No. 767,988. PATENTED AUG. 16, 1904.

J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED DEC. 8, 1903.

NO MODEL.

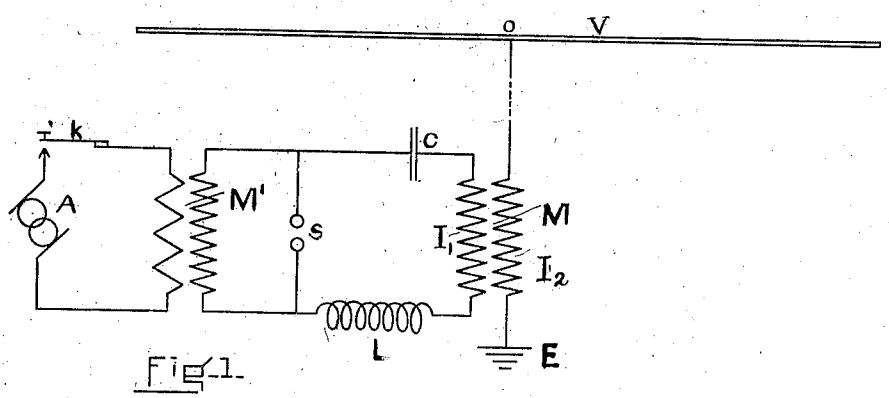

Fig. 1.

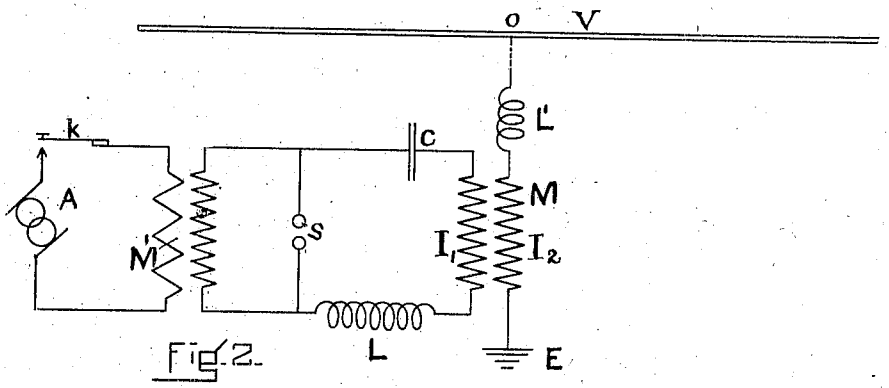

Fig. 2.

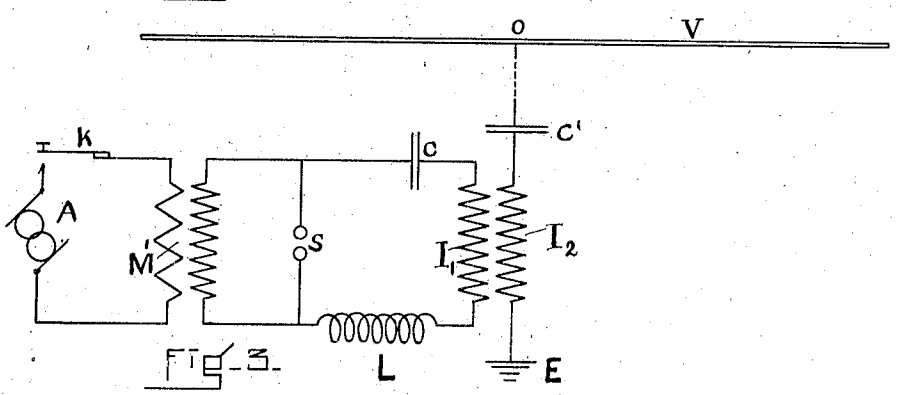

Fig. 3.

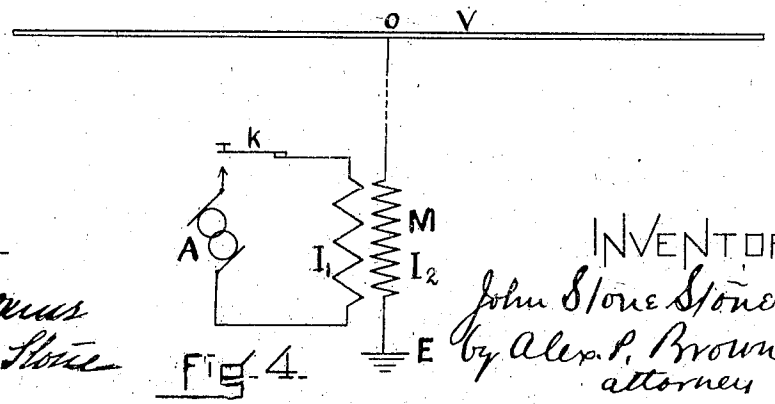

Fig. 4.

WITNESSES.

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by Alex. P. Browne

attorney

No. 767,988. 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. 767,988, dated August 16, 1904.

Original application filed November 25, 1903, Serial No. 182,634. Divided and this application filed December 8, 1903. Serial No. 184,283. (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 No. 714,756, dated December, 1902, I have described such system of space telegraphy in which forced simple harmonic electric vibrations are developed in an elevated conductor by means of a sonorous or persistently-oscillating circuit associated therewith. In this system and in other systems of space telegraphy in operation to-day it has been found necessary to employ elevated transmitting-conductors of considerable height in order to transmit appreciable amounts of energy by electromagnetic waves over commercial distances.

This invention consists of an apparatus for transmitting large amounts of energy by electromagnetic waves without the use of the high vertical conductor heretofore employed.

The invention may be best understood by having reference to the drawings which accompany and form a part of this specification.

In the drawing the figure represents various embodiments of my invention whereby the employment of a high vertical conductor is rendered unnecessary.

In the figure, A is an alternating-current generator. *k* is a key. M M′ are transformers. I_1 I_2 are the primary and secondary windings of transformer M. L L′ are inductances. C C′ are condensers. *s* is a spark-gap. V is an elevated conductor consisting of a metal plate, preferably circular in form and parallel to earth and whose diameter, and consequently whose periphery, is preferably great compared to its distance from the ground. However, a metallic plate of other shape or any other suitable laterally-extending member may be employed, and preferably its distance from the ground should be small compared to its smallest dimension.

The natural period of the sonorous circuit *s* C I_1 L is made equal to the fundamental period of the elevated-conductor system, consisting of the metal plate V or other suitable laterally-extending member and its connection *o* I_2 E to earth or to some harmonic of such fundamental period, and for this purpose the electromagnetic constants of the sonorous circuit may be varied. An inductance L′ or a condenser C′ may be connected in the circuit *o* I_2 E for the purposes hereinafter set forth.

The function of the auxiliary inductance L is, as explained in my hereinbefore-mentioned Letters Patent, to swamp the effect of the mutual inductance between the sonorous circuit and the elevated-conductor system and to thereby reduce the complex of interrelated circuits to the equivalent of a system of circuits each having a single degree of freedom, so that simple harmonic electromagnetic waves of a frequency determined by the capacity and inductance of the sonorous circuit may be radiated.

The reactance at the driving-point *o* for slow frequencies is determined by the capacity of the plate V with respect to earth and varies as the area of the plate and inversely as its separation from earth. As the frequency is increased the reactance at the driving-point *o* is in the nature of a capacity reactance and diminishes as the frequency increases, finally becoming zero when the frequency is equal to the fundamental frequency *n* of the elevated conductor V. For any further increase in frequency from this point the reactance at the driving-point *o* becomes in the nature of an inductance reactance,

which increases as the frequency is further increased, the curve which shows the variation of reactance with frequency becoming asymptotic with the ordinate drawn in the positive direction from the point on the axis of abscissæ representing the first harmonic 2^n of the fundamental frequency n. As the frequency passes through the value 2^n the reactance at the driving-point o suddenly changes from an inductance reactance of infinite value to a capacity reactance of infinite value, the curve which shows the variation of reactance with frequency being asymptotic to the ordinate drawn in the negative direction from the point on the axis of abscissæ representing the first harmonic 2^n of the fundamental frequency n. When the frequency is equal to the first harmonic 2^n and the reactance at the driving-point o is infinite, the elevated-conductor system refuses to vibrate—*i. e.*, the elevated-conductor system is then equivalent in length to a half-wave length of the oscillations impressed upon it. As the frequency is further increased from the first harmonic the capacity reactance again wanes, becoming zero when the frequency is equal to the second harmonic 3^n of the fundamental frequency n, and so on. In other words, the curve showing the variation of reactance at the driving-point o with frequency is a discontinuous curve, which is zero when the frequency is equal to the fundamental frequency n, which passes from plus infinity to minus infinity as the frequency passes through the value 2^n, which is zero when the frequency is 3^n, which passes from plus infinity to minus infinity when the frequency passes through the value 4^n, which is zero when the frequency is 5^n, and so on, the positive values of said curve representing inductance reactances and the negative values thereof representing capacity reactances.

When the reactance at the driving-point o is a capacity reactance, an inductance of suitable value is inserted in the conductor $o\ I_2\ E$, connecting the center o of the plate V to earth, as shown at L', Fig. 2, in order to balance said reactance, so that the fundamental period of the elevated-conductor system will be equal to the frequency of the oscillations or vibrations developed by the sonorous circuit $s\ C\ I_1\ L$ or to some multiple or submultiple of such frequency.

When the reactance at driving-point o is an inductance reactance, a condenser of suitable value is inserted in the conductor $o\ I_2\ E$, as shown at C', Fig. 3, in order to balance said reactance so that the fundamental period of the elevated-conductor system will be equal to the frequency of the oscillations or vibrations developed by the sonorous circuit $s\ C\ I_1\ L$ or to some multiple or submultiple of such frequency.

In Fig. 4 an alternating-current generator of frequency high compared with the alternating-current generators of commerce is connected in series with the primary I_1 of the transformer M, whose secondary I_2 has large inductance to reduce the frequency of the fundamental of the elevated-conductor system to the frequency of the currents developed by the generator or to some harmonic of such frequency.

This application is a division of my application, Serial No. 182,634, filed November 25, 1903.

I claim—

1. In a system of space telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth, and means for developing electric vibrations therein.

2. In a system of spaee telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and means for developing forced electric vibrations therein.

3. In a system of space telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth, and means for developing forced, simple harmonic electric oscillations therein.

4. In a system of space telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth, and means for developing therein electric vibrations of a period equal to the fundamental period of said elevated-conductor system or to some harmonic of such fundamental period.

5. In a system of space telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and means, including an inductance-coil, connecting said plate to earth.

6. In a system of space telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and means, including an inductance-coil, connecting said plate to earth, in combination with means for developing electric vibrations in said elevated-conductor system.

7. In a system of space telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and means, including an inductance-coil, connecting said plate to earth, in combination with means for developing therein electric vibrations of a period equal to the fundamental period of said elevated-conductor system or to some harmonic of such fundamental period.

8. In a system of space telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and means connecting said plate to earth, in combination with a so-

norous circuit for developing electric vibrations in said elevated-conductor system.

9. In a system of space telegraphy, an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and means connecting said plate to earth, in combination with a sonorous circuit for developing therein electric vibrations of a period equal to the fundamental period of said elevated-conductor system or to some harmonic of such fundamental period.

10. In a system of space telegraphy, an elevated-conductor system comprising a laterally-extending conducting member and means connecting said member to earth, in combination with a sonorous circuit for developing electric vibrations in said elevated-conductor system.

11. In a system of space telegraphy, an elevated-conductor system comprising a laterally-extending conducting member and means connecting said member to earth, in combination with a sonorous circuit for developing therein electric vibrations of a period equal to the fundamental period of said elevated-conductor system or to some harmonic of such fundamental period.

12. In a system of space telegraphy, an elevated-conductor system comprising a laterally-extending conducting member and means, including an inductance-coil, connecting said member to earth, in combination with a sonorous circuit for developing electric vibrations in said elevated-conductor system.

13. In a system of space telegraphy, an elevated-conductor system comprising a laterally-extending conducting member and means, including an inductance-coil, connecting said member to earth, in combination with a sonorous circuit for developing therein electric vibrations of a period equal to the fundamental period of said elevated-conductor system or to some harmonic of such fundamental period.

14. In a system of space telegraphy, means for developing electric vibrations of definite frequency associated with an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and means for balancing the reactance of the elevated-conductor system for electric vibrations of said definite frequency.

15. In a system of space telegraphy, a sonorous circuit for developing electric vibrations of definite frequency associated with an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and means for balancing the reactance of the elevated-conductor system for electric vibrations of said definite frequency.

16. In a system of space telegraphy, means for developing electric vibrations of definite frequency associated with an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and an inductance-coil for balancing the reactance of the elevated-conductor system for electric vibrations of said definite frequency.

17. In a system of space telegraphy, a sonorous circuit for developing electric vibrations of definite frequency associated with an elevated-conductor system comprising a metallic plate of periphery large compared with its distance above the earth and an inductance-coil for balancing the reactance of the elevated-conductor system for electric vibrations of said definite frequency.

18. In a system of space telegraphy, means for developing electric vibrations of definite frequency associated with an elevated-conductor system comprising a laterally-extending conducting member and means for balancing the reactance of said elevated-conductor system for electric vibrations of said definite frequency.

19. In a system of space telegraphy, a sonorous circuit for developing electric vibrations of definite frequency associated with an elevated-conductor system comprising a laterally-extending conducting member and means for balancing the reactance of said elevated-conductor system for electric vibrations of said definite frequency.

20. In a system of space telegraphy, means for developing electric vibrations of definite frequency associated with an elevated-conductor system comprising a laterally-extending conducting member and an inductance-coil for balancing the reactance of said elevated-conductor system for electric vibrations of said definite frequency.

21. In a system of space telegraphy, a sonorous circuit for developing electric vibrations of definite frequency associated with an elevated-conductor system comprising a laterally-extending conducting member and an inductance-coil for balancing the reactance of said elevated-conductor system for electric vibrations of said definite frequency.

In testimony whereof I have hereunto subscribed my name this 7th day of December, 1903.

JOHN STONE STONE.

Witnesses:

ALEX. P. BROWNE,

BRAINERD T. JUDKINS.

Corrections in Letters Patent No. 767,988.

It is hereby certified that in Letters Patent No. 767,988, granted August 16, 1904, upon the application of John Stone Stone, of Cambridge, Massachusetts, for an improvement in "Space Telegraphy," errors appear in printed specification requiring correction, as follows: On page 1, line 38, the word "drawing" should read *drawings*, the word "figure" should read *figures*, and the word "represents" should read *represent*; on page 2, in lines 7, 8, 16, 18, and 35, the symbol "2^n" should read $2n$, in lines 27 and 36 the symbol "3^n" should read $3n$, in line 38 the symbol "4^n" should read $4n$, and in line 39 "5^n" should read $5n$; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 4th day of July, A. D. 1905.

[SEAL.]

F. I. ALLEN,

Commissioner of Patents.