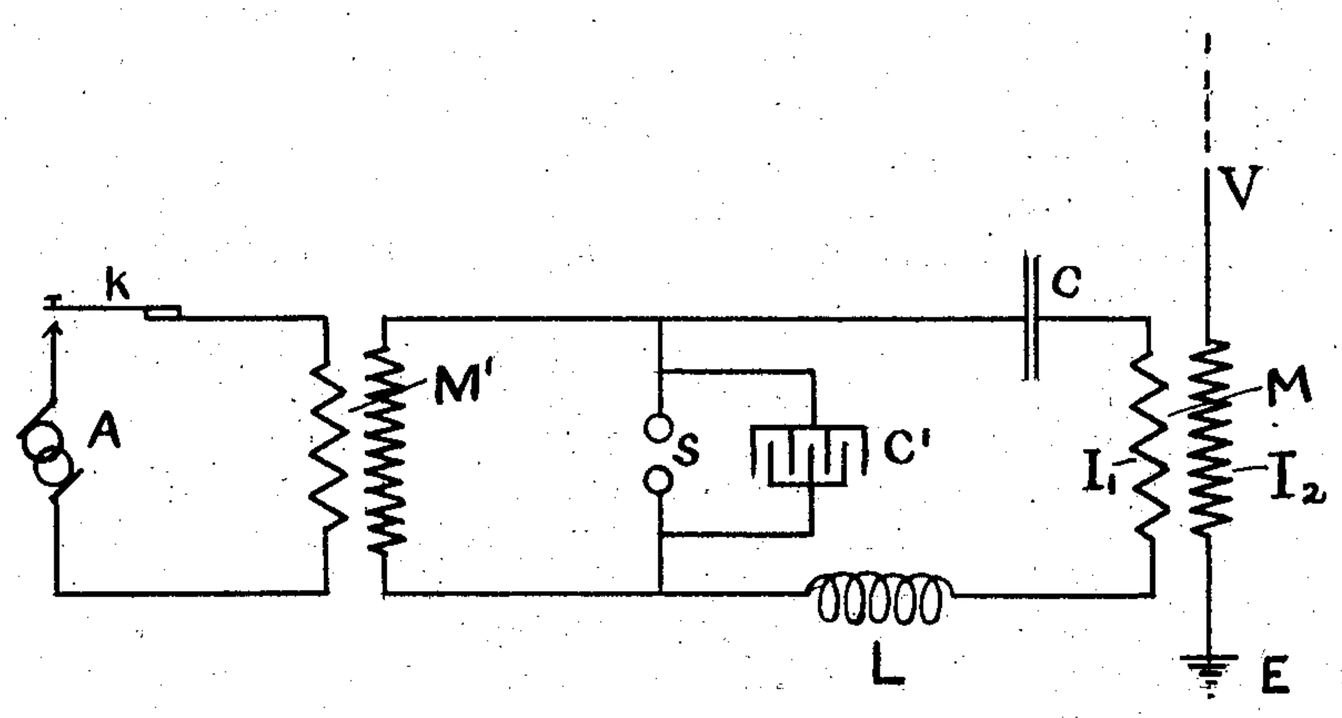
No. 767,975. PATENTED AUG. 16, 1904.

J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED NOV. 24, 1903.

NO MODEL.



WITNESSES

G. Adelaide Higgins.

Ellen B. Tomlinson

INVENTOR

John Stone Stone.

No. 767,975. Patented August 16, 1904.

UNITED STATES PATENT OFFICE.

JOHN STONE STONE, OF CAMBRIDGE, MASSACHUSETTS, ASSIGNOR TO WILLIAM W. SWAN, TRUSTEE, OF BROOKLINE, MASSACHUSETTS.

SPACE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 767,975, dated August 16, 1904.

Application filed November 24, 1903. Serial No. 182,544. (No model.)

To all whom it may concern:

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

My invention relates to the art of transmitting intelligence from one station to another by means of electromagnetic waves without the use of wires to guide the waves to their destination; and it relates more particularly to the system of such transmission in which the electromagnetic waves are developed by producing electric vibrations in an elevated conductor, preferably vertically elevated.

In my Letters Patent Nos. 714,756 and 714,831, granted December 2, 1902, I have described a system of selective space telegraphy in which a sonorous or persistently-oscillating circuit is associated with an elevated transmitting-conductor for developing in said conductor forced simple harmonic electrical oscillations. The forced simple harmonic electrical oscillations thus developed in the elevated conductor cause the radiation of simple harmonic electromagnetic waves, which, to distinguish them from waves guided to their destination by wires, I have termed "free or unguided electromagnetic waves," although the earth, water, or other natural media over which they pass exerts a guiding influence upon them. In said Letters Patent I have also described a receiving system consisting of a resonant circuit attuned to the frequency of the transmitted waves and associated with an elevated receiving-conductor. I have further described means whereby the system consisting of a complex of circuits is reduced to the equivalent of a system the circuits of which are the equivalent of circuits having a single degree of freedom, said means broadly consisting of an auxiliary inductance for swamping the effect of the mutual inductance between the sonorous circuit and the elevated transmitting-conductor or between the resonant circuit and the elevated receiving-conductor, said inductance being supplied by auxiliary coils or by the windings of the coil which associates the sonorous circuit with the elevated conductor.

In the drawing which accompanies and forms a part hereof the figure represents in diagram a transmitting system embodying my invention.

In the figure, V is an elevated conductor connected to earth at E. V I_2 E is an elevated conductor system. M M′ are transformers. I_1 I_2 are respectively the primary and secondary windings of the transformer M. C C′ are condensers. L is an inductance. S is a spark-gap. A is an alternating-current generator or other source of periodically-varying electromotive force. *k* is a key.

For the construction of parts and the operation thereof reference may be had to my hereinbefore-mentioned Letters Patent.

It has long been known that in spark-producing devices—such as static machines, Ruhmkorff coils, &c.—the spark is made larger or "fatter"—*i. e.*, that it has more energy—if a condenser be connected across the terminals of a spark-gap. Such use of a condenser in wireless-telegraph transmitting apparatus has been described by Dr. Martin Tietz in the *Elektrotechnische Zeitschrift*, Vol. 19, No. 33, August 18, 1898, page 562, and a condenser for this purpose has been shown in Patents Nos. 706,735 and 706,736, dated August 12, 1902, and in Patent No. 711,130, dated October 14, 1902.

I have found it advantageous to connect across terminals of the spark-gap S of the sonorous circuit S C I_1 L a large condenser C′ for the purpose of increasing the size of the spark and for increasing the energy of the disruptive discharge of the condenser C across this gap and also to form a path of low impedance to the electrical oscillations resulting from said disruptive discharge of the condenser C. As I have explained in my Letters Patent hereinbefore referred to, the condenser C in the oscillator-circuit S C I_1 L should be devoid of dielectric hysteresis if the oscillations developed in said circuit are to be accurately simple harmonic oscillations, and for this purpose the condenser C may

advantageously be supplied with a dielectric of air. However, the condenser C′ being of great capacity compared to the condenser C cannot materially influence the form of the oscillations developed in said circuit, and therefore the dielectric of said condenser C′ may be of any substance of high specific inductive capacity and great dielectric strength. This condenser has a capacity great as compared to the capacity of the condenser C, and as the capacity of the condenser C depends upon the energy desired to be radiated and upon the distance to be traversed I cannot lay down any specific rule as to the actual value of the capacity of condenser C′. The size and length of the conductors connecting the condenser C′ with the spark-gap are quite immaterial, and they may have either an appreciable inductance or a negligible inductance without affecting the simple harmonic form of the oscillations developed in the circuit S C L_1 L. However, it is preferred that the resistance and inductance of these leads be made negligibly small in order to reduce to a minimum the impedance of the shunt around the spark-gap. It will be obvious that the condenser C′ is practically short-circuited by the discharge of condenser C across the spark-gap S, so that condenser C′ and the circuit in which it is placed are practically cut out of action after its first discharge so long as the spark lasts. No harmonics whatever, therefore, can be detected when said condenser C′ is employed, the form of the radiated wave remaining practically simple harmonic.

Wherever throughout this specification and its claims I have used the words "simple harmonic waves" I desire to be understood as meaning waves which are as close an approximation as possible to the perfect simple harmonic form; but I herein point out that the discussion of the departure of the waves from such perfect simple harmonic form found in lines 19 to 68 on page 10 of my Letters Patent No. 714,831 is applicable to this case and is hereby made a part hereof, with reference to which my claims are to be construed.

In my Letters Patent No. 714,156 and No. 714,831 I have described and claimed, broadly, a method and apparatus for developing simple harmonic electromagnetic signal-waves of a predetermined frequency by producing forced simple harmonic vibrations in an elevated conductor. Certain elevated-conductor systems have a pronounced fundamental rate of vibration, and, as has long been known, if a simple harmonic force be impressed upon such system the resulting forced vibrations will be most energetic when the period of the force is the same as the period of this fundamental. Under these circumstances its radiation is also more energetic.

In my prior patents I have shown how a simple harmonic force may be impressed upon an elevated-conductor system without modifying the fundamental of the said elevated-conductor system, so that the resulting forced vibrations therein if of the same period as the fundamental as the elevated-conductor system may have a maximum of amplitude.

A sharp line of demarcation is to be drawn between the system herein described and such systems as that described, for example, in British Patent No. 7,777, series of 1900. In the system herein described the frequency of the radiated waves is determined solely by the capacity and inductance of the sonorous circuit, which, determining the frequency of the electrical oscillations developed in said circuit and by it forced in the elevated conductor, necessarily determine the frequency of the waves radiated by said elevated conductor, the length or other geometric constants of said elevated conductor or its fundamental or its natural periods having no effect in determining the frequency of the radiated waves. In the system described in said British patent and elsewhere, as, for example, in the *Journal of the Society of Arts*, Vol. LI, page 722, in connection with Fig. 14, the frequency of the radiated electromagnetic waves is determined not solely by the capacity and inductance of the sonorous circuit associated with the elevated conductor independently of the capacity and inductance of the latter, but by the capacity and inductance of the elevated conductor taken in conjunction with the capacity and inductance of the associated sonorous circuit and the mutual inductance and capacity of the two circuits. In these systems, which are systems of at least two degrees of freedom, as explained in my prior Letters Patent, any change in the length or other geometric constants of the elevated conductor whereby the capacity and inductance of said conductor is altered will produce a change in the frequency of the radiated waves, and therefore it cannot be said that electrical oscillations in the elevated conductor are forced oscillations of a frequency determined by the electromagnetic constants of the sonorous circuit and irrespective of the constants of the elevated conductor. On the contrary, the system described herein is the equivalent of a system of a single degree of freedom and radiates simple harmonic or substantially simple harmonic electromagnetic waves of a predetermined definite frequency, which frequency is determined entirely by the capacity and inductance of the sonorous circuit and is therefore practically independent of the electromagnetic constants of the elevated conductor. Whereas the system described in said British Patents depends for its operativeness upon the correspondence between the fundamental of the elevated conductor with the period of the associated sonorous circuit, the system herein described is merely made more efficient by producing forced vibrations in the elevated con-

ductor of the period of the fundamental of said elevated conductor. The effect may be roughly compared to a stretched cord in a viscous medium vibrated by means of a tuning-fork. Forced vibrations are thereby developed in the stretched cord which are of frequency corresponding with that of the tuning-fork irrespective of the fundamental or natural periods of the cord; but if the fundamental of the cord (which corresponds in this analogy to the elevated-conductor system described herein) corresponds with the period of the tuning-fork (which corresponds in this analogy to the sonorous circuit associated with the elevated conductor) it will be found that the amplitude of the vibrations executed by the cord are greater, other things being equal, than they would be without such correspondence in period.

I claim—

1. In a system for developing free or unguided simple harmonic electromagnetic signal-waves of a definite frequency, an elevated-conductor system the fundamental of which has a period equal to the period of the waves to be transmitted, and means for developing therein forced simple harmonic electric vibrations of corresponding frequency.

2. In a system of space telegraphy, an elevated conductor, a sonorous circuit, associated therewith and containing a condenser, and a condenser of capacity large as compared with the capacity of the condenser in said sonorous circuit, connected across the terminals of a spark-gap in said sonorous circuit.

3. In a system of space telegraphy, a sonorous circuit adapted to develop electric vibrations of a definite frequency, and elevated-conductor system associated therewith, the fundamental period of which is the same as the period of said sonorous circuit, and means for swamping the effect of the mutual inductance between said sonorous circuit and the elevated-conductor system.

4. In a system of space telegraphy, an elevated conductor, a sonorous circuit associated therewith and a condenser connected across the terminals of a spark-gap in said sonorous circuit.

5. In a system for developing free or unguided simple harmonic electromagnetic signal-waves of a definite frequency, an elevated-conductor system and a sonorous circuit associated therewith and adapted to develop simple harmonic electric vibrations corresponding in period with the fundamental period of said elevated-conductor system.

6. In a system of space telegraphy, a transmitting system comprising a persistently-oscillating circuit, a good radiating-circuit, the fundamental period of which is equal to the period of said persistently-oscillating circuit, and means whereby said transmitting system is reduced to the equivalent of a system of a single degree of freedom.

7. In a system of space telegraphy, a transmitting system comprising a persistently-oscillating circuit, a good radiating-circuit, attuned as to its fundamental to the period of said persistently-oscillating circuit, and an auxiliary inductance for swamping the effect of the mutual inductance between said circuits.

8. As a means for developing electrical oscillations, a sonorous circuit containing a spark-gap and a condenser of large capacity connected across the terminals of said spark-gap by conductors of low impedance.

9. In a system of space telegraphy, an elevated conductor, a sonorous circuit, containing a spark-gap, associated therewith and a condenser connected across the terminals of said spark-gap by conductors of low impedance.

10. In a system of space telegraphy, an elevated conductor, a sonorous circuit, containing a spark-gap, associated therewith and a circuit consisting of large capacity and low resistance for affording a path of low impedance to the electrical oscillations developed in said sonorous circuit, connected across the terminals of said spark-gap.

11. In a system of space telegraphy, a transmitting system comprising a persistently-oscillating circuit containing the primary of a step-up transformer, a good radiating-circuit containing the secondary of said transformer, the fundamental period of said radiating-circuit being equal to the period of the persistently-oscillating circuit, and means whereby said transmitting system is reduced to the equivalent of a system each of whose circuits has a single degree of freedom.

12. In a system of space telegraphy, a sonorous circuit adapted to develop electrical vibrations of a definite frequency, an elevated-conductor system associated therewith by means of a step-up transformer, the fundamental of the elevated-conductor system being equal to the period of the persistently-oscillating circuit, and means for swamping the effect of the mutual inductance between said sonorous circuit and said elevated-conductor system.

13. In a system for developing free or unguided, simple harmonic, electromagnetic signal-waves of definite frequency, an elevated-conductor system the fundamental of which has a period equal to the period of the waves to be transmitted, means for developing simple harmonic electrical oscillations of corresponding frequency and means for impressing said electrical oscillations on said elevated-conductor system at increased potential.

14. In a system of space telegraphy, an elevated conductor, the fundamental of which has a period equal to the period of the waves to be transmitted, a sonorous circuit associated with said elevated conductor and adapted to develop electrical oscillations of corre-

sponding period and a condenser or other capacity connected across the terminals of the spark-gap of said sonorous circuit.

15. In a system of space telegraphy, a persistently-oscillating circuit, and a good radiating-circuit, attuned as to its fundamental to the period of said persistently-oscillating circuit, in combination with means for increasing the amplitude of the electrical oscillations developed in said persistently-oscillating circuit.

16. In a system of space telegraphy, a persistently-oscillating circuit containing a spark-gap, a good radiating-circuit, attuned as to its fundamental to the period of said persistently-oscillating circuit, and a condenser connected across the terminals of said spark-gap.

17. In a system of space telegraphy, a sonorous circuit, a good radiating-circuit, attuned as to its fundamental to the period of said sonorous circuit, and means for impressing the oscillations created in said sonorous circuit upon said good radiating-circuit at increased potential, in combination with means for increasing the persistency of the oscillations developed in said sonorous circuit.

In testimony whereof I have hereunto subscribed my name this 23d day of November, 1903.

JOHN STONE STONE.

Witnesses:
G. ADELAIDE HIGGINS,
ELLEN B. TOMLINSON.