J. S. STONE.

SPACE TELEGRAPHY.

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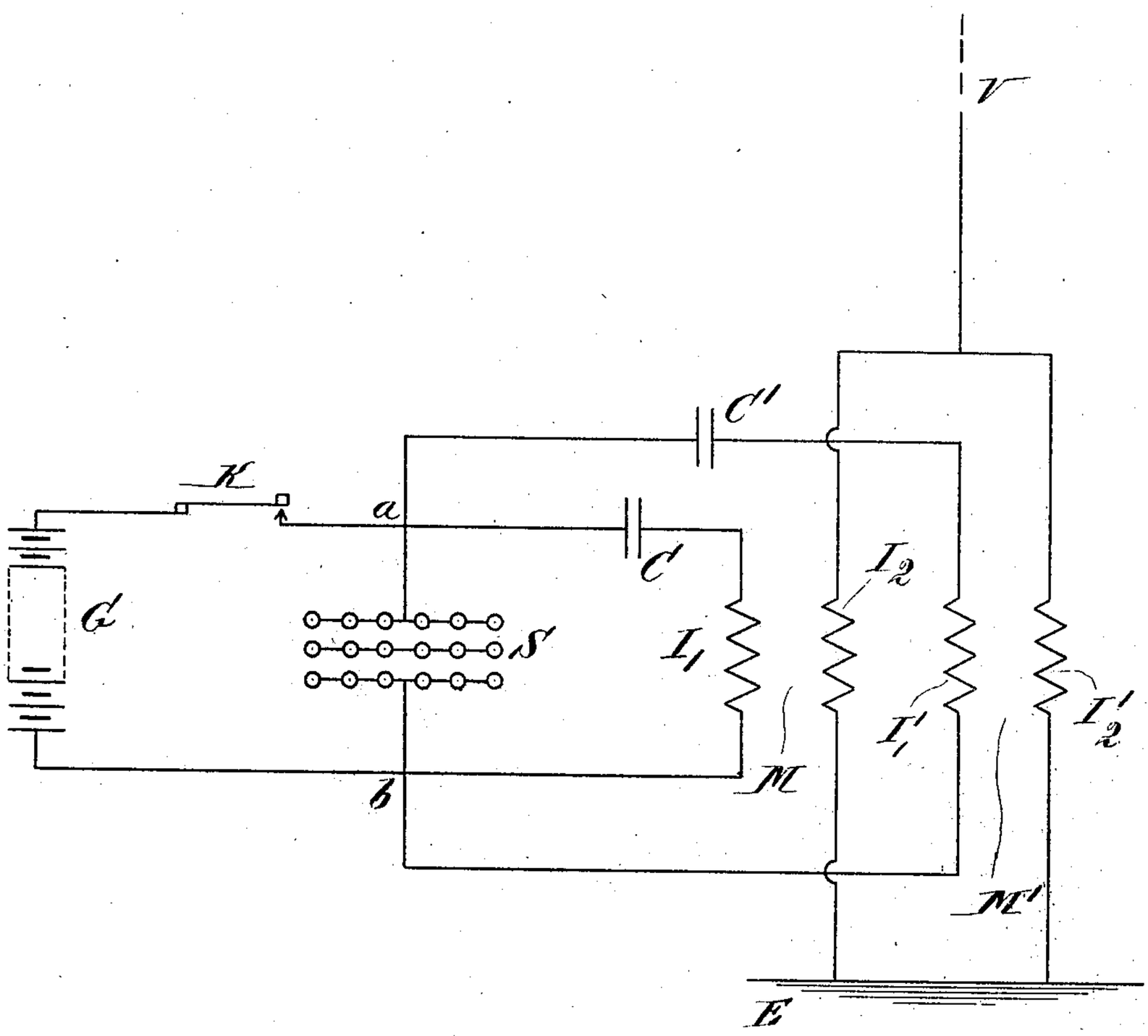
946,167. Patented Jan. 11, 1910.



WITNESSES=

E. B. Tomlinson.

G. A. Higgins.

INVENTOR=

John S. Stone & Stone

by Browne & Woodworth

attys.

UNITED STATES PATENT OFFICE.

JOHN STONE STONE, OF BOSTON, MASSACHUSETTS.

SPACE TELEGRAPHY.

946,167. Specification of Letters Patent. Patented Jan. 11, 1910.

Application filed February 7, 1907. Serial No. 356,144.

To all whom it may concern:

Be it known that I, JOHN STONE STONE, a citizen of the United States, and a resident of Boston, in the county of Suffolk and State of Massachusetts, have invented a new and useful Improvement in Space Telegraphy, of which the following is a specification.

My invention relates to the art of transmitting intelligence by means of electromagnetic waves without the use of wires to guide the waves to their destination, and it relates more particularly to systems for developing such waves.

The object of my invention is to provide a space telegraph transmitting system whereby a practically continuous or undamped train of electromagnetic waves of high frequency and large energy may be efficiently radiated from an elevated conductor.

In United States Letters Patent No. 638,152, dated November 28, 1899, I have disclosed a system for developing a continuous or undamped train of electrical oscillations of frequencies higher than the limit of audibility for the transmission of speech over wires, and the adaptation to telegraphy without connecting wires of the general principle set forth in said Letters Patent has been described in my U. S. Letters Patent No. 767,983, dated August 16, 1904. Reference may therefore be had to the aforesaid Letters Patent for a more complete description of a continuously-oscillating circuit and a more extended discussion of the principles involved than is necessary to set forth in the present specification. The system disclosed in my Letters Patent No. 767,983 is, however, limited either in power or frequency, or in the control exercised by the oscillating circuit upon the spark gap.

In my United States Letters Patent No. 802,427, dated Oct. 24, 1905, I have shown how to increase the power of a high-frequency transmitting system without decreasing the persistency of said system by employing a plurality of persistent high-frequency oscillating circuits connected in parallel to a common spark-gap; and I have discovered that such parallel arrangement of high frequency oscillators connected to a common spark-gap not only increases the power of the system without decreasing the persistency of said system, but increases both the control exercised by continuously oscillating circuits upon said spark-gap and also increases the frequency of the oscillations that may be developed with a given amount of power. Accordingly, by means of the system of circuits which constitutes the subject matter of the present invention, I am enabled not only to increase the frequency of the continuous or practically continuous oscillations developable with a given amount of energy in a circuit of the type described in my Letters Patent No. 767,983, but also to increase the control exercised by said circuit upon the spark gap.

It will be obvious that when a plurality of identical circuits of the type shown in my Letters Patent No. 767,983 are connected across a common gap and excited by a given source of energy, a much larger amount of current will pass across the gap than in the case of a single one of said circuits connected with said source; but if each one of said identical circuits be so designed that the resultant capacity of the system and the total inductance of the system are equal respectively to the capacity and inductance of another circuit of the same type, then the energy of said system will be found, other things being equal, to be greater than that of the said single circuit. Specifically, if two circuits having capacity $c'=c''$ and inductance $l'=l''$ are connected across the common gap and $c'=c''=c/2$ and $l'=l''=2\ l$, where c and l represent the capacity and inductance of another circuit having same natural period as each of the two circuits which are connected with the common gap, then the energy of the high frequency oscillations in the system consisting of the two circuits will be greater than that of the oscillations created in the said single circuit. Furthermore the oscillations developed in the single circuit of the type shown in my Letters Patent No. 767,983 are only practically continuous and not absolutely continuous, being produced in groups each consisting of a large number of oscillations of substantially constant amplitude; but I have found that by the parallel arrangement of such circuits described herein, the continuity of the oscillations is increased, *i. e.*, the number of oscillations in each group is increased and the intervals between the successive groups is decreased, and this result is the more pronounced as the number of circuits employed is increased. Thus it will be seen that the arrangements of circuits

herein described not only results in an increase of power out of proportion to the number of circuits employed, but also results in an increase of persistency and continuity.

In a circuit of the type shown in my Letters Patent No. 767,983, the frequency of the oscillations developed does not depend entirely upon the electromagnetic constants of the circuit as in the case where the circuit is energized by alternating current, in which case the frequency is equal approximately to

$$\eta = \frac{1}{2\pi\sqrt{CL}},$$

but does depend among other things upon the current or energy taken from the supply circuit. As this current is increased, other things remaining unchanged, the frequency increases. By means of the parallel arrangement of circuits herein described, I am enabled without increasing the power supplied to the system or increasing the current taken from the supply circuit, to increase the frequency of the oscillations developed in a given system.

In a circuit of the type described in my Letters Patent No. 802,427, commonly known as a sonorous circuit when energized by alternating current, the condenser always charges and discharges across the gap one or more times during each half cycle of the current in the power circuit, thereby creating oscillations in the sonorous circuit, and the problem of increasing the "control exercised by the circuit on the gap" obviously does not arise. However in a circuit of the type shown in my Letters Patent No. 767,983, oscillations will take place only between certain definite maximum and minimum values of direct current in the arc. I have discovered that by connecting two or more such circuits in parallel with a common gap, the separation of said limiting maximum and minimum values of current is greatly increased. This means that in a given system of circuits connected in parallel with a given gap, oscillations will be developed when the current in the arc is much less, and when it is much greater, than that in the arc of a single one of said circuits; and accordingly the oscillations in said system for a given amount of energy supplied will have a much wider range of frequency than those in said single circuit. Increasing the control exercised by the circuit upon the gap, as used herein, means increasing the range of the maximum and minimum values of direct current in the arc within which oscillations will be developed.

My invention may best be understood by having reference to the drawing which accompanies and forms a part of this specification and which represents in diagram one arrangement of apparatus and circuits whereby the foregoing objects may be realized in practice.

In the drawing, the figure represents a space telegraph transmitting system.

In the figure V is an elevated conductor terminating in two parallel branches which are earthed at E.

S is a spark gap, herein shown as a multiple-series gap.

C C′ are condensers.

M M′ are transformers. I_1 I_1' are primaries and I_2 I_2' are the secondaries of said transformers respectively.

G is a source of unidirectional electromotive force.

K is a transmitting device herein shown as a key.

The circuit *a* G *b* is a circuit of large resistance or impedance and high electromotive force. The circuits S C I_1 and S C′ I_1' are sonorous or oscillating circuits of large persistency and are both constructed so as to have identical time periods and, preferably, equal persistence functions. It will be understood of course that I do not limit myself to two oscillating circuits, but that any number of such circuits may be connected in parallel with respect to a common spark gap and that, if more than two circuits be employed, all will be designed to have identical time periods and, preferably, equal persistence functions.

The windings of the transformers M M′ preferably are so arranged that the mutual energy of each circuit with respect to the other circuits of the system is small compared to the self-energy of said circuit, and this may be accomplished either by so spatially adjusting the two windings of each transformer as to produce a transformer of large magnetic leakage or else by employing an auxiliary loading coil for swamping the effect of the mutual inductance between a primary and its corresponding secondary circuit, as more fully set forth in my Letters Patent No. 802,427, these two arrangements being equivalents.

While the spark gap S is shown in the drawings as a multiple series spark gap, it will be understood that a spark gap of any other suitable type may be employed and that such multiple-series gap is the equivalent in many respects of an artificially chilled single gap.

It will be understood of course that an electric arc may be considered as made up of a large number of sparks, and that in the operation of the apparatus herein described, the passage of the current across the gap S creates what is commonly known as an "arc."

I claim:

1. In a space telegraph system, a plurality of oscillating circuits, each including a condenser and an inductance coil and all connected in parallel with respect to a common

spark gap, an elevated transmitting conductor including a plurality of parallel branches, each branch being associated with a different one of said oscillating circuits, and a circuit of large resistance and high unidirectional electromotive force connected to the terminals of said spark gap.

2. In a space telegraph system, a plurality of oscillating circuits, each including a condenser and an inductance coil and all connected in parallel with respect to a common multiple-series spark gap, an elevated transmitting conductor including a plurality of parallel branches, each branch being associated with a different one of said oscillating circuits, and a circuit of large resistance and high unidirectional electromotive force connected to the terminals of said gap.

3. In a space telegraph system, a plurality of oscillating circuits, each including a condenser and an inductance coil and all connected in parallel with respect to a common spark-gap, an elevated transmitting conductor associated with all of said oscillating circuits, and a source of unidirectional electromotive force connected to the terminals of said spark-gap.

4. In an electromagnetic wave transmitting system, a plurality of oscillating circuits, each including a condenser and an inductance coil and all connected in parallel with respect to a common gap, an elevated transmitting conductor associated with all of said circuits, a source of unidirectional electromotive force connected to the terminals of said gap and a transmitting device operatively associated with said system.

In testimony whereof, I have hereunto subscribed my name this fifth day of Feb., 1907.

JOHN STONE STONE.

Witnesses:

GEORGE LEMIST CLARKE,

GEO. K. WOODWORTH.