radiation is also doubled, and if it be quadrupled the radiation is also quadrupled, showing that after a certain critical pressure is reached radiation increases proportionally to increase of potential of the source—*i. e.*, approximately to the potential of the spark length in air. By "radiation" as used herein is meant that quantity which on being doubled enables a receiver to be operated at double the distance at which it operated before the radiation was doubled. Radiation is mathematically expressible by the formula $V\sqrt{C}$, where C is the capacity and V is the sparking potential used. In the form of apparatus shown the terminals are arranged in a chamber 7, which is connected to a pump 8, whereby gas or air may be forced into the chamber and maintained under any desired pressure therein. It is preferred that one of the terminals, as 4, should be small relative to the other. In other words, the area of one terminal should be considerably in excess of the other. The best effects are produced by reducing one of the terminals to or approximately to a point and employing a disk or plate as the other terminal, said disk or plate being so arranged that its surface adjacent to the other terminal is at or approximately at right angles to a line connecting the points in the two terminals most closely adjacent to each other. Generally this line will coincide with the axis of the smaller terminal. In the construction shown the bottom of the chamber forms one of the terminals, while the other terminal is formed by the point of a rod 10, which is passed through an insulating-sleeve 11, though this is not necessary, as the broad terminal may be insulated from the containing-chamber.

In using this apparatus the terminals are adjusted, preferably, to about one-quarter of an inch apart when using a twelve-inch coil. By increasing the pressure the dielectric strength of the medium is increased and the spark potential can be raised to almost any extent without any material loss in oscillatory power, as indicated by the line *a* in Fig. 2, whereas in air under ordinary pressure it is found that no matter how high the potential is raised practically no increase in efficiency is obtained over that given with a spark length of one inch, as indicated by the line *b*. In Fig. 2 the horizontal line *c* indicates spark potential in inches, and the radiation is indicated by the vertical line *d*.

I am aware that spark-gaps occupied by insulating material under pressure greater than atmospheric pressure have been used in switches for breaking or making electric circuits and that it has been proposed to substitute gases under pressure in lieu of oil, as employed by Marconi and others, for giving a more abrupt spark. The purpose of substituting insulating-gases for oil was to avoid evil effects arising from the carbonization of the oil. The effect produced by the gases under pressure differed in degree only from that produced by oil and not in kind. Neither of the materials as used would have any effect toward securing and maintaining the desired relation between the resistance and the self-induction and capacity of the sending mechanism.

I claim herein as my invention—

1. An apparatus for the generation of radiation, having in combination sparking terminals directly connected respectively to the radiating portion of the sending-conductor and to ground, and the gap or space between the terminals being occupied by an insulating medium under pressure greater than atmospheric pressure, substantially as set forth.

2. An apparatus for the generation of radiation, having in combination sparking terminals directly connected respectively to the radiating portion of the sending-conductor and to ground, and the gap or space between the terminals being occupied by a gaseous insulating material under pressure greater than atmospheric pressure, substantially as set forth.

3. An apparatus for the generation of radiation, having in combination sparking terminals, one of said terminals having a large superficial area relative to the other and the gap or space between the terminals being occupied by an insulating medium under pressure greater than atmospheric pressure, substantially as set forth.

4. An apparatus for the generation of radiation, having in combination sparking terminals, the space between the terminals being occupied by an insulating medium under pressure, the gap between said terminals forming, when the spark passes, practically all the resistance between the radiating portion of the sending-conductor and the ground, substantially as set forth.

5. An apparatus for the generation of radiation, having in combination a conductor for radiating electromagnetic waves, and sparking terminals, all gaps between sparking terminals being occupied by insulating

material under pressure greater than atmospheric pressure, substantially as set forth.

6. An apparatus for the generation of radiation, having in combination sparking terminals, one of said terminals having a large superficial area relative to the other, the surface of the larger terminal being arranged at or approximately at right angles to a line passing through points on said terminals most closely adjacent to each other, and the gap or space between the terminals being occupied by an insulating medium under pressure greater than atmospheric pressure, substantially as set forth.

7. In an apparatus for the generation of radiation, the combination of a chamber having at least one of its walls formed of conducting material, and connected to ground and a rod projecting into the chamber but not in electric connection with the metallic wall, the conducting-wall and rod being connected to the radiating portion of the sending-conductor, said chamber containing an insulating medium under pressure, substantially as set forth.

8. An apparatus for the generation of radiation having in combination sparking terminals directly connected to the circuit in which the oscillations occur, and the gap or space between the terminals being occupied by an insulating medium under pressure greater than atmospheric pressure, substantially as set forth.

9. An apparatus for the generation of radiation having in combination a conductor for radiating electromagnetic waves and sparking terminals, all gaps between sparking terminals being occupied by insulating material under pressure greater than sixty (60) pounds above atmospheric pressure, substantially as set forth.

10. An apparatus for the generation of radiation having in combination a conductor for radiating electromagnetic waves and sparking terminals, all gaps between sparking terminals being occupied by insulating material under pressure greater than eighty (80) pounds above atmospheric pressure, substantially as set forth.

11. An apparatus for the generation of radiation having in combination a conductor for radiating electromagnetic waves and sparking terminals, all gaps between sparking terminals being occupied by insulating material under pressure above a certain critical high pressure.

In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:

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