No. 767,989. PATENTED AUG. 16, 1904.

J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED DEC. 19, 1903.

NO MODEL.

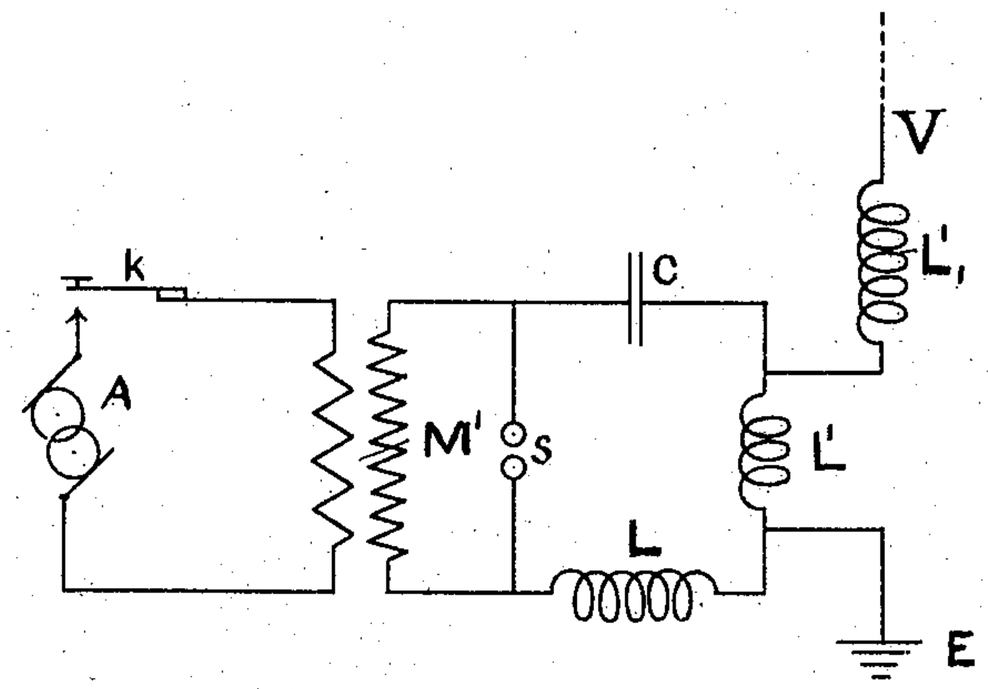

Fig. 1.

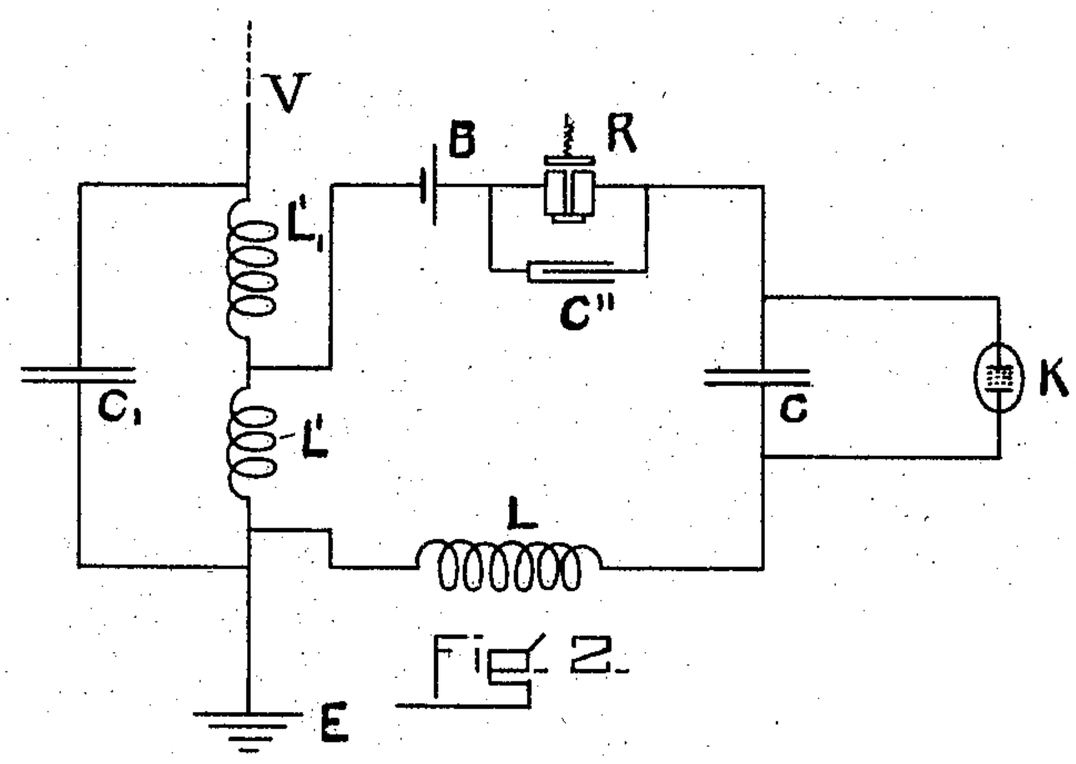

Fig. 2.

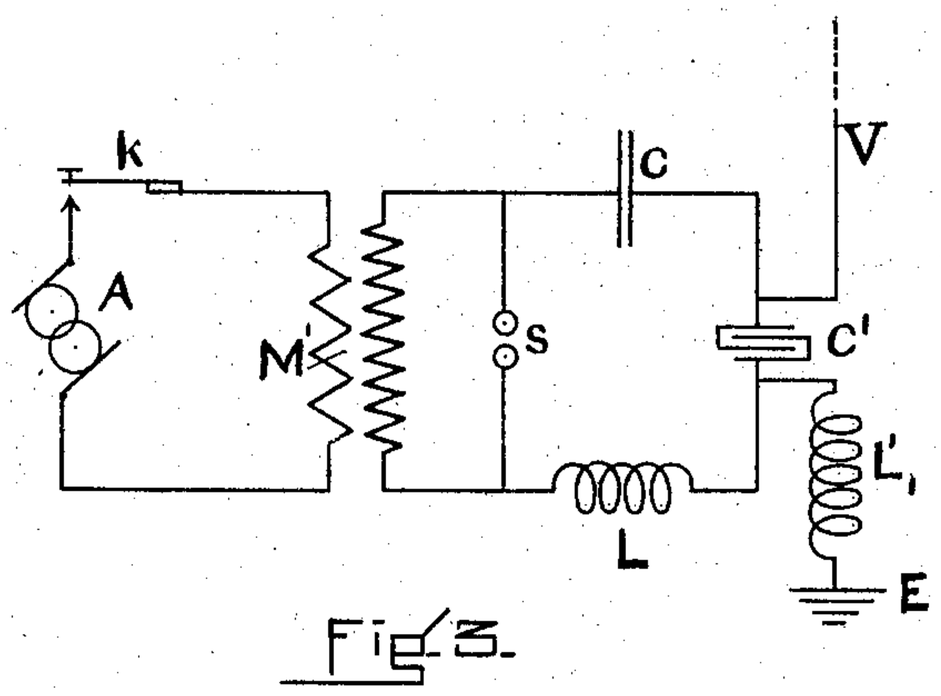

Fig. 3.

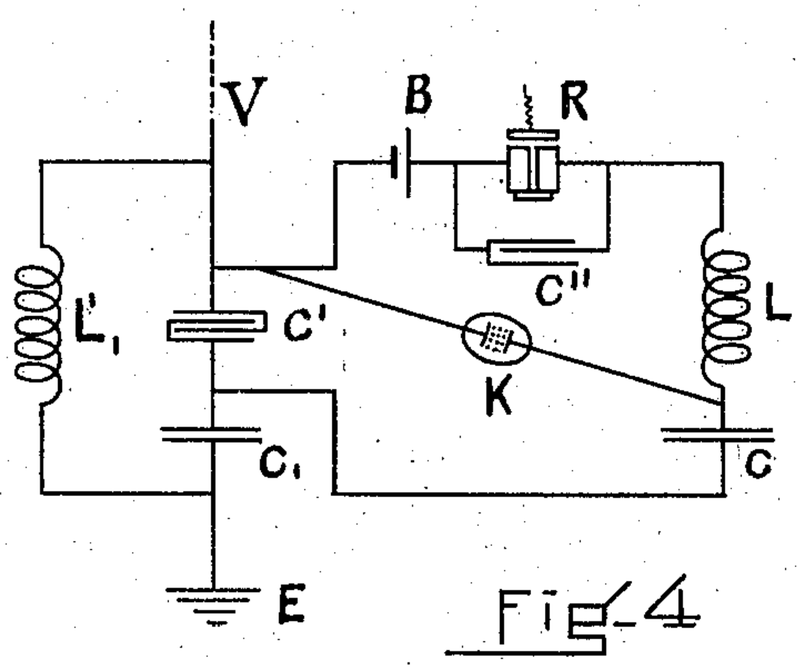

Fig. 4.

WITNESSES.

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No. 767,989. Patented August 16, 1904.

UNITED STATES PATENT OFFICE.

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SPACE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 767,989, dated August 16, 1904.

Original application filed November 25, 1903, Serial No. 182,632. Divided and this application filed December 19, 1903. Serial No. 185,872. (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 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, dated December 2, 1902, and in other Letters Patent I have described systems of space telegraphy in which electromagnetic waves substantially simple harmonic in form are transmitted by creating substantially simple harmonic vibrations or oscillations in a sonorous circuit or system of circuits and impressing such vibrations or oscillations upon an elevated conductor. In order that the electric vibrations so impressed upon the elevated conductor, and consequently the electromagnetic waves radiated therefrom, may be simple harmonic in form, I have employed means whereby the individual circuits of a complex of interrelated circuits are made capable of vibrating as circuits of a single degree of freedom. In my Letters Patent Nos. 714,756 and 714,831 and in my Reissued Letters Patent No. 12,149, reissued August 25, 1903, I have described and broadly claimed means whereby such complex of interrelated circuits may be reduced to the equivalent of a number of circuits having a single degree of freedom. I have also specifically claimed therein one of the means whereby this result may be accomplished. The means broadly described and claimed consist in providing each circuit with sufficient auxiliary inductance to render the mutual inductance between it and an associated circuit small compared to the square root of the product of the inductances of the circuits. The specific means therein claimed was an auxiliary inductance-coil in each circuit whereby the mutual inductance between said circuit and an associated circuit is rendered small compared to the square root of the product of the inductances of the two circuits. Another specific means whereby the same result is accomplished is fully set forth by me in my Letters Patent Nos. 714,832 and 714,833, dated December 2, 1902, wherein I have shown that the function of the auxiliary inductance-coil may be performed by the primary of the transformer connecting the sonorous circuit with the elevated conductor by so proportioning said primary that it shall supply the auxiliary inductance, which in the other specific form of my invention was supplied by means of the auxiliary inductance-coil. This is accomplished by so designing the transformer that the ratio $\frac{M^2_{12}}{L_1 L_2}$ is small compared to unity, which is the opposite course from that in general pursued in constructing a step-up transformer, and is only resorted to in the construction of the so-called "constant-current" transformers, and it may also be accomplished in a plurality of ways set forth in my Letters Patent Nos. 717,467 and 717,515 in the art of wire telegraphy.

In the present specification I confine myself and limit my claims to means for reducing a complex of conductively-connected circuits to the equivalent of a system of circuits each of a single degree of freedom. The circuits in this case at the transmitting-station are a sonorous circuit or closed oscillator, which is a persistently-oscillating and poor radiating circuit, and an elevated transmitting-conductor or linear oscillator, which is a poor oscillator and good radiating-circuit. At the receiving-station the circuits are an elevated receiving-conductor or linear oscillator, which is a poor oscillator and a good absorbing-circuit, and a closed resonant circuit, which is a persistently-oscillating circuit, and therefore

a poor absorbing-circuit, except of the energy of currents, to the frequency of which it is attuned. The particular means employed for reducing the aforesaid complex of conductively-connected circuits to the equivalent of a system of circuits each having a single degree of freedom is either an inductance-coil of inductance great compared with the inductance of the coil which connects the two circuits or a condenser of capacity small compared with the capacity of the condenser which connects the two circuits. In my Letters Patent Nos. 717,467 and 717,515 in the art of wire telegraphy I have described and claimed these specific means of reducing a complex of circuits to the equivalent of a system of circuits each of a single degree of freedom. The underlying principle for accomplishing this result is in all instances that the mutual energy of each circuit with all of the interrelated circuits of the system shall be small compared with the self-energy of said circuit.

The relation of the specific invention herein to be claimed to the broad principle hereinbefore stated may be best understood by having reference to the drawings, which accompany and form a part of the present specification.

In the drawings, Figures 1 and 3 represent in diagram apparatus and arrangements of circuits constituting transmitting systems. Figs. 2 and 4 represent in diagram apparatus and arrangements of circuits constituting receiving systems.

In the figures, V is an elevated conductor. M′ is a transformer. L L′ L'_1 represent inductances. C C′ C_1 C″ represent condensers. *s* is a spark-gap. A is an alternating-current generator or other source of periodically-varying electromotive force. B is a battery. R is a relay. K is a receiver, herein illustrated as a coherer. *k* is a key.

In Fig. 1 the elevated conductor is conductively associated with a sonorous circuit *s* C L′ L. In order to impress a simple harmonic electromotive force upon the elevated conductor V, electrical oscillations are produced in the sonorous circuit. These give rise to a corresponding difference of potential at the terminals of the inductance-coil L′ in the elevated-conductor system V L'_1 L′ E and corresponding forced simple harmonic electric vibrations result therein. The inductance of the coil L′ being small compared to that of the coil L the oscillations in the sonorous circuit are not materially affected by the association of this circuit with the elevated-conductor system.

In Fig. 2 the elevated conductor is conductively associated with a resonant circuit C L L′. When simple harmonic electric oscillations are set up in the elevated conductor, a corresponding difference of potential is set up at the terminals of the inductance-coil L′ and corresponding forced simple harmonic electric vibrations result in the resonant circuit. If the frequency of these vibrations is the same as that to which the resonant circuit is attuned, said resonant circuit responds energetically and has electrical oscillations of relatively great amplitude developed in it, whereas if the frequency of these vibrations be different from that to which the resonant circuit is attuned the resonant circuit responds but feebly and has electric vibrations of relatively small amplitude developed in it. The inductance of the coil L′ being small compared to that of the coil L, the oscillations in the resonant circuit are not materially affected by the association of this circuit with the elevated conductor.

In Fig. 3 the elevated conductor is again conductively connected to a sonorous circuit *s* C C′ L. In order to impress a simple harmonic electromotive force upon the elevated conductor V, electrical oscillations are produced in the sonorous circuit. These give rise to a corresponding difference of potential at the terminals of the condenser C′ in the elevated-conductor system V C′ L'_1 E, and corresponding forced simple harmonic electric oscillations result therein. The capacity of the condenser C′ being large compared to that of the condenser C, the oscillations in the sonorous circuit are not materially affected by the association of this circuit with the elevated-conductor system.

In Fig. 4 the elevated conductor is conductively associated with a resonant circuit C L C′. When simple harmonic electric oscillations are set up in the elevated conductor, a corresponding difference of potential is set up at the terminals of the condenser C′ and corresponding forced simple harmonic electrical vibrations result in the resonant circuit. If the frequency of these vibrations is the same as that to which the resonant circuit is attuned, said resonant circuit responds energetically and has electrical oscillations of relatively great amplitude developed in it, whereas if the frequency of these vibrations be different from that to which the resonant circuit is attuned the resonant circuit responds but feebly and has electric oscillations of relatively small amplitude developed in it. The capacity of the condenser C′ being great compared to that of the condenser C, the oscillations in the resonant circuit are not materially affected by the association of this circuit with the elevated conductor.

No mention has heretofore been made of the function of the condensers C″, as these condensers are not essential to the tuning of the circuits in which they are placed, but merely serve to shunt the relays R out of the resonant circuits. In order that these condensers may not appreciably affect the tuning of the circuits in which they are included, and thereby lower the resonant rise of potential

at the plates of the condenser C, they are so constructed as to have large capacities compared to the capacities of the condenser C.

No mention has heretofore been made of the function of the condensers C_1 and inductance-coils L'_1, as the functions of these elements have been fully described in my applications Serial No. 193,371 and Serial No. 193,372, filed February 13, 1904, and as they form no essential part of the present invention.

This application is a division of my application Serial No. 182,632, filed November 25, 1903.

I claim—

1. In a system of space telegraphy, a sonorous or persistently-oscillating circuit, a good radiating-circuit, means for conductively connecting said circuits, and means whereby the mutual energy of each circuit with its interrelated circuit is made small compared with the self-energy of each circuit.

2. In a system of space telegraphy, a resonant circuit, a good absorbing-circuit, means for conductively connecting said circuits and means whereby the mutual energy of each circuit with its interrelated circuit is made small compared to the self-energy of each circuit.

3. In a system of space telegraphy, a persistently-oscillating circuit, an elevated conductor, means for conductively connecting the persistently-oscillating circuit with the elevated conductor and means whereby the mutual energy of the persistently-oscillating circuit with the elevated conductor is made small compared to the self-energy of said persistently-oscillating circuit.

4. In a system of space telegraphy, a sonorous circuit, an elevated transmitting-conductor and an inductance-coil for conductively connecting the sonorous circuit with the elevated conductor, and means whereby the mutual energy of the sonorous circuit with the elevated conductor is made small compared to the self-energy of said sonorous circuit.

5. In a system of space telegraphy, a resonant circuit, an elevated receiving-conductor and an inductance-coil for conductively connecting the resonant circuit with the elevated conductor, and means whereby the mutual energy of the resonant circuit with the elevated conductor is made small compared to the self-energy of said resonant circuit.

6. In a system of space telegraphy, a persistently-oscillating circuit, an elevated conductor and an inductance-coil for conductively connecting the persistently-oscillating circuit with the elevated conductor, and means whereby the mutual energy of the persistently-oscillating circuit with the elevated conductor is made small compared to the self-energy of said persistently-oscillating circuit.

7. In a system of space telegraphy, a sonorous circuit containing a coil, an elevated transmitting-conductor connected to the terminals of said coil, and a second coil in said sonorous circuit of inductance great compared with the inductance of the first-mentioned coil whereby the mutual energy of the sonorous circuit with the elevated conductor is made small compared with the self-energy of said sonorous circuit.

8. In a system of space telegraphy, a resonant circuit containing a coil, an elevated receiving-conductor connected to the terminals of said coil, and a second coil in said resonant circuit of inductance great compared to the inductance of the first-mentioned coil whereby the mutual energy of the resonant circuit with the elevated conductor is made small compared to the self-energy of said resonant circuit.

9. In a system of space telegraphy, a persistently-oscillating circuit containing a coil, an elevated conductor conductively connected to the terminals of said coil, and a second coil in said persistently-oscillating circuit of inductance great compared to the inductance of the first-mentioned coil whereby the mutual energy of the persistently-oscillating circuit with the elevated conductor is made small compared to the self-energy of said persistently-oscillating circuit.

10. In a system of space telegraphy, a sonorous or persistently-oscillating circuit, a good radiating-circuit, means for conductively connecting said circuits and means whereby the mutual energy of each circuit with its interrelated circuit is made small compared with the self-energy of each circuit, in combination with a resonant circuit, a good absorbing-circuit, mean for conductively connecting said circuits and means whereby the mutual energy of each circuit with its interrelated circuit is made small compared with the self-energy of each circuit.

11. In a system of space telegraphy, a sonorous circuit, an elevated transmitting-conductor, an inductance-coil for conductively connecting said sonorous circuit with said elevated conductor, and means whereby the mutual energy of the sonorous circuit with the elevated conductor is made small compared to the self-energy of said sonorous circuit, in combination with an elevated receiving-conductor, a resonant circuit, an inductance-coil for conductively connecting said resonant circuit with said elevated conductor, and means whereby the mutual energy of the resonant circuit with the elevated conductor is made small compared to the self-energy of said resonant circuit.

In testimony whereof I have hereunto subscribed my name this 12th day of December, 1903.

JOHN STONE STONE.

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

Correction in Letters Patent No. 767,989.

It is hereby certified that in Letters Patent No. 767,989, granted August 16, 1904, upon the application of John Stone Stone, of Cambridge, Massachusetts, for an improvement in "Space Telegraphy," an error appears in the printed specification requiring correction, as follows: In line 102, page 3, the word "mean" should read *means;* and that 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.