No. 802,417. PATENTED OCT. 24, 1905.

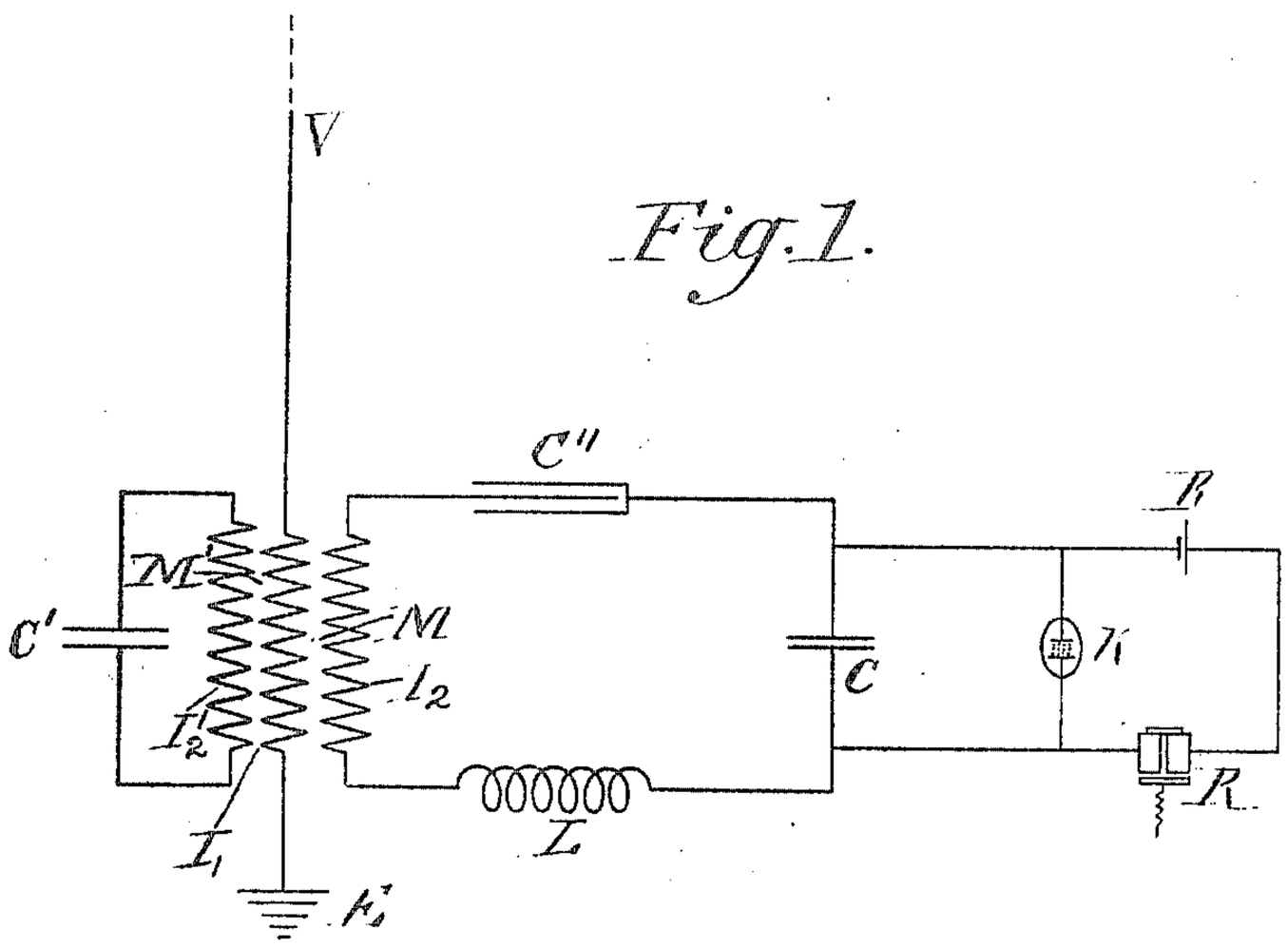
J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED FEB. 23, 1904.

2 SHEETS—SHEET 1.

Fig. 1.



WITNESSES.

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No. 802,417. PATENTED OCT. 24, 1905.

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SPACE TELEGRAPHY.

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2 SHEETS—SHEET 2.

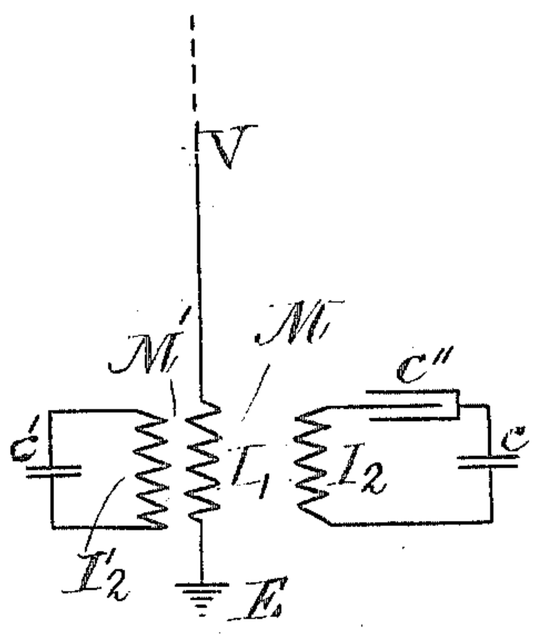

Fig. 2.

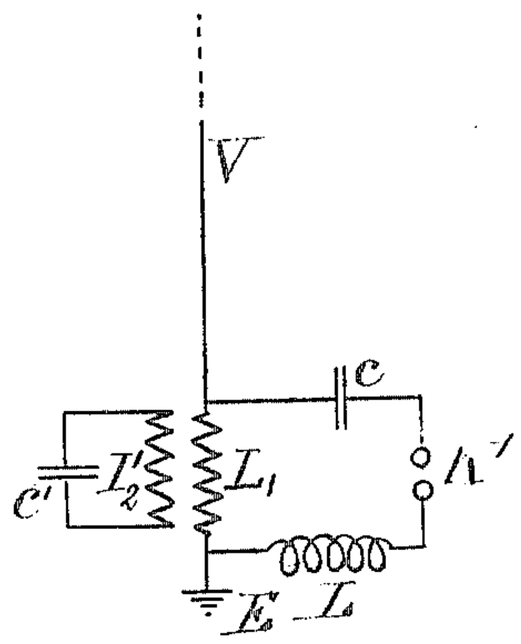

Fig. 3.

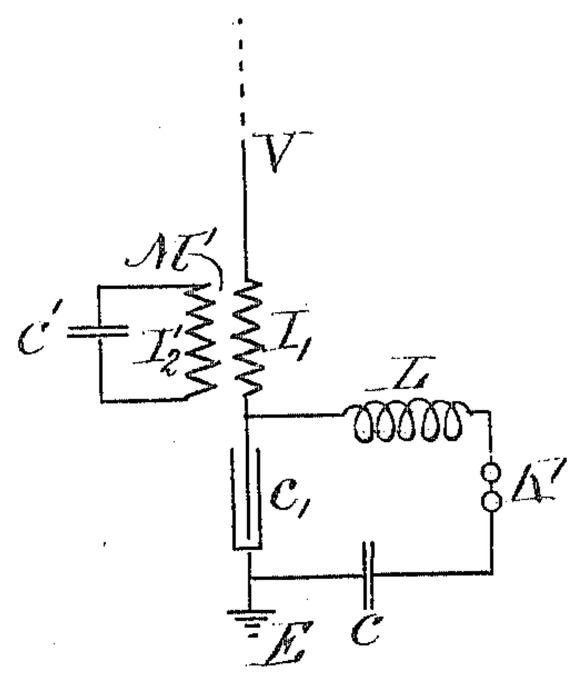

Fig. 4.

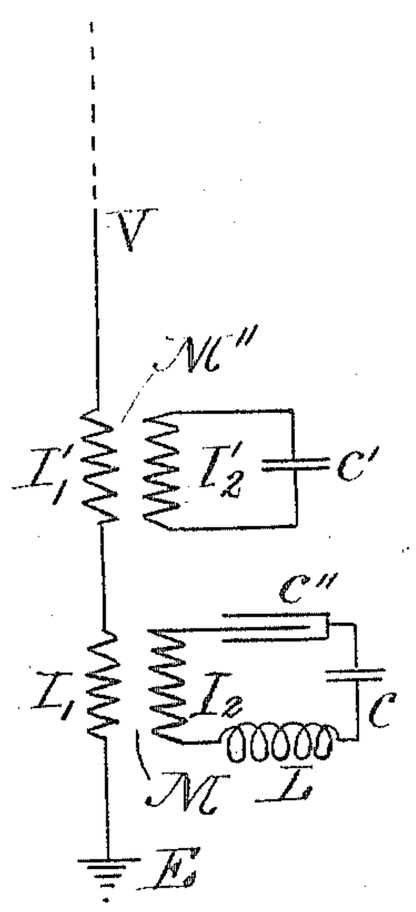

Fig. 5.

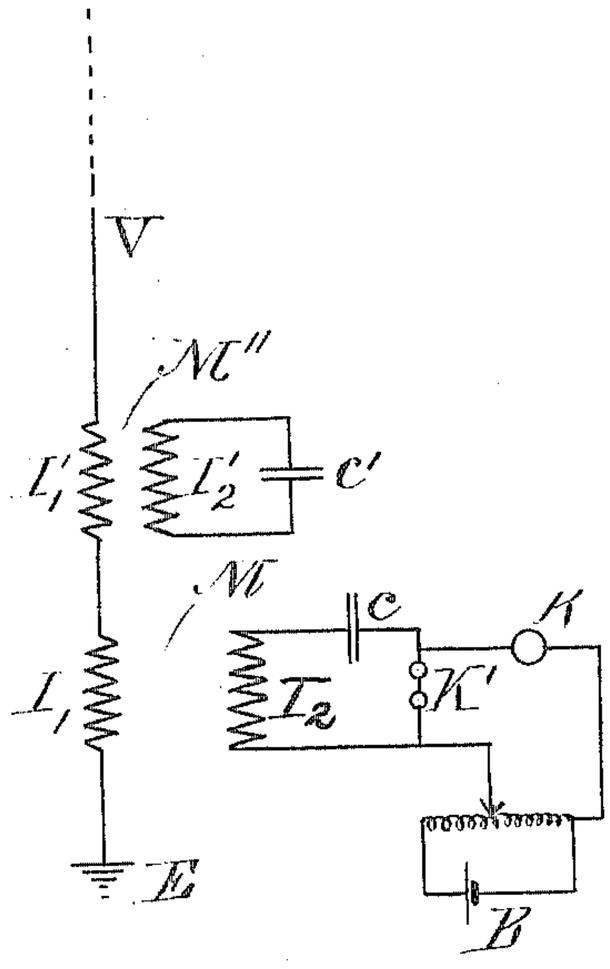

Fig. 6.

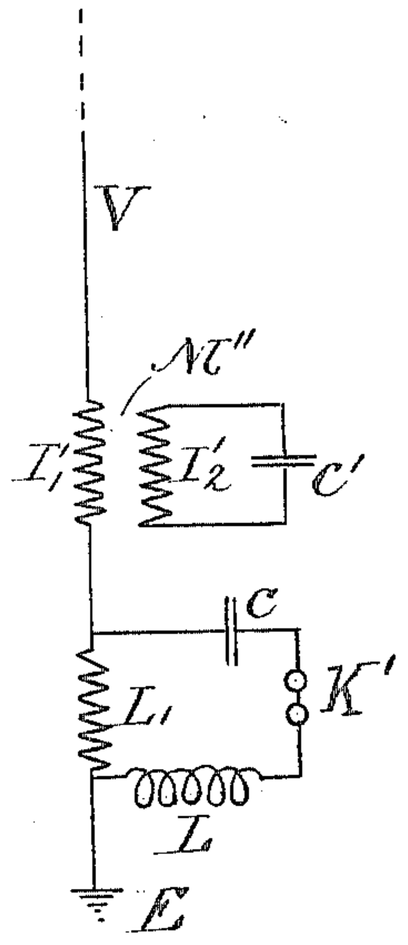

Fig. 7.

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UNITED STATES PATENT OFFICE.

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SPACE TELEGRAPHY.

No. 802,417. Specification of Letters Patent. Patented Oct. 24, 1905.

Application filed February 23, 1904. Serial No. 194,649.

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.

This 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 systems for receiving signals transmitted by such waves.

The object of the present invention is to so adjust the elevated conductor system of a wireless or space telegraph receiving station relative to an associated tuned or resonant receiving circuit or circuits that, first, a persistent train of electromagnetic waves of a predetermined frequency impinging upon the elevated conductor shall cause the associated circuit or circuits to respond energetically; that, second, a persistent train of electromagnetic waves of frequency other than said predetermined frequency impinging upon the elevated conductor shall cause the associated tuned or resonant circuit or circuits to respond but feebly; and that, third, abrupt or impulsive electric forces acting upon the elevated conductor shall likewise produce but feeble response in the associated tuned or resonant circuit or circuits.

The first and second objects of this invention may be attained by giving the elevated receiving conductor system a pronounced fundamental of a frequency which is the same as that to which the associated tuned or resonant receiving circuit or circuits is attuned.

The first and second objects of this invention may therefore be attained by placing a suitable inductance or capacity in the elevated conductor near its connection to earth, if it be an earthed elevated conductor, or at the center of a receiving conductor, if it be an unearthed conductor, as thereby the receiving conductor will be given a pronounced and predetermined fundamental much as a stretched string may be given a predetermined and more pronounced fundamental by the addition of a suitable load at its center.

If therefore the loading inductance or capacity added be made such as to give the elevated conductor system a fundamental whose frequency is the same as that of the associated tuned or resonant receiving circuit or circuits, the first and second objects of the invention will be realized.

But this simple device is not sufficient to accomplish the third object of the present invention, and for that purpose it is necessary to give the elevated conductor natural periods of vibration whose frequencies are different from that to which the associated tuned or resonant receiving circuit or circuits is attuned, and this in turn I accomplish by giving the elevated conductor system a plurality of degrees of freedom by any one of a variety of means.

In other words, I accomplish the third object of this invention by employing an elevated conductor system having natural rates of vibration different from the frequency of the waves the energy of which is to be received, and consequently different from the frequency to which the associated tuned or resonant receiving circuit or circuits is attuned.

The invention may best be understood by having reference to the drawings which accompany and form a part of this specification, and which illustrate diagrammatically arrangements of apparatus and circuits whereby the present invention may conveniently be carried into effect.

Fig. 1 illustrates a space telegraph receiving system.

Figs. 2, 3, 4, 5, 6 and 7 illustrate modifications of the present invention.

In the figures,

V is an elevated receiving conductor.

E is an earth connection.

M is a transformer whose primary and secondary windings are I_1 and I_2.

M′ is a transformer having the same primary winding as the transformer M and whose secondary winding is I'_2.

M″ is a transformer whose primary and secondary windings are I'_1 and I'_2.

C, C′, C″ and C_1 are condensers.

L is an auxiliary inductance coil.

L_1 is an inductance coil.

K is a coherer or other suitable wave detector.

K′ is a wave detector adapted to utilize in its operation the dissipative energy of the electrical oscillations developed in the circuit

in which it is included such, for example, as a bolometer fine wire or strip.

B is a battery.

R is a relay or signal indicating device.

For the purpose of illustrating my invention I have shown the same in Fig. 1 applied to the space telegraph receiving system which I have fully described in my U. S. Letters Patent Nos. 714,756 and 714,831, dated December 2, 1902. Reference may therefore be had to said Letters Patent for a more complete description of the construction of parts and the operation thereof than is necessary to set forth herein, it being sufficient to state that by means of the auxiliary inductance L the effect of the mutual inductance between the resonant receiving circuit I_2 C″ C L and the elevated conductor system V I_1 E is swamped and therefore the resonant receiving circuit is rendered equivalent to a circuit having but a single degree of freedom.

In Fig. 1 the means whereby natural rates of vibration are given the elevated conductor system which natural rates are made different from that of the associated resonant receiving circuit I_2 C″ C L is the circuit C′ I_2' inductively association with the primary winding I_1 of the transformer M′. This circuit C′ I_2' is equivalent in function to the condenser C_1' connected in parallel to the primary winding I_1 of the transformer M shown in Fig. 1 of my application Serial No. 193,371, filed February 13, 1904, now patent No. 767,994 because, as is well understood, a system of two degrees of freedom such as that formed by the circuit C′ I_2' and the circuit V I_1 E is the equivalent of a system consisting of a circuit such as V I_1 E having the condenser C′ conductively connected to the terminals of the coil I_1, provided the coil I_1 in such case be given an inductance equivalent to the apparent inductance of the primary winding I_1 when inductively associated with its secondary winding I_2'. In fine, the condenser C′ reacts through the magnetic field of the transformer M′ upon the circuit V I_1 E and this reaction will be different for different frequencies of the impressed force.

Careful consideration will show that the circuit C′ I_2' employed for giving the elevated conductor system natural rates of vibration different from that to which the associated resonant receiving circuit is responsive, inductively associated with the primary winding I_1 which is interposed in the vertical wire near its earth connection, will, in combination with said winding I_1 and by its reaction thereon, present a definite inductance reactance or capacity reactance for a predetermined frequency of impressed force and that said reactance will be different for different frequencies of the impressed force.

When the waves to be received are longer than those natural to the elevated conductor per se, i. e., when the frequency of the waves is less than the fundamental frequency of the elevated conductor per se, the reactance of the elevated conductor per se is a capacity reactance.

If therefore the waves to be received are longer than those natural to the elevated conductor per se, the circuit C′ I_2' may be so proportioned as to present, in combination with the primary winding I_1 and by its reaction thereon, for the frequency of these waves an inductance reactance equivalent to that which would be given by a loading coil adapted to make the fundamental of the elevated conductor of a frequency equal to that of the waves to be received.

The reactance offered by the elevated conductor system to the electrical oscillations developed therein by a persistent train of simple harmonic waves the energy of which is to be received is therefore zero.

When the waves to be received are shorter than those natural to the elevated conductor per se and not less than one-half the length of those natural to the elevated conductor per se, i. e., when the frequency of the waves is between the fundamental frequency of the elevated conductor per se and the first even harmonic of said fundamental frequency, the reactance of the elevated conductor per se is an inductance reactance.

If the waves to be received are shorter than those natural to the elevated conductor per se and not less than one half the length of those natural to the elevated conductor per se, the circuit C′ I_2' may be so proportioned as to present, in combination with the primary winding I_1 and by its reaction thereon, for the frequency of these waves a capacity reactance equivalent to that which would be presented by a loading condenser adapted to make the fundamental of the elevated conductor equal to the frequency of the waves to be received.

Here again the reactance offered by the elevated conductor system to the electrical oscillations developed therein by a persistent train of simple harmonic waves the energy of which is to be received is therefore zero.

I find by experience that when such proportions are given to the constants of the inductively related circuit C′ I_2' that it, in combination with the primary winding and by its reaction thereon, will present for the frequency of the waves to be received and to which the resonant receiving circuit is attuned a reactance equal and opposite to the reactance of the elevated conductor per se,—the elevated conductor system in responding to electrical impulses of frequencies to which said resonant receiving circuit is not attuned, or to abrupt or impulsive electrical forces, has developed in it natural oscillations of frequencies ill adapted to cause a response of the associated resonant receiving circuit, because the frequencies of said natural oscilla-

tions are different from the frequency to which said resonant circuit is attuned.

In explanation of the foregoing, attention is again called to the fact that the closed secondary circuit C′ I′$_2$ reacts upon the elevated conductor system V I$_1$ E when electromagnetic waves impinge upon said elevated conductor system and create electrical oscillations therein because no means, such as an auxiliary inductance coil, are provided for elimitating the effect of such closed secondary reaction and that, therefore, the system shown in Fig. 1 is functionally equivalent to the system shown in Fig. 1 of my aforesaid Letters Patent No. 767,994. Reference may therefore be had to said Letters Patent for a more complete explanation of the theory of operation of Fig. 1 of the present application than is necessary to set forth herein.

I do not wish to be understood as confining myself to the specific arrangement shown in Fig. 1 because it will be obvious to those skilled in the art that there are many other arrangements in which the inductively associated circuit C′ I′$_2$ may be employed for carrying out the hereinbefore stated objects of this invention. For example as shown in Fig. 2 said circuit may be employed with the systems described in my application Serial No. 182,632, filed November 25, 1903, now patent No. 767,984, in which the auxiliary inductance coil L of the resonant receiving circuit is eliminated and the windings of the transformer M are so spatially related as to cause the resonant receiving circuit to vibrate as a system having but a single degree of freedom; or as shown in Figs. 3 and 4 it may be employed with the systems described in my applications Serial Nos. 185,872 and 185,873 filed December 19, 1903, now patents Nos. 767,989 and 767,990 in which the resonant receiving circuits are conductively connected to the elevated receiving conductor in such manner that the self energy of each of the conductively connected circuits is great as compared to the mutual energy of each circuit with respect to the other. In cases of conductive connection of the resonant receiving circuit to the terminals of a condenser as described in said application Serial No. 185,873, now patent No. 767,990, it is necessary to provide a primary winding I$_1$ serially connected with the elevated conductor either directly above or below the said condenser as shown in Fig. 4. Also the system shown in Fig. 1 may be modified as shown in Fig. 5 by providing a secondary primary winding I′$_1$ for the secondary I′$_2$ of the circuit C′ I′$_2$ either directly above or below the primary winding I$_1$ of said Fig. 1 and such second primary winding I′$_1$ may also be employed when the circuit C′ I′$_2$ is used as shown, respectively, in Figs. 6 and 7 in connection with the systems described in my applications Serial Nos. 182,632 and 185,872 now patents Nos. 767,984 and 767,989 aforesaid.

Although I have described the wave detector K as a coherer it is obvious that any other suitable receiver such as a bolometer fine wire or strip K′ may be used in the manner shown in Fig. 7 of my application Serial No. 193,371 filed February 13, 1904, now patent No. 767,994. It is obvious that many other modifications may be devised by those skilled in the art without departing from the spirit of my invention.

I make no claim in this application for the herein disclosed methods which may be carried into effect by the apparatus herein claimed, inasmuch as such methods constitute the subject matter of my divisional application Serial No. 244,350, filed Feb. 6, 1905.

I claim—

1. As a means for preventing a resonant receiving circuit of a space telegraph receiving system from responding to extraneous electrical impulses of a frequency to which said resonant receiving circuit is not attuned or to abrupt or impulsive electrical forces, a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, an elevated receiving conductor system associated with said resonant receiving circuit and a circuit, containing a condenser, inductively associated with said elevated receiving conductor system and so designed as to give the elevated receiving conductor system natural rates of vibration different from that of the associated resonant receiving circuit.

2. In a space telegraph receiving system, a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, a receiving conductor associated with said resonant receiving circuit, and a circuit, containing a condenser, inductively associated with said receiving conductor.

3. In a space telegraph receiving system, a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, a receiving conductor associated with said resonant receiving circuit, and a circuit, containing capacity and inductance, inductively associated with said receiving conductor.

4. In a space telegraph receiving system, a receiving circuit attuned by capacity and inductance to the frequency of the waves the energy of which is to be received, a receiving conductor associated with said receiving circuit, and a circuit, containing capacity and inductance, inductively associated with said receiving conductor.

5. In a space telegraph receiving system, a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, a receiving conductor inductively associated therewith, means for rendering the resonant receiving circuit the equivalent of a circuit having but a single degree of freedom, and a circuit, containing a condenser, induct-

ively associated with said receiving conductor.

6. In a space telegraph receiving system, a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, a receiving conductor associated therewith, means for rendering the resonant receiving circuit the equivalent of a circuit having but a single degree of freedom, and a circuit, containing a condenser, inductively associated with said receiving conductor.

7. In a space telegraph receiving system, a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, a receiving conductor associated therewith and adapted to present for impressed forces of said frequency an inductance reactance, and a circuit, containing capacity and inductance, inductively associated with the receiving conductor system and so designed as to present, by its reaction on said receiving conductor system for impressed forces of said frequency, a capacity reactance equivalent to that which would be presented by a loading condenser adapted to make the fundamental of said receiving conductor system of a frequency equal to that of the waves to be received and thereby to balance the inductance reactance of the receiving conductor per se for impressed forces of said frequency.

8. In a space telegraph receiving system, a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, a receiving conductor associated therewith and adapted to present for impressed forces of said frequency a definite reactance, and a circuit, containing capacity and inductance, inductively associated with the receiving conductor system and so designed as to present, by its reaction on said receiving conductor system for impressed forces of said frequency, a. reactance equal and opposite to the reactance of the receiving conductor per se and thereby to balance the reactance of said receiving conductor per se for impressed forces of said frequency.

9. In a space telegraph receiving system, a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, a receiving conductor inductively associated therewith and adapted to present for impressed forces of said frequency a definite reactance, and a circuit, containing a condenser, inductively associated with the receiving conductor system and so designed as to present, by its reaction on said receiving conductor system for impressed forces of said frequency, a reactance equal and opposite to the reactance of the receiving conductor per se and thereby to balance the reactance of said receiving conductor per se for impressed forces of said frequency.

10. As a means for preventing a resonant receiving circuit of a space telegraph receiving system from responding to extraneous electrical forces of a frequency to which said resonant receiving circuit is not attuned, or to abrupt or impulsive electric forces, and for assisting said resonant circuit to respond to persistent forces of the frequency to which said circuit is attuned, the combination of a resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, an elevated receiving conductor system associated with said resonant receiving circuit, and a circuit, containing a condenser, inductively associated with said elevated receiving conductor system and so designed that it shall by its reaction on the elevated conductor system cause the elevated conductor system to have zero reactance for electrical oscillations developed therein by a persistent force acting thereon and of the frequency to which said resonant receiving circuit is attuned.

In testimony whereof I have hereunto subscribed my name this 16th day of February, 1904.

JOHN STONE STONE.

Witnesses:
BRAINERD T. JUDKINS,
G. ADELAIDE HIGGINS.