No. 840,908. PATENTED JAN. 8, 1907.

S. CABOT.

SPACE TELEGRAPHY.

APPLICATION FILED NOV. 18, 1905.

6 SHEETS—SHEET 1.

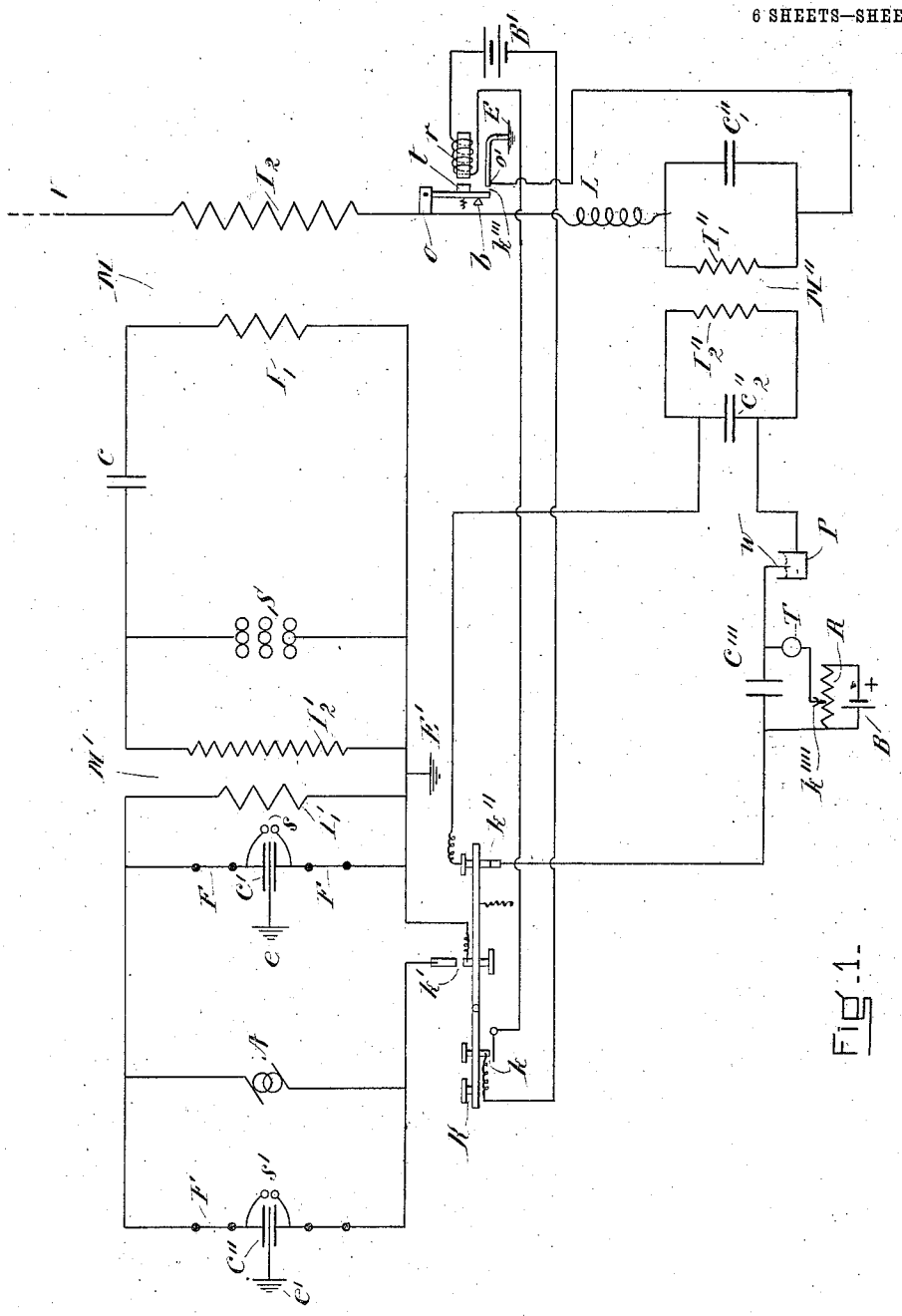

Fig. 1.

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Georgia A. Huggins

INVENTOR:

Sumner Cabot

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6 SHEETS—SHEET 2.

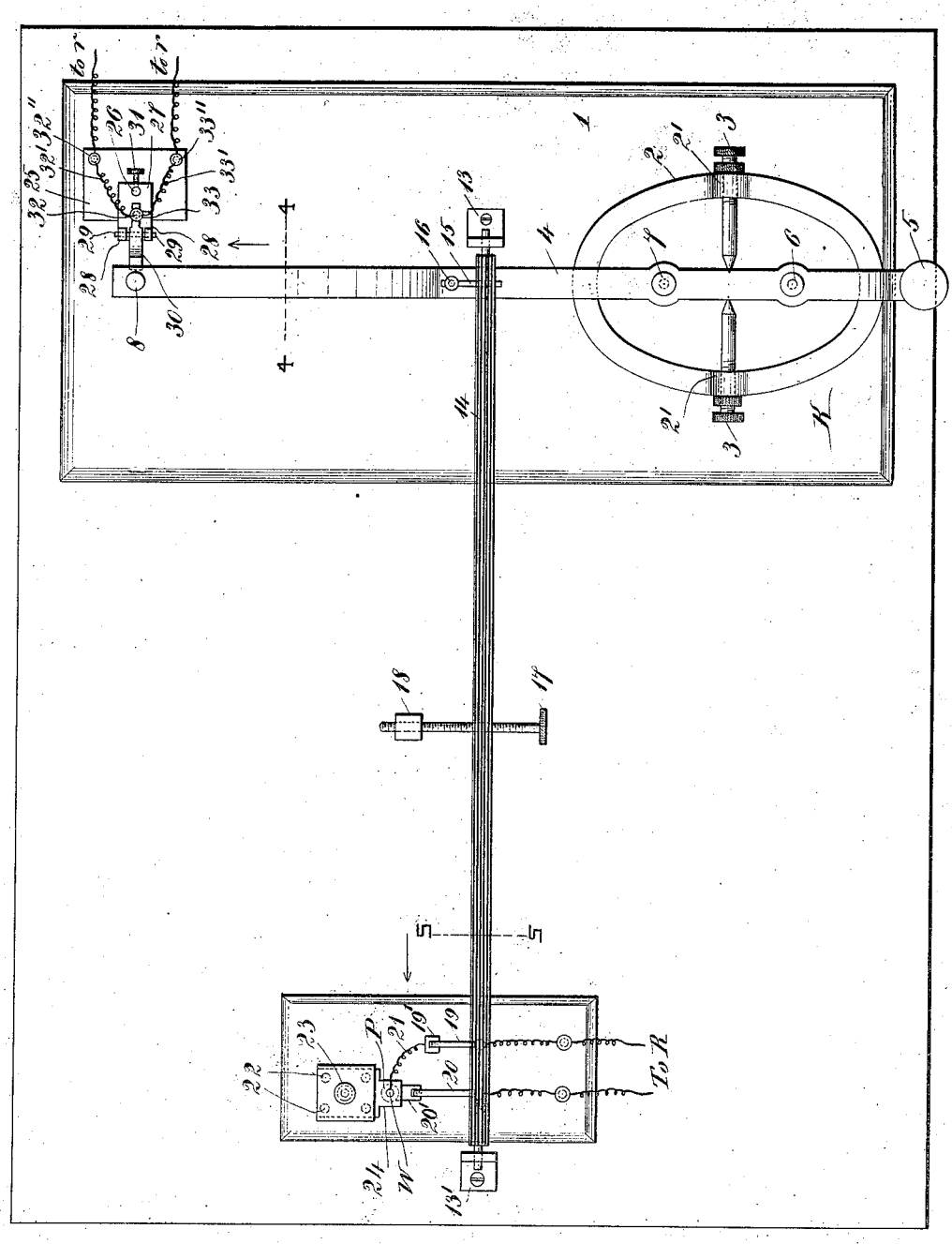

FIG. 2.

WITNESSES:

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6 SHEETS—SHEET 3.

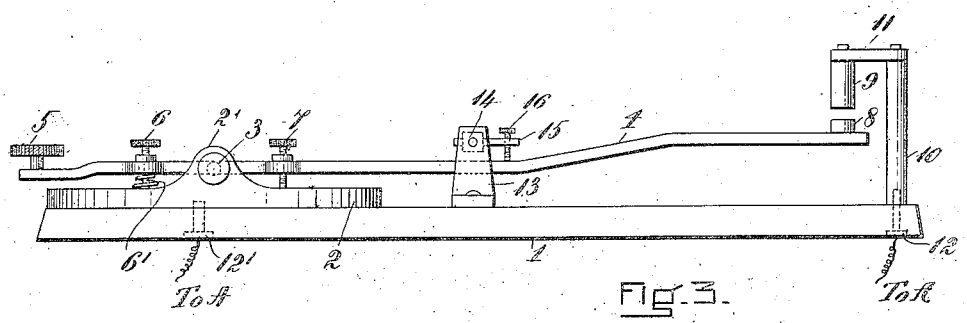

Fig. 3.

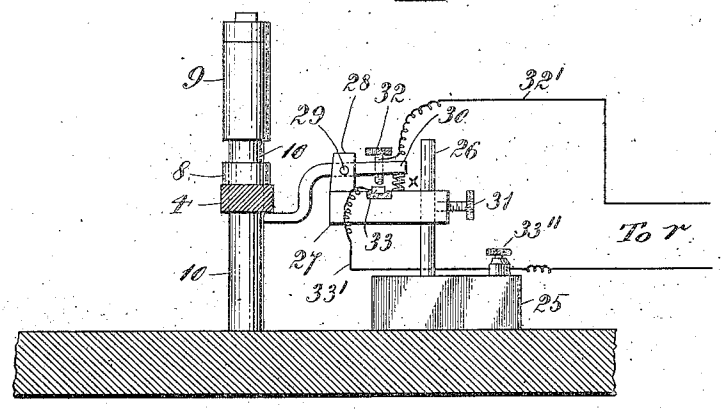

Fig. 4.

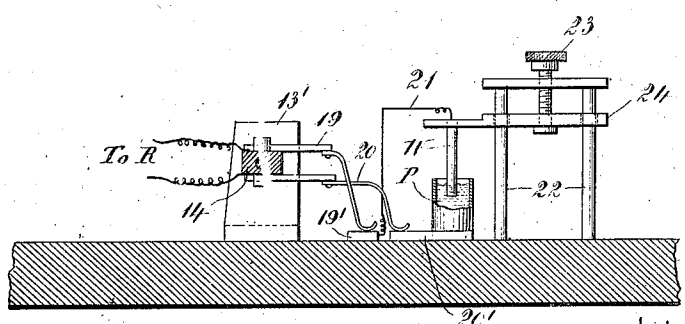

Fig. 5.

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6 SHEETS—SHEET 4.

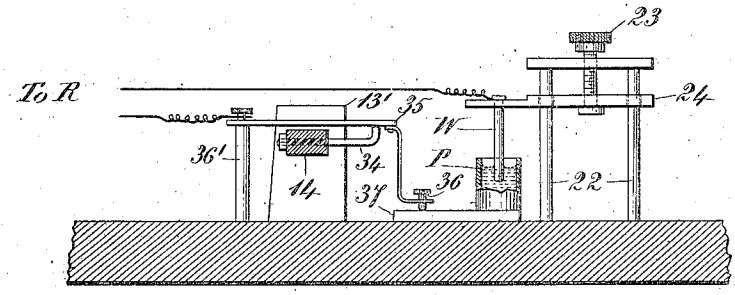

Fig. 5.

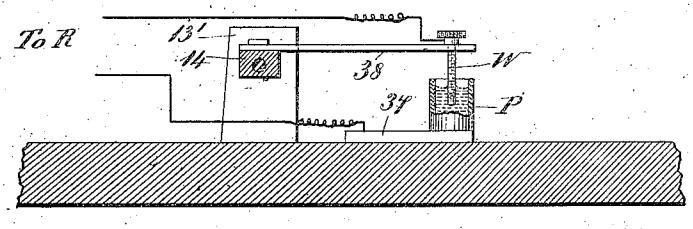

Fig. 8.

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APPLICATION FILED NOV. 18, 1905.

6 SHEETS—SHEET 6.

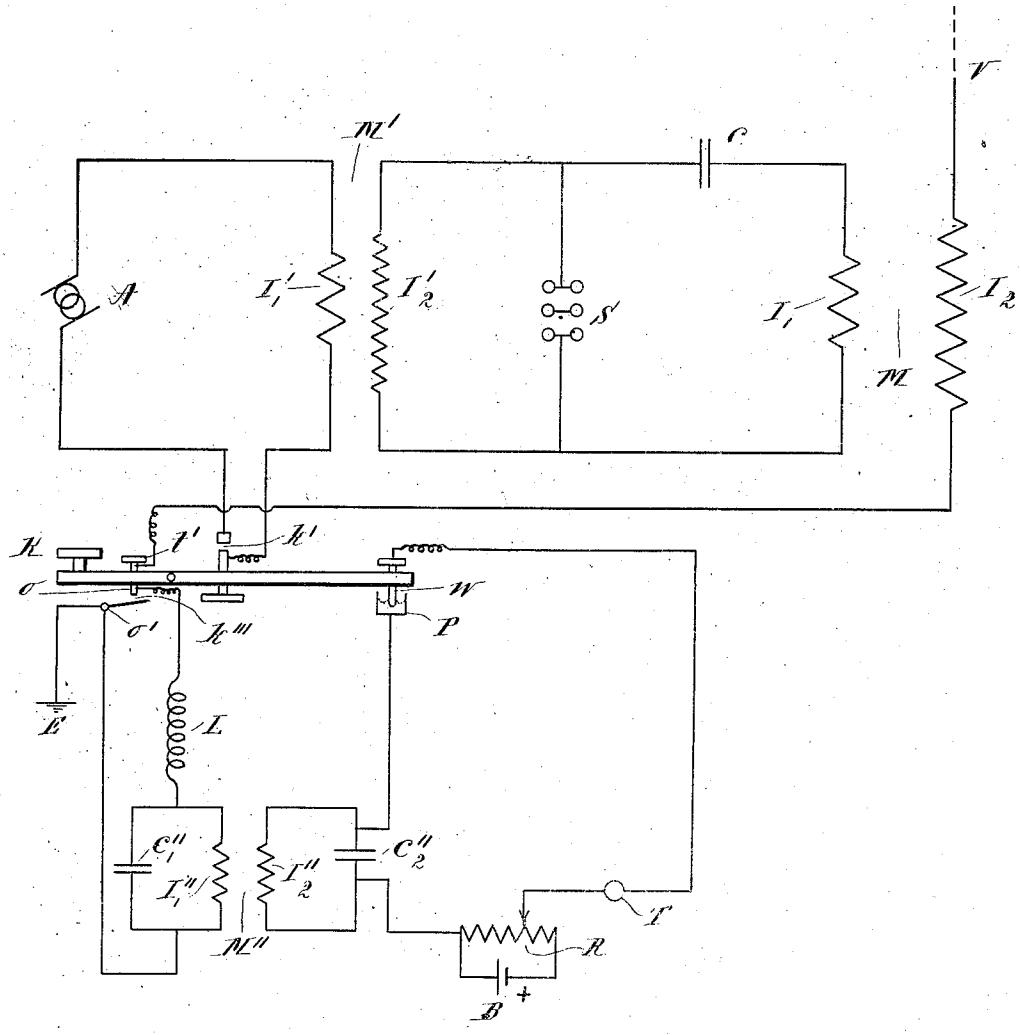

Fig. 7.

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SPACE TELEGRAPHY.

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6 SHEETS—SHEET 6.

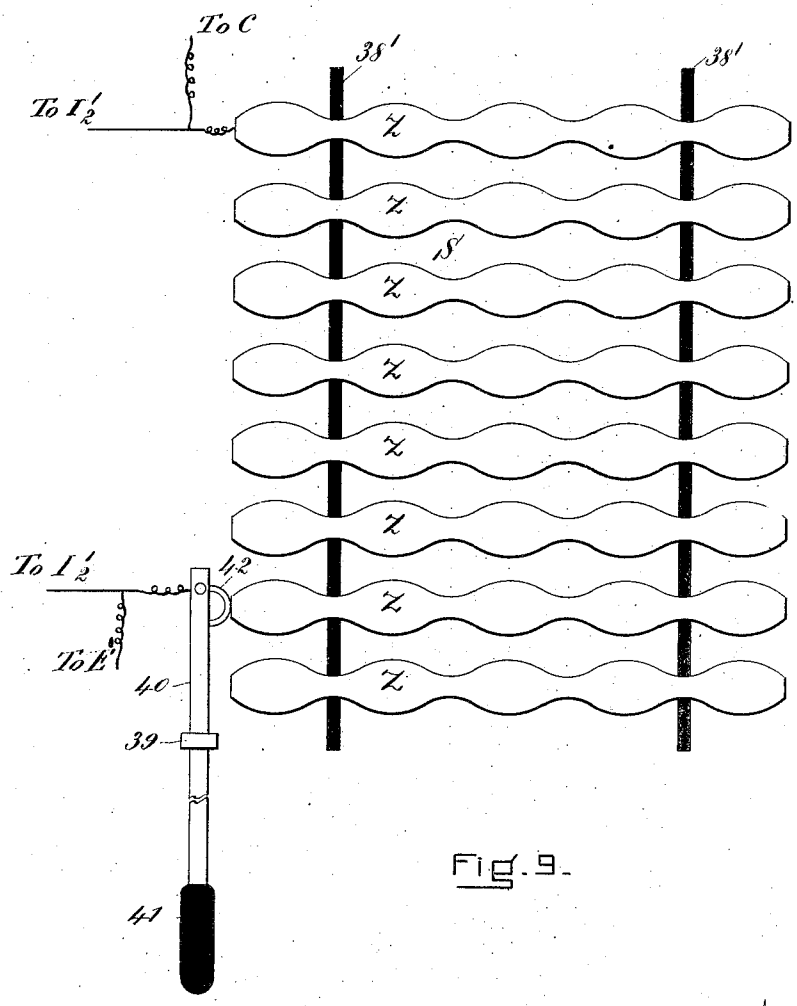

Fig. 9.

WITNESSES:

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Georgia A. Driggins

INVENTOR:

Samuel Cabot

UNITED STATES PATENT OFFICE.

SEWALL CABOT, OF BROOKLINE, MASSACHUSETTS, ASSIGNOR TO STONE TELEGRAPH AND TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MAINE.

SPACE TELEGRAPHY.

No. 840,908. Specification of Letters Patent. Patented Jan. 8, 1907.

Application filed November 18, 1905. Serial No. 288,032.

To all whom it may concern:

Be it known that I, SEWALL CABOT, a citizen of the United States, and a resident of Brookline, in the county of Norfolk and State of Massachusetts, have invented a 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 a complete system for transmitting and receiving such waves.

The object of the present invention is to provide a system whereby the well-known operation of "breaking" such as used to-day in wire-telegraph traffic, and especially in duplex and quadruplex systems, may be applied to the handling of wireless-telegraph traffic.

With this object in view my invention comprises a receiving system connected to an elevated-transmitting-conductor system at a point which during the operation of the transmitting system has practically zero potential to ground; and it further comprises a key provided with means whereby at the commencement of the downward movement of said key the receiver is rendered inoperative, the receiving system is automatically short-circuited, and the transmitting system is connected to earth, thereby automatically putting said transmitting system in condition for transmitting, whereby at the completion of the downward movement of said key the said transmitting system is energized, whereby at the commencement of the upward movement of said key the transmitting system is deënergized, and, finally, whereby subsequently to such deënergization the receiving system is put in condition for receiving by disconnecting the transmitting system from earth, automatically opening the short circuit around the receiving system, and rendering the receiver operative.

For the purpose of more fully disclosing my invention I have illustrated and shall particularly describe several specific embodiments thereof, although it is to be understood that I do not limit myself thereto, for my invention is capable of many other embodiments.

My invention may best be understood by having reference to the drawings which accompany and form a part of this specification and in which the same reference characters are used to designate like parts in the several figures.

In the drawings, Figure 1 is a diagram representing an organization of apparatus and circuits whereby the objects of my invention may be carried into effect. Fig. 2 is a plan view of one form of key and associated apparatus which in practice I have found well suited for performing in the desired order the series of functions hereinbefore set forth. Fig. 3 is a side elevation of the key shown in Fig. 2 with the contact device for controlling the relay *r* omitted for the sake of clearness. Fig. 4 is a section taken on the line 4 4 of Fig. 2 looking in the direction of the arrow and showing in end view the contacts for controlling the relay *r*. Fig. 5 is a section taken on the line 5 5 of Fig. 2 looking in the direction of the arrow and showing in end view the contacts for rendering the oscillation-responder inoperative when the key is in abnormal position. Fig. 6 represents a view similar to Fig. 5 and shows a modification of the means whereby the oscillation-responder is rendered inoperative during the abnormal position of the sending-key. Fig. 7 is a diagram representing an organization of apparatus and circuits whereby the hereinbefore-stated objects of my invention may be carried into effect. Fig. 8 is a view similar to Figs. 5 and 6 and shows a concrete embodiment of the means diagrammatically shown in Fig. 7 for rendering the oscillation-responder inoperative during the abnormal position of the key, and Fig. 9 is a concrete embodiment of the device conventionally illustrated in Fig. 1 for disturbing the electrical equilibrium of the sonorous circuit S C I_1.

In the figures, C C′ C″ C″$_1$ C″$_2$ C‴ are condensers.

L is an inductance-coil.

M is a transformer whose primary and secondary windings I_1 and I_2 are preferably so spatially related as to produce a transformer of large magnetic leakage. The spatial separation is herein shown for the sake of clearness as a transverse separation, although in practice the separation is axial. M′ is a transformer adapted to raise the potential

impressed upon its primary winding I'_1 to a very high potential in its secondary winding I'_2. M'' is a transformer whose primary and secondary windings I''_1 and I''_2 are preferably so spatially related as to produce a transformer of large magnetic leakage. Here again the separation of the coils is for the purpose of clearness shown as a transverse separation, although in practice the separation is preferably axial.

S *s s'* are spark-gaps.

V is a vertical consisting of one or any number of conductors.

E E' are earth connections.

F F are fuses.

P is an oscillation-responder of any suitable kind and herein illustrated as an electrolytic cell the anode of which is a Wollaston electrode.

T is a telephone or other suitable signal-indicating device.

R is a resistance forming with the battery B and adjustable contact *k''''* a potentiometer.

In wireless or space telegraphy, as in telegraphy by connecting-wires, it is often desirable for the receiving operator to interrupt the transmitting operator—that is to say, if the receiving operator should fail to understand a portion of a message it is desirable that he should be able immediately to notify the transmitting operator of the fact so that the latter may repeat that portion of the message which the former failed to understand instead of having to wait until the transmitting operator has finished sending the message and then notifying him that a portion of the message had not been understood. In wire telegraphy, especially as developed in the practical operation of the duplex and quadruplex systems, this is accomplished very simply in a manner well known to those skilled in the art of telegraphy; but in wireless telegraphy the peculiar difficulties involved in arranging the circuit connections in transmitting and receiving systems, as well as the differences between said circuit connections, and also the extreme sensitiveness of the oscillation-responder, render the operation of breaking more difficult, and, so far as I am advised, no system has yet been devised whereby such operation may be effected. In all the embodiments of the present invention I accomplish the hereinbefore-stated objects by means of a sending-key or other sending device provided with auxiliary mechanisms whereby the key or sending device performs a series of functions in a definite order. These are, first, rendering the responder inoperative at the beginning of the downstroke of the key, automatically short-circuiting the receiving system and connecting the transmitting system to ground, and then closing the power-circuit. In that embodiment of the present invention shown in Fig. 1 the receiver or responder is rendered inoperative by opening the circuit in which it is included, while in that embodiment of my invention shown in Fig. 7 the receiver is rendered inoperative by physically separating the parts thereof. By the phrase "rendering the receiver inoperative" as used in the specification and claims I desire to be understood as meaning an operation whereby the receiver is rendered incapable of performing its natural functions, and it will be obvious that although I have described in this specification only two ways of effecting this result many other ways will readily occur to those skilled in the art, so that it is not my intention to limit myself to the particular means disclosed for rendering the receiver inoperative as aforesaid, since I consider any suitable means within the scope of my invention. It is to be understood that although I have herein shown for the purpose of more clearly illustrating my invention one particular form of oscillation responder or receiver—namely, an electrolytic receiver—nevertheless my invention is not limited in its use to a system provided with such a receiver, but may be used in connection with any suitable receiver.

Referring now particularly to Fig. 1, upon the depression of the key K for the purpose of sending a signal the first operations effected are the separation of the two contacts, which in the normal position of the key are closed at *k''*, and the opening of the circuit *k''* I''_2 P W T *k'''*, thereby rendering the receiver P inoperative or incapable of responding, and the closure of the contact *k*, herein shown as a screw coöperating with a spring. These two operations may be simultaneous or successive, all that is necessary being that they occur prior to the closure of the contact *k'* and the consequent energization of the transmitting-circuit. The closure of the circuit *r* B' *k* at the point *k* energizes the relay *r* and causes the armature *t*, normally held against its back-stop *b*, to close the contact *k'''*, thereby connecting the transmitting system to earth at E and automatically short-circuiting the receiving system. The transmitting system now being connected directly to earth, the receiving system being short-circuited, and the circuit of the receiver being opened, the system is in condition for transmitting, and the further depression of the key K effects such transmission by the closure of the circuit containing the source of energy A, the primary of the high-potential transformer M', and the contact *k'*, thereby energizing the transmitting system. By such closure of the contact *k'* the alternating current developed in the primary I'_1 is transformed into a high-potential current in the secondary I'_2, and such current charges the condenser C to a corresponding high potential. The discharge of said condenser across the gap S develops high-potential high-fre-

quency electrical oscillations in the sonorous circuit C S I_1. These oscillations are simple harmonic in form if as set forth in United States Letters Patent Nos. 714,832 and 767,984 the windings of the transformer M are so spatially related as to render the sonorous circuit the equivalent of a circuit having a single degree of freedom. While such relation between the windings of said transformer is preferred, it will be understood that my invention is not limited thereto, but is capable of application to any system irrespective of the form of the oscillations developed therein or the waves transmitted therefrom.

At the point *o* the receiving system is connected to the transmitting system. This receiving system for the purpose of more clearly illustrating my invention is shown as embodying the system of circuits described in United States Letters Patent No. 767,994, and reference may be had thereto for a more complete description than need be set forth herein of the manner in which the reactance of the elevated conductor *per se*, the coil I_2, and the coil L is balanced by the reactance of the parallel branch circuit C''_1 I''_1 for a persistent train of waves of the frequency to which the resonant receiving-circuit I''_2 C''_2 is attuned. It will be noted that the point of connection of the receiving system to the elevated-transmitting-conductor system is a point which during the operation of the transmitting system has practically zero potential to ground, because during transmission this point is connected to earth by a conductor of practically zero impedance, so that the potential of the receiving system as a whole is practically zero. During such transmission, even when oscillations of large current value are being developed in the elevated-transmitting-conductor system E *o' t o* I_2 V, there is developed between the points *o o'*, which form the terminals of the receiving system, practically no difference of potential, or at least not a sufficient difference of potential to damage delicate parts of the receiving apparatus. So far as I am aware no combined transmitting and receiving system has heretofore been devised in which the receiving system is connected to the transmitting system at a point which during transmission has practically zero potential to ground, and this, being a salient feature of my invention, inasmuch as thereby the operator may retain the head-telephone in position during transmission with safety, is hereinafter claimed broadly, irrespective of the character of the transmitting and receiving systems, the character of the receiver, or the character of the means employed for rendering the receiver inoperative during transmission.

When the operator has depressed the key to its full extent for a sufficient length of time to produce the desired signal element, the key is allowed to regain its normal position and the following cycle of operations is effected: First the contact *k'* is opened, thereby deënergizing the transformer M', and, second, the contact *k* is opened an appreciable interval of time after the opening of the contact *k'*, and accordingly the armature *t* of the relay *r*, which may be a sluggish relay, is retracted against its back-stop an appreciable interval of time after the opening of the aforesaid contact *k'*, thereby ungrounding the transmitting system and automatically opening at the point *k'''* the short circuit around the receiving system. The object of making the relay *r* sluggish in its action, as well as providing for the time interval between the opening of the contacts *k'* and *k*, is to permit the complete subsidence of electrical movement in the transmitting system before breaking its connection to earth. Simultaneously with the deënergization of the relay *r*, or before or after such deënergization, the closure of the contact *k''* is effected, thereby rendering the receiver operative.

An appreciable interval of time must elapse between the sending of signal elements, and it is during such intervals of time when the key is in its normal position that the sending operator, who sends with the head-telephone T placed over his ears, may ascertain that the receiving operator at the distant station is signaling "break." Said receiving operator having failed to understand a portion of the message transmitted to his station depresses his sending-key immediately upon such failure to understand a word or portion of a message and sends a predetermined signal indicating that he wishes the transmission stopped. The waves sent out by said receiving operator develop in the vertical at the station from which the message is being sent to said receiving operator electrical oscillations which pass to earth E by way of the secondary I_2, which for said oscillations operates merely as an inductance, the coil L and the parallel branch circuit when the key K is in its normal position and the contact *k'''* accordingly is open. Said oscillations are of such frequency that for them the elevated-receiving-conductor system V I_2 *o* L I''_1, C''_1 *o'* E has zero reactance, so that currents of relatively large amplitude are developed in the resonant receiving-circuit and create at the terminals of the condenser C''_2 a sufficient difference of potential to cause the oscillation-responsive device P to respond and produce a signal in the telephone T. This signal is an indication to the transmitting operator that the receiving operator is signaling "break," and he thereupon ceases his transmission and receives from the receiving operator instructions concerning the repetition desired by said receiving operator. If the oscillations created in the elevated conductor by the waves sent out from the distant receiving-station, whose operator de-

sires to break, are so created when the key is down, it is obvious that such oscillations will not effect the operation of the receiver P; but it will be observed that as soon as the key is again in its normal position the oscillations will affect the receiver, and the transmitting operator will then receive the break-signal and cease to send.

The device W in Figs. 1, 5, 6, and especially in Figs. 7 and 8, is known in the art as the "Wollaston anode" and consists of a wire, very large as compared with the silver-coated platinum Wollaston wire, inclosed in a capillary tube and having its end surface only exposed to an electrolyte contained in the cup of the receiver P. The construction of this Wollaston anode need not further be specified herein, inasmuch as full directions for making the same will be found in a paper by Dr. William H. Wollaston in the *Philosophical Transactions of the Royal Society of London*, volume 91, Part II, pages 430 to 432, published 1801.

I shall now describe one specific embodiment of the key K and auxiliary or associated devices whereby the aforesaid cycle of operations may be effected.

Referring to Fig. 2, 1 is a base containing the base-plate 2 of the key, which is pivoted to the standards 2′ by the screws 3 3 in the usual manner. The key-arm 4 is provided at one end with a finger-piece 5 and at the other end with a contact member 8, made, preferably, of silver or other metal whose vapor is non-conducting. For the purpose of simplifying Fig. 2 the contact member 9, with which the lower contact member 8 cooperates, has been omitted from Fig. 2 and is shown in Fig. 3 supported from a cross-piece 11, which is mounted upon a standard 10, secured to the base by screw 12. Supported by and pivoted to the standards 13 13′ is a rod 14, preferably of insulating material, carrying a projection 15, which is provided with an adjusting-screw 16, the end of which rests upon the key-arm 4. About midway between the standards 13 13′ a screw 17, carrying an adjustable weight 18, is passed through the rod 14, whereby the screw 16 is held in contact with rod 4 and the strips 19 and 20 are held in contact with the plates 19′ 20′, respectively, which connect with the oscillation-responder by the conductor 21 in the one case and by direct contact in the other, as shown more plainly in Fig. 5. For the purpose of more clearly illustrating the invention the contact-strip 20 is shown as secured to the under side, and the contact-strip 19 as secured to the upper side, of the rod 14. Secured to the standards 22 is an adjusting-screw 23, cooperating with the member 24, which carries one member of the oscillation-responder—in the present case the anode or Wollaston electrode of the electrolytic receiver—for the purpose of effecting a relative movement between said anode and its cooperating cell. The connections shown in Figs. 2 and 5 and marked "To R" connect the contact-strips 19 and 20 with the adjustable resistance R of the potentiometer.

It will now be obvious that upon a very slight depression of the key K the rod 14 will be rotated about its pivots and the contacts of the strips 19 and 20 with the plates 19′ and 20′ will be broken, thus breaking the connections of the oscillation-responder with the potentiometer, an operation which in purely diagrammatic form is illustrated in Fig. 1, in which a very slight depression of the key K opens at the point k'' the circuit of the oscillation-responder P.

In that particular embodiment of my invention shown in Fig. 2 the means whereby the grounding of the transmitting system and the short-circuiting of the receiving system are effected is shown in plan view at the upper right-hand corner of Fig. 2 and in end elevation in Fig. 4, although said means has been omitted from Fig. 3 for the purpose of simplifying the drawing. Mounted upon the base of the key near the end of the arm 4 is a block 25, carrying a standard 26, upon which another block 27 is held in adjusted position by the screw 31. The block 27 carries two projections 28, between which is pivoted by pivots 29 a bent lever 30, one end of which rests under the key-arm 4 and the other end of which carries the contact-screw 32, which by means of the spring x is drawn into contact with the metal plate 33 when the arm 4 is raised. A conductor 33′ connects said plate 33 with the binding-post 33″, and a conductor 32′ connects the screw 32 to a binding-post 32″. (Shown in Fig. 2.) As indicated on Fig. 4 and on Fig. 2, the binding-posts 32″ and 33″ are connected to the relay r. By suitably adjusting the height of the block 27 it will be obvious that the screw 32 may be made to contact the plate 33 at the same time or shortly after the strips 19 and 20 have opened the circuit of the receiver P and before the contact member 8 strikes the contact member 9 and closes the power-circuit through the transformer-primary I'_1. This operation is indicated purely diagrammatically in Fig. 1 by the contact k between a screw inserted through the key and a spring. The last of the aforesaid cycle of operations is effected when the key has been fully depressed and the silver block or contact member 8 brought into contact with the silver block or contact member 9, an operation indicated in diagrammatic form in Fig. 1 by the contact k'. It will now be obvious that as the key is brought to its normal position by the spring 6′, adjusted by the screw 6, such normal position being determined by the screw 7, the contact member 8 leaves its cooperating member 9, the arm 4 by striking the inner end of the lever 30 causes the con-

tact-screw 32 to leave its plate 33, thereby deënergizing the relay *r*, and simultaneously or afterward the receiver is connected to its circuit by the strips 19 and 20.

It is not necessary to employ two contact-strips 19 and 20 one on either side of the receiver, for, as shown in Fig. 6, which is a view similar to Fig. 5, a spring contact-strip 35, which may be provided with an adjusting-screw 36, may be rigidly attached at one end to a standard 36′ and raised so as to break contact between the screw 36 and its coöperating plate 37, conductively connected to the cell P by means of a projection 34, rigidly attached to the rod 14. In such case one terminal of the potentiometer resistance R is connected to the Wollaston electrode, and the other terminal thereof is connected to the contact-strip 35.

It will be obvious that many other simple mechanical expedients may be devised for rendering the receiver or oscillation-responder inoperative by a slight movement of the sending-key. For example, as shown diagrammatically in Fig. 7, one terminal W of the receiver P may be adjustably attached to the key, so that the first slight movement of the latter will separate said terminal from its coöperating member. In Fig. 7 the circuit of the telephone T and receiver P is the same as shown in Fig. 1, with the exception that the condenser C‴ of Fig. 1 has been omitted in Fig. 7. The function of this condenser in Fig. 1 is to add to the distributed capacity of the circuit containing the telephone T and resistance R, so as to afford a path of small impedance to the electrical oscillations which pass through the cell P. Such shunting-condenser C‴, however, is not essential, because the telephone T and potentiometer resistance R have such large distributed capacity as to offer but small impedance to oscillations of the frequencies employed in space telegraphy.

In Fig. 8, which is a view similar to Fig. 6, is shown one of the many mechanical embodiments whereby the arrangement shown in diagram in Fig. 7 may be carried into effect. In Fig. 8 a projection 38 is secured to the bar 14 and carries at its extremity one member W of the receiver P. As indicated in Fig. 8, the terminals of this receiver connect with the potentiometer resistance R, as in Fig. 6.

As will be observed, the transmitting system shown in Fig. 7 is substantially the same as that shown in Fig. 1, the difference between the two figures residing in the means whereby the transmitting-conductor is connected to earth and the receiver is rendered inoperative prior to the energization of the transmitting system. In Fig. 7 the elevated conductor is connected to the contact-screw *t*′ on the key K, and this contact-screw and its coöperating spring connect the transmitting-conductor to earth when the contact *k*‴ is closed. It will be noted that the contact-screw *t*′ and its coöperating spring perform the functions of the relay-armature *t* and its coöperating contact. Further, it will be noted that, as in Fig. 1, there exists zero difference of potential between the points *o* and *o*′, which form the connections of the receiving system, and that the point *o*, at which the receiving system is connected to the elevated transmitting-conductor system, is a point which during transmission has practically zero potential to ground. In Fig. 1 when the key K is in its normal position the path of the oscillations developed in the elevated receiving-conductor system by electromagnetic waves consists of the vertical V, inductance I_2, point *o*, inductance L, parallel branch circuit, point *o*′, and the earth connection E, and in Fig. 7 such path consists of the vertical V, inductance I_2, contact-screw *t*′, point *o*, inductance L, parallel branch circuit, point *o*′, and the earth connection E.

In Fig. 1 when the key K is in depressed or sending position and the receiving system is short-circuited between the points *o* and *o*′ by the armature *t* the path of the electrical oscillations developed in the elevated transmitting-conductor system is V I_2 *o t k*‴ *o*′ E, and in Fig. 7 when the key is in sending position and the receiving system is short-circuited between the points *o* and *o*′ by the screw *t*′ and its coöperating spring such path is V I_2 *t*′ *o k*‴ *o*′ E.

Fig. 9 shows a preferred form of multiple-series spark-gap. (Diagrammatically shown in Fig. 1.) The electrodes of said multiple-series gap are formed, preferably, of zinc, although any suitable material may be employed, and if of zinc they may be formed into the desired shape by working an ordinary battery-zinc by means of a hand-tool. The members Z are placed, as shown, with their ends resting upon the insulating members 38′. As indicated, one terminal of the gap is connected to one terminal of the secondary I'_2 and to the condenser C, while the other terminal is connected to the second terminal of said secondary and to the earth connection E′. In order to regulate the number of the members Z employed in the multiple-series spark-gap, I may employ a rod 40, provided at one end with a handle 41, of insulating material, and at the other with a spring-contact 42 and mounted slidably in the standard 39. The advantages of series spark-gaps are well known, having been set forth in United States Letters Patent No. 768,000 and elsewhere; but so far as I am aware a multiple-series spark-gap has not before been used. Such gap is highly advantageous for the purpose of affording as large a number of short paths for the spark as may be desired, and thereby reducing the resistance to electrical oscillations initiated in the sonorous circuit by the first discharge

of the condenser across the gap. The advantages of using zinc are that it absorbs the oxygen from the nitrous acid created by the spark-discharges and fixes it and also that its vapor is non-conducting, or, in other words, a gap having zinc electrodes is a non-arcing gap.

The condensers C′ C″, shunted by the gaps *s s′* and having their middle plates connected to earth at *e e′* respectively, and the earth connection E′ are protective devices which, in connection with the fuses F F, protect the apparatus from excessive tensions in a manner that will be obvious.

Although for the purpose of more clearly disclosing my invention I have described with great particularity several specific systems of circuits and several specific mechanical devices, it is to be understood that I do not limit myself to any of said systems or devices, inasmuch as many modifications may be made therein without departing from the spirit of my invention.

I claim—

1. In a space-telegraph system, an elevated transmitting-conductor system and a receiving system having its terminals connected thereto at a point which during transmission has practically zero potential to ground.

2. In a space-telegraph system, a receiver, an elevated conductor, means associating said receiver therewith, a sending device and apparatus operated by said sending device for automatically putting said system in condition for receiving by grounding said elevated conductor through said means when said sending device is in one position and for automatically putting said system in condition for transmitting by short-circuiting said means and thereby connecting said elevated conductor directly to earth when said sending device is in another position.

3. In a space-telegraph system, a receiver, an elevated conductor, means associating said receiver therewith, a sending device and apparatus operated by said sending device for automatically putting said system in condition for receiving by grounding said elevated conductor through said means when said sending device is in its normal position and for automatically putting said system in condition for transmitting by short-circuiting said means and thereby connecting said elevated conductor directly to earth when said sending device is in another position.

4. In a space-telegraph system, a receiver, an elevated conductor, means associating said receiver therewith, a sending-key and apparatus operated by said sending-key for automatically putting said system in condition for receiving by grounding said elevated conductor through said means when said sending-key is in one position and for automatically putting said system in condition for transmitting by short-circuiting said means and thereby connecting said elevated conductor directly to earth when said sending-key is in another position.

5. In a space-telegraph system, a receiver, an elevated conductor, means associating said receiver therewith, a sending-key and apparatus operated by said sending-key for automatically putting said system in condition for receiving by grounding said elevated conductor through said means when said sending-key is in its normal position and for automatically putting said system in condition for transmitting by short-circuiting said means and thereby connecting said elevated conductor directly to earth when said sending-key is in another position.

6. In a space-telegraph system, a transmitting system including a power-circuit, a receiving system, an elevated conductor, means associating said receiving system therewith, a sending-key provided with devices for closing and opening said power-circuit, and apparatus operated by said sending-key for automatically putting said receiving system in condition for receiving by grounding said elevated conductor through said means when said sending-key is in such position that said power-circuit is opened and for automatically putting said transmitting system in condition for transmitting before said sending-key is in such position that said power-circuit is closed by short-circuiting said means and thereby connecting said elevated conductor directly to earth.

7. In a space-telegraph system, a transmitting system including means for energizing the same, a receiving system, an elevated conductor, means associating said receiving system therewith, a sending device, and apparatus operated by said sending device for automatically putting said transmitting system in condition for transmitting prior to the energization thereof by short-circuiting said means and thereby connecting said elevated conductor directly to earth and for automatically putting said receiving system in condition for receiving subsequent to the deënergization of said transmitting system by grounding said elevated conductor through said means.

8. In a space-telegraph system, a transmitting system, a receiving system including a receiver, an elevated conductor, means associating said receiver therewith, and apparatus associated with said transmitting and receiving systems for rendering said receiver inoperative, short-circuiting said means, thereby directly grounding said elevated conductor, and then energizing said transmitting system.

9. In a space-telegraph system, a transmitting system, a receiving system including a receiver, an elevated conductor, means associating said receiving system therewith, a

sending device associated with said transmitting and receiving systems, and apparatus operated by said sending device for rendering said receiver inoperative, short-circuiting said means, thereby directly grounding said elevated conductor, and energizing said transmitting system.

10. In a space-telegraph system, a transmitting system, a receiving system including a receiver, an elevated conductor, means associating said receiving system therewith, a sending device, and apparatus operated by said device for putting said system in condition for transmitting by rendering said receiver inoperative, short-circuiting said means, and thereby directly grounding said elevated conductor.

11. In a space-telegraph system, a transmitting system, a receiving system including a receiver, an elevated conductor, means associating said receiving system therewith, and apparatus associated with said transmitting and receiving systems for breaking the circuit of said receiver, short-circuiting said means, thereby directly grounding said elevated conductor, and then energizing said transmitting system.

12. In a space-telegraph system, a transmitting system, a receiving system including a receiver, an elevated conductor, means associating said receiving system therewith, a sending-key associated with said transmitting and receiving systems, and apparatus operated by said key for breaking the circuit of said receiver, short-circuiting said means, thereby directly grounding said elevated conductor, and then developing electrical oscillations in said transmitting system.

13. In a space-telegraph system, a transmitting system, a receiving system including a receiver, an elevated conductor, means associating said receiving system therewith, a sending-key and apparatus operated by said key for putting said system in condition for transmitting by breaking the circuit of said receiver, short-circuiting said means and thereby directly grounding said elevated conductor.

14. In a space-telegraph system, a transmitting system, a receiving system, an elevated conductor, means associating said receiving system therewith, a sending device, and apparatus operated by said sending device for protecting said receiving system during the operation of said transmitting system by short-circuiting said means and means for indicating to the transmitting operator, during the time intervals between his signal elements, that a receiving operator at another station is sending a signal.

15. In a space-telegraph system, a transmitting system, a receiving system, an elevated conductor normally grounded through said receiving system, a sending-key and means operated by said key for successively short-circuiting said receiving system, thereby directly grounding said elevated conductor, and developing electrical oscillations in said transmitting system.

16. In a space-telegraph system, a transmitting system, a receiving system, an elevated conductor normally grounded through said receiving system and means for successively short-circuiting said receiving system, thereby directly grounding said elevated conductor, and creating electrical oscillations in said transmitting system.

17. In a space-telegraph system, a transmitting system, a receiving system including a receiver, an elevated conductor, means associating said receiving system therewith, a sending device, and apparatus operated by said sending device for successively rendering said receiver inoperative, short-circuiting said means and energizing said transmitting system.

18. In a space-telegraph system, a transmitting system, a receiving system, an elevated conductor normally grounded through said receiving system, a sending device and apparatus operated by said sending device for successively short-circuiting said receiving system, thereby directly grounding said elevated conductor, and energizing said transmitting system.

19. In a space-telegraph system, a transmitting system, a receiving system, an elevated conductor normally grounded through said receiving system, a sending-key and means operated by said sending-key for short-circuiting said receiving system and thereby directly grounding said elevated conductor.

20. In a space-telegraph system, a transmitting system, a receiving system, an elevated conductor, means associating said receiving system therewith, a magnetically-operated device for short-circuiting said means, thereby directly grounding said elevated conductor, and a sending device provided with means for closing the circuit of said magnetically-operated device.

21. In a space-telegraph system, the combination with a transmitting and receiving system at the same station, of means controlled by the sending device of the transmitting system to short-circuit the receiving system during the time of transmission of each signal element.

22. In a space-telegraph system, the combination with transmitting and receiving apparatus at the same station, of means for automatically short-circuiting the receiving system synchronously with the transmission of each signal element.

23. In a space-telegraph system, the combination with transmitting and receiving apparatus at the same station, of an elevated conductor associated with said transmitting and receiving apparatus, a sending device,

and means operated by said sending device for protecting said receiving apparatus by short-circuiting the same during the operation of said transmitting apparatus and means for indicating to the transmitting operator, during the time intervals between his signal elements, that a receiving operator at another station is sending a signal.

24. In a space-telegraph system, an elevated conductor, a source of electrical oscillations, means associating said elevated conductor and said source of electrical oscillations, and a receiving system serially connected with said elevated conductor between the lower end of the aforesaid means and the earth connection of said elevated conductor.

25. In a space-telegraph system, an elevated conductor, a source of electrical oscillations, means for inductively translating the energy of said electrical oscillations to the said elevated conductor, and a receiving system serially connected with said elevated conductor between the lower end of the aforesaid means and the earth connection of said elevated conductor.

26. In a space-telegraph system, an elevated conductor, an oscillation-circuit, an inductance included in said elevated conductor, an inductance included in said oscillation-circuit, and a receiving system serially connected with said elevated conductor between the lower end of the inductance which is included in said elevated conductor and the earth connection of said elevated conductor.

27. In a space-telegraph system, an elevated transmitting-conductor system, a receiving system connected thereto at a point which during transmission has practically zero potential to ground, a sending device and means controlled thereby for connecting said receiving system to said elevated transmitting-conductor system between two points across which there exists a practically zero difference of potential during transmission.

28. In a space-telegraph system, an elevated conductor, means whereby electrical oscillations may be developed therein and a receiving system serially connected with said elevated conductor between the earth connection thereof and the point of association of said means therewith.

29. In a space-telegraph system, an elevated conductor, means whereby electrical oscillations may be developed therein, a receiving system serially connected with said elevated conductor between the earth connection thereof and the point of association of said means therewith, and means for protecting said receiving system during the development of oscillations in said conductor.

30. In a space-telegraph system, an elevated conductor, an oscillation-producer, means associating said oscillation-producer with said elevated conductor, and a receiving system serially connected with said elevated conductor between said means and the earth connection of said conductor.

31. In a space-telegraph system, an elevated conductor, an oscillation-producer, means associating said oscillation-producer with said elevated conductor, a receiving system serially connected with said elevated conductor between said means and the earth connection of said conductor, and means for protecting said receiving system during the operation of said oscillation-producer.

32. In a space-telegraph system, an elevated conductor, means whereby electrical oscillations may be developed therein, a sending device controlling said means, a receiving system connected between the earth connection of said elevated conductor and the point of association of said means with said conductor, and means controlled by the said sending device for connecting said elevated conductor directly to earth and short-circuiting said receiving system.

33. In a space-telegraph system, an elevated conductor, an oscillation-producer, a sending device controlling said oscillation-producer, means associating said oscillation-producer with said elevated conductor, a receiving system connected to said elevated conductor between said means and the earth connection of said conductor, and means controlled by said sending device for connecting said elevated conductor directly to earth and short-circuiting said receiving system.

34. In a space-telegraph system, an elevated conductor, an inductance included in said elevated conductor, a receiving system serially connected with said elevated conductor between the lower end of said inductance and the earth connection of said conductor, means associated with said inductance for developing electrical oscillations in said elevated conductor, and apparatus for protecting said receiving system during the development of oscillations in said elevated conductor by said means.

35. In a space-telegraph system, an elevated transmitting-conductor system, a receiving system, a sending device and means controlled thereby for connecting said receiving system to said elevated transmitting-conductor system between two points across which there exists a practically zero difference of potential during transmission.

36. In a space-telegraph system, an elevated transmitting-conductor system, a receiving system, one terminal of which is connected to said transmitting system at a point having practically zero potential to ground, a sending device and means controlled thereby for connecting the other terminal of said receiving system to said elevated transmitting-conductor system at a point which dur-

ing transmission has practically zero potential to ground.

37. In a space-telegraph system, an elevated transmitting-conductor system, a receiving system and means connecting the terminals of said receiving system during transmission to said elevated transmitting-conductor system at a point which during transmission has practically zero potential to ground.

38. In a space-telegraph system an elevated transmitting-conductor system, a receiving system, a sending device and means controlled thereby for connecting the terminals of said receiving system during transmission to said elevated transmitting-conductor system at a point which during transmission has practically zero potential to ground.

39. In a space-telegraph system, an elevated transmitting-conductor system, a sending device, a receiving system having one terminal connected to said elevated transmitting-conductor system at a point, a conductor of practically zero impedance connecting said point to earth, and a conductor of practically zero impedance controlled by said sending device for connecting the other terminal of said receiving system to the aforesaid point.

40. In a space-telegraph system, an elevated conductor, a source of electrical oscillations, means associating said elevated conductor and said source of electrical oscillations, a receiving system connected to said elevated conductor between the lower end of the aforesaid means and the earth connection of said elevated conductor, a sending device and means controlled thereby for short-circuiting said receiving system.

41. In a space-telegraph system, an elevated conductor, a source of electrical oscillations, means for inductively translating the energy of said electrical oscillations to said elevated conductor, a receiving system connected to said elevated conductor between the lower end of the aforesaid means and the earth connection of said elevated conductor, a sending device and means controlled thereby for short-circuiting said receiving system.

42. In a space-telegraph system, an elevated conductor, an oscillating circuit, an inductance included in said elevated conductor, an inductance included in said oscillation-circuit, a receiving system connected to said elevated conductor between the lower end of the inductance which is included in said elevated conductor and the earth connection of said elevated conductor, a sending device and means controlled thereby for short-circuiting said receiving system.

43. In a space-telegraph system, an elevated conductor, means whereby electrical oscillations may be developed therein, a sending device controlling said means, a receiving system connected between the earth connection of said elevated conductor and the point of association of said means with said conductor and means controlled by said sending device for short-circuiting said receiving system.

44. In a space-telegraph system, an elevated conductor, an oscillation-producer, a sending device controlling said oscillation-producer, means associating said oscillation-producer with said elevated conductor, a receiving system connected to said elevated conductor between said means and the earth connection of said conductor, and means controlled by said sending device for short-circuiting said receiving system.

45. In a space-telegraph system, a receiver, an elevated conductor, means associating said receiver therewith, a sending device and apparatus operated by said sending device for automatically putting said system in condition for receiving by grounding said elevated conductor through said means when said sending device is in one position and for automatically putting said system in condition for transmitting by short-circuiting said means when said sending device is in another position.

46. In a space-telegraph system, a receiver, an elevated conductor, means associating said receiver therewith, a sending device and apparatus operated by said sending device for automatically putting said system in condition for receiving by grounding said elevated conductor through said means when said sending device is in its normal position and for automatically putting said system in condition for transmitting by short-circuiting said means when said sending device is in another position.

In testimony whereof I have hereunto subscribed my name this 15th day of November, 1905.

SEWALL CABOT.

Witnesses:
WM. D. MEELER,
GEO. K. WOODWORTH.