No. 802,425. PATENTED OCT. 24, 1905.

J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED MAY 4, 1905.

3 SHEETS—SHEET 1.

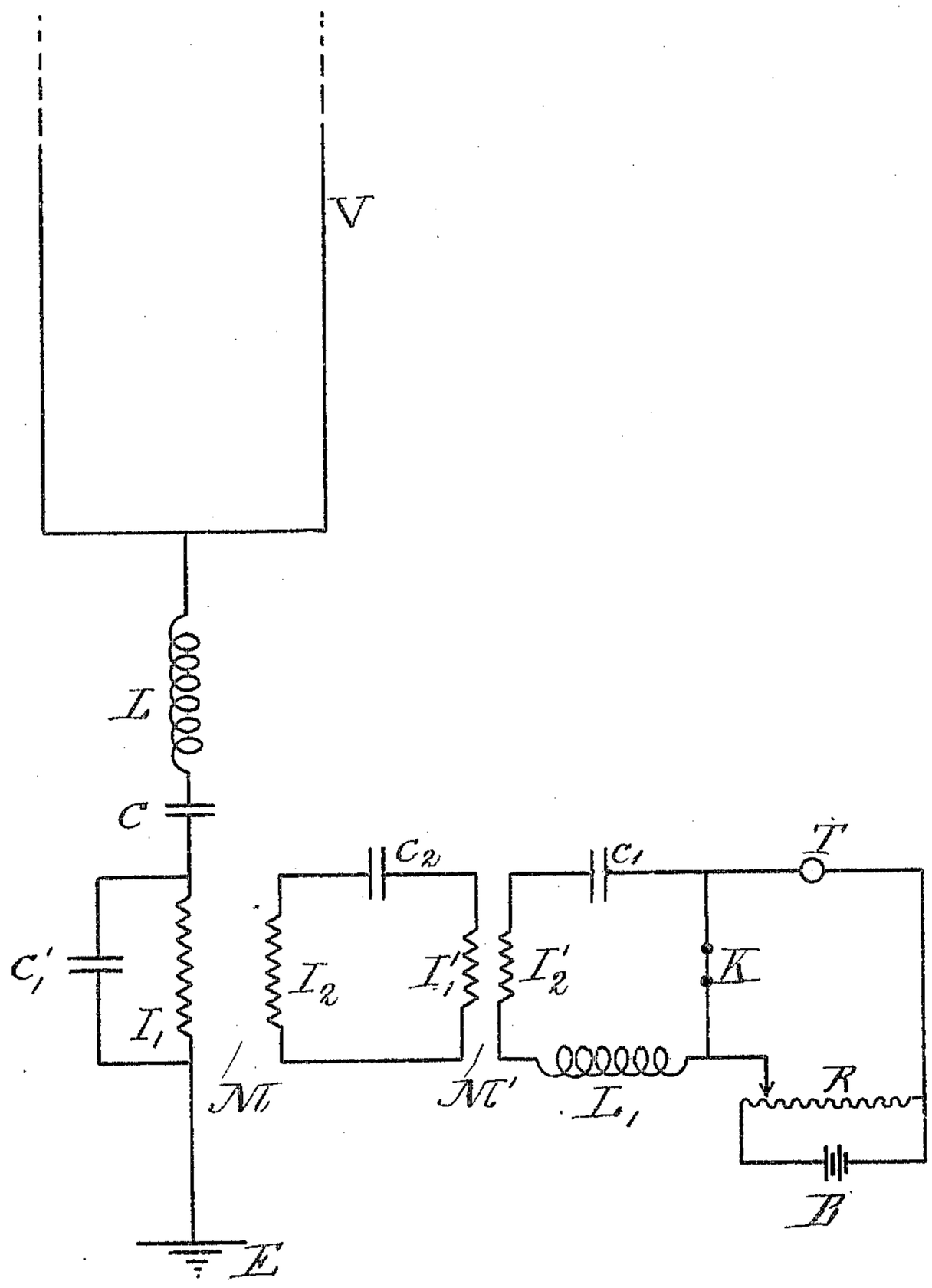

Fig. 1.

WITNESSES
Braimerd T. Judkins
G. A. Higgins

INVENTOR
John Stone Stone
by Alex. P. Browne
attorney

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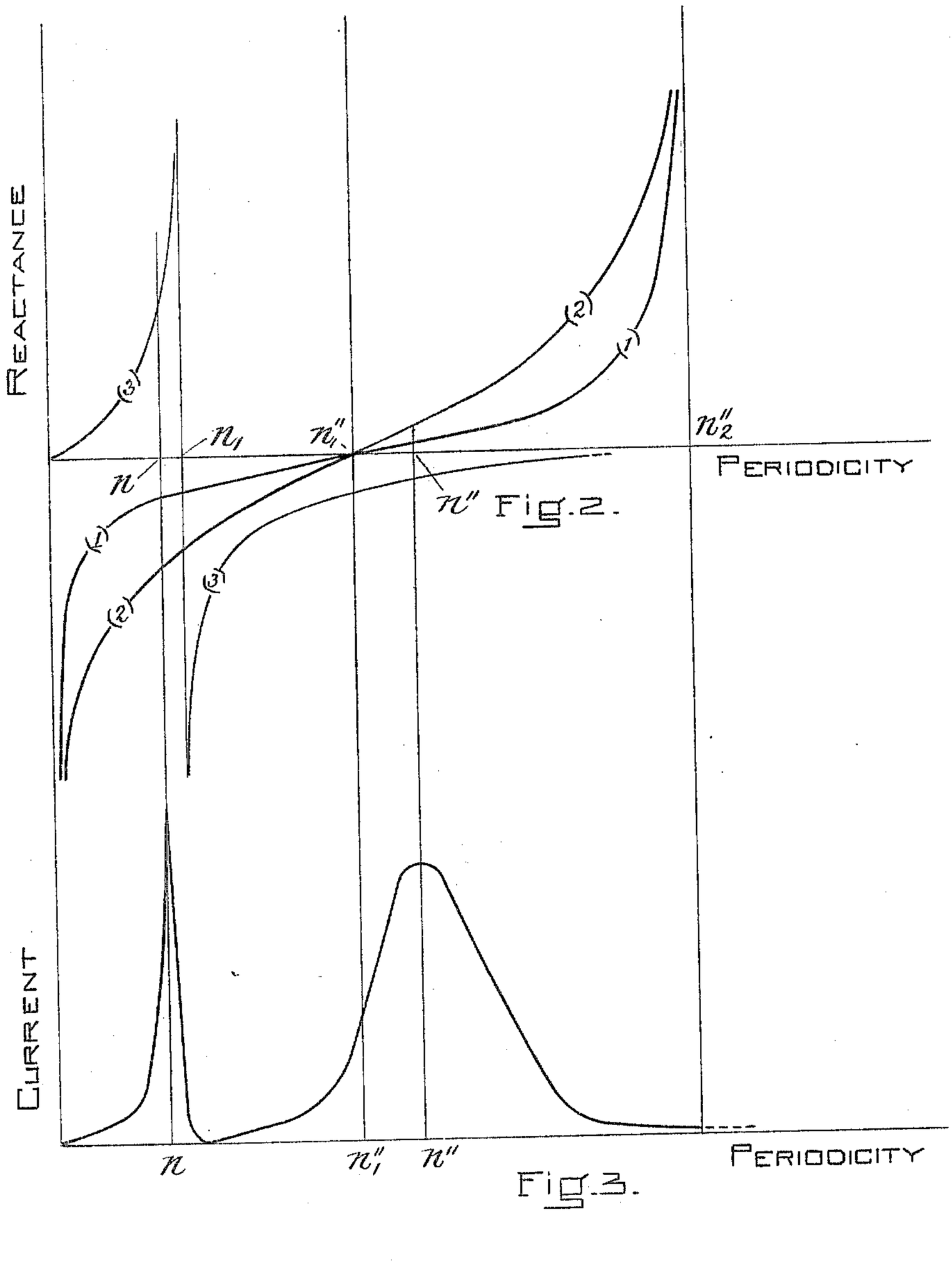

Fig. 2.

Fig. 3.

WITNESSES

Braimerd T. Judkins

G. A. Higgins

INVENTOR

John Stone Stone

by Alex. P. Browne

attorney

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3 SHEETS—SHEET 3.

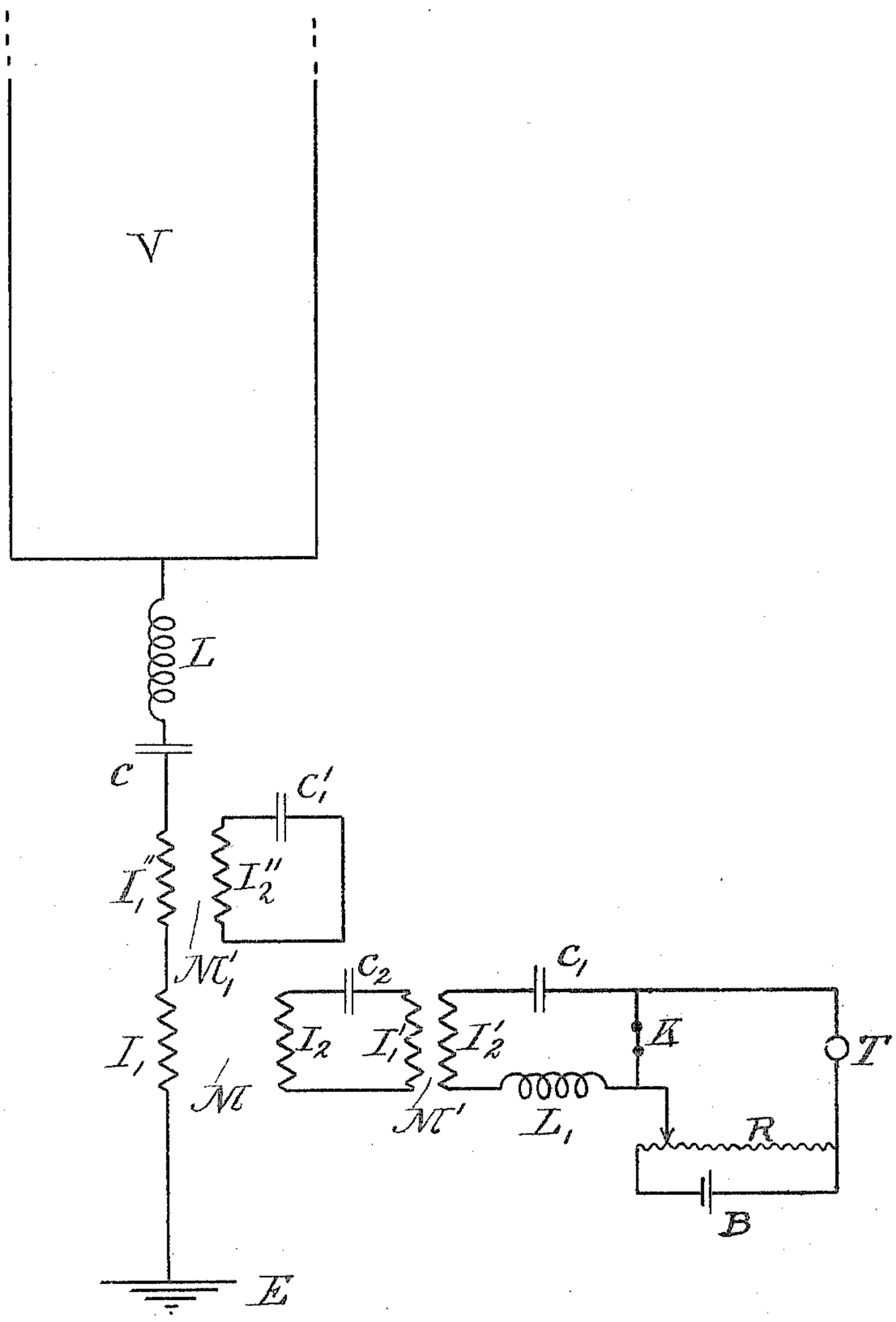

Fig. 4.

WITNESSES

Braincard T. Jackins

G. A. Higgins

INVENTOR

John Stone Stone

by Alex. P. Browne.

attorney.

ANDREW. B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

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

SPACE TELEGRAPHY.

No. 802,425. Specification of Letters Patent. Patented Oct. 24, 1905.

Application filed May 4, 1905. Serial No. 258,763.

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 system 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 system 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 this purpose I may give the elevated conductor system a pronounced natural rate of vibration different from that to which the associated tuned or resonant receiving circuit or circuits is attuned, while making the elevated conductor system highly responsive to persistent trains of waves of the frequency to which the associated resonant receiving circuit or circuits is attuned. In other words, I accomplish the object of the present invention by giving the elevated conductor system a pronounced natural rate of vibration different from that of the waves the energy of which is to be received and, consequently, different from that to which the associated tuned or resonant receiving circuit or circuits is attuned, and by making the elevated conductor system responsive to persistent trains of waves of the frequency of those the energy of which is to be received and consequently of 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 conventionally two organizations of circuits and apparatus whereby the hereinbefore stated objects may conveniently be realized in practice.

In the drawings,

Fig. 1 is a diagram representing a space telegraph receiving system.

Fig. 4 is a diagram representing a modification of the system shown in Fig. 1.

Figs. 2 and 3 show a set of curves drawn to rectangular co-ordinates and illustrating the mode of operation of the invention.

In the figures,

V is an elevated receiving conductor.

E is an earth connection.

L L_1 are inductance coils.

C C_1 C_2 and C_1' are condensers.

I_1 and I_2 are the primary and secondary

coils of the transformer M, the coils being so spatially related as to produce a transformer of large magnetic leakage.

I_1' I_2' are the primary and secondary coils of the transformer M'.

I_1'' I_2'' are the primary and secondary coils of the transformer M_1'.

K is an oscillation responsive device.

T is a telephone receiver.

R is an adjustable resistance.

B is a battery.

The circuits C_2 I_2 I_1' and C_1 I'_2 L_1 K are both attuned or made resonant to the frequency which we shall designate by n, this being the frequency of the waves the energy of which is to be received and conveyed to the responder K. Each of said circuits is made the equivalent of a circuit having a single degree of freedom by making the self energy of each circuit large compared to its mutual energy with the other circuits of the system, and this may be accomplished by any of the several methods pointed out in my prior Letters Patent.

For absorbing the energy of electromagnetic signal waves I prefer to employ an elevated conductor system comprising at least two elevated conductors and, as pointed out by me in Letters Patent No. 767,979, such multiple conductor system is far less selective than a closed resonant circuit and therefore for the purposes of the present invention has not a sufficiently pronounced fundamental. But even when an elevated conductor consisting of a single vertical wire is employed the present invention is still employed with advantage.

Electromagnetic waves of frequency n impinging upon the elevated conductor system or receiving oscillator V L C C'_1 I_1 E develop forced electrical oscillations therein of the frequency n and the energy of said oscillations is transmitted to the responder K in a manner fully described in my prior U. S. Letters Patent.

It remains to be described in this specification how a pronounced natural rate of vibration is given to the receiving oscillator and how the receiving vertical is made highly responsive to persistent trains of simple harmonic waves of frequency n.

The manner in which the apparatus of Fig. 1 accomplishes these results is illustrated in Figs. 2 and 3 and for the purpose of assisting the reader in his interpretation I may point out that they closely resemble Figs. 27 and 28 of my prior patent No. 767,994 to which reference may be had for a more complete interpretation of the function of the loop circuit C_1' I_1 than need be given in this case. Suffice it to say in regard to the loop circuit C_1' I_1 that its function is the same with respect to the rest of the receiving oscillator as it is in the inventions described in said patent No. 767,994 and that in this specification the particular interest centers in the function of the coil L and condenser C, which is clearly brought out by the obvious differences between Figs. 2 and 3 of this case and Figs. 27 and 28 of said prior patent.

In Fig. 2 the ordinates of curve (1) represent the reactance of the elevated conductor *per se* for different frequencies. The ordinates of the curve (2) represent the reactance of the serially connected condenser C and coil L for various frequencies. The ordinates of curve (3) represent the reactance of the loop circuit C_1' I_1 for various frequencies. In Fig. 3 the ordinates show the amplitude of the oscillatory current in the receiving oscillator for different frequencies of a persistently impressed force.

The principal improvement effected by the present invention over the state of the art as given in my prior patent No. 767,994 is that by the means herein described I give the receiving oscillator a more pronounced natural rate of vibration of a frequency different from that of the waves the energy of which is to be received than exists in the receiving vertical by virtue of its own electromagnetic constants.

By inspection it will be seen that curve (2) which shows the reactance variation of the coil and condenser L and C is a "steeper" curve than curve (1) which shows the reactance variation of the elevated conductor *per se*.

Careful consideration will show that in order to accomplish the objects of the present invention it is necessary in order to obtain a maximum of current for a persistently impressed force of frequency n that the algebraic sum of the reactances shown in curves (1) (2) and (3) reduce to zero and that the curve, not shown but resulting from the sum of the reactances shown in curves (1) and (2), should be "steeper" than curve (1). In other words, the condenser C by virtue of its capacity and the coil L by virtue of its inductance tend to give the receiving oscillator a more pronounced natural rate of oscillation than in Letters Patent No. 767,994 while the loop circuit C_1' I_1 enables this receiving oscillator to respond energetically to persistent trains of waves of frequency n or that of the waves the energy of which is to be conveyed to the oscillation responder and opposes the development of natural oscillations of such frequency by other waves or extraneous electrical forces.

To further assist in the interpretation of the graphical illustration contained in Figs. 2 and 3 it may be stated that n_1 is the frequency to which the loop circuit responds when isolated; n''_1 and n''_2 are respectively the fundamental and first even harmonic of the elevated conductor *per se* when isolated, and n'' is the hereinbefore mentioned pronounced natural

rate of vibration of the elevated conductor system or the natural rate of vibration of the elevated conductor *per se* as affected by the coil L and condenser C and the parallel branch circuit C_1' I_1 through which it is connected to earth.

It will be observed that whereas in the organization described and illustrated in Letters Patent 767,994 the function of the loop circuit was to balance the reactance of the elevated conductor *per se*, in the present case the reactance of the loop circuit balances the algebraic sum of the reactances of the elevated conductor, of the condenser C and of the coil L.

Though I have shown, for the purpose of illustrating a preferred form of the broad invention, the special case in which the algebraic sum of the reactances of the condenser C and coil L is zero at the frequency at which the reactance of the elevated conductor *per se* is zero, yet I do not wish to be understood as limiting my claims to such special case since in certain exigencies it may be both desirable and necessary to depart from this specific form and employ a serially connected coil and condenser whose resultant reactance is zero for a frequency far different from that for which the reactance of the elevated conductor *per se* when isolated is zero.

It is to be understood that many other modifications may be made in the broad invention generically covered by the appended claims. It is also to be understood that the hereinbefore stated objects of the present invention may be realized in practice without departing from the spirit of my invention by many other organizations of apparatus and circuits different from that shown in Fig. 1. For example, in Fig. 4 is shown another specific embodiment of the broad invention in which the circuit C_1' I_2'', which functionally is equivalent to the parallel branch circuit C_1' I_1 of Fig. 1, is inductively related to the elevated conductor system by means of the transformer M_1' and is proportioned to so inductively react upon the elevated conductor system as to balance the reactance of the rest of the elevated conductor system for frequency *n*. In other words, this inductively related circuit bears the same relation to the elevated conductor system including the serially connected coil and condenser L and C as the similar inductively related circuit described in my application Serial Number 194,649, filed Feb. 23, 1904, bears to its elevated conductor system. In this connection it may be noted that the curve showing the component of reactance produced in the primary of a transformer by a secondary containing a condenser for varying frequencies is identical in form to curve (3) of Fig. 2.

I make no claim in the present application to the method which may be carried into effect by the apparatus hereinafter claimed as such method forms the subject matter of a divisional application Serial No. 266,859, filed June 24, 1905.

Having fully described my invention, I claim—

1. In a space telegraph receiving system, an elevated conductor system comprising an elevated conductor *per se* and means for giving the same a pronounced natural rate of vibration, in combination with a circuit containing capacity and inductance and adapted to balance, by its reactance for a persistent train of electrical oscillations of definite frequency, the reactance of the rest of the elevated conductor system.

2. In a space telegraph receiving system, an elevated conductor system comprising an elevated conductor *per se* and a serially connected inductance and capacity for giving the same a pronounced natural rate of vibration, in combination with a circuit containing capacity and inductance and adapted to balance, by its reactance for a persistent train of simple harmonic electrical oscillations of definite frequency, the reactance of the rest of the elevated conductor system.

3. In a space telegraph receiving system, an elevated conductor system comprising an elevated conductor *per se* and means for giving the same a pronounced natural rate of vibration, in combination with means for rendering the reactance of the elevated conductor system zero for persistent trains of electrical oscillations of definite frequency.

4. In a space telegraph receiving system, an elevated conductor system comprising an elevated conductor *per se* and a serially connected capacity and inductance for giving the same a pronounced natural rate of vibration, in combination with means for rendering the reactance of the elevated conductor system zero for persistent trains of electrical oscillations of definite frequency.

5. In a space telegraph receiving system, an elevated conductor system comprising an elevated conductor *per se* and means for giving the same a pronounced natural rate of vibration, in combination with means for rendering the reactance of the elevated conductor system zero for persistent trains of electrical oscillations of definite frequency, and a resonant receiving circuit, attuned to said definite frequency, associated with said elevated conductor system.

6. In a space telegraph receiving system, an elevated conductor system comprising an elevated conductor *per se* and a serially connected capacity and inductance for giving the same a pronounced natural rate of vibration, in combination with means for rendering the reactance of the elevated conductor system zero for persistent trains of electrical oscillations of definite frequency, and a resonant receiving circuit associated with said elevated conductor system.

7. In a space telegraph receiving system, an

elevated conductor system comprising an elevated conductor *per se* and a serially connected coil and condenser so designed that their resultant reactance is zero for the fundamental frequency of the elevated conductor *per se* when isolated, in combination with a parallel branch circuit containing capacity in one branch and inductance in the other branch and adapted to present, for persistent trains of simple harmonic electrical oscillations of definite frequency, a reactance equal but opposite in sign to the reactance of the rest of the elevated conductor system.

8. In a space telegraph receiving system, an elevated conductor system comprising an elevated conductor *per se* and means for giving the same a pronounced natural rate of vibration, in combination with a parallel branch circuit containing capacity in one branch and inductance in the other branch and adapted to balance, by its reactance for a persistent train of electrical oscillations of definite frequency, the reactance of the rest of the elevated conductor system, and a resonant receiving circuit associated with said parallel branch circuit.

9. In a space telegraph receiving system, an elevated conductor system comprising an elevated conductor *per se* and a serially connected coil and condenser for giving the same a pronounced natural rate of vibration, in combination with a parallel branch circuit containing capacity in one branch and inductance in the other branch and adapted to balance, by its reactance for a train of electrical oscillations of definite frequency, the reactance of the rest of the elevated conductor system, and a resonant receiving circuit associated with said parallel branch circuit.

10. In a space telegraph receiving system, an elevated receiving conductor system and an associated resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, in combination with means for giving the elevated conductor system a pronounced natural rate of vibration different from that of the waves the energy of which is to be received, and consequently different from that to which said associated resonant receiving circuit is attuned, and means for making the elevated receiving conductor system highly responsive to persistent trains of waves of the frequency to which said resonant circuit is attuned.

11. In a space telegraph receiving system, an elevated receiving conductor system and an associated resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, in combination with a serially connected coil and condenser for giving the elevated conductor system a pronounced natural rate of vibration different from that of the waves the energy of which is to be received and consequently different from that to which said associated resonant receiving circuit is attuned, and a parallel branch circuit containing a condenser in one branch and an inductance coil in the other branch and adapted to balance, by its reactance for a train of electrical oscillations of the frequency to which the associated resonant receiving circuit is attuned, the reactance of the rest of the elevated conductor system.

12. In a space telegraph receiving system, an elevated receiving conductor system and an associated resonant receiving circuit attuned to the frequency of the waves the energy of which is to be received, in combination with a serially connected coil and condenser for giving the elevated conductor system a pronounced natural rate of vibration different from that of the waves the energy of which is to be received and consequently different from that to which said associated receiving circuit is attuned, and a conductively connected parallel branch circuit containing a condenser in one branch and an inductance coil in the other branch and adapted to balance, by its reactance for a train of electrical oscillations of the frequency to which the associated resonant receiving circuit is attuned, the reactance of the rest of the elevated conductor system.

In testimony whereof I have hereunto subscribed my name this 2d day of May, 1905.

JOHN STONE STONE.

Witnesses:
MARSHALL P. THOMPSON,
BRAINERD T. JUDKINS.