No. 725,636. PATENTED APR. 14, 1903.

J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED MAR. 12, 1903.

NO MODEL. 5 SHEETS—SHEET 1.

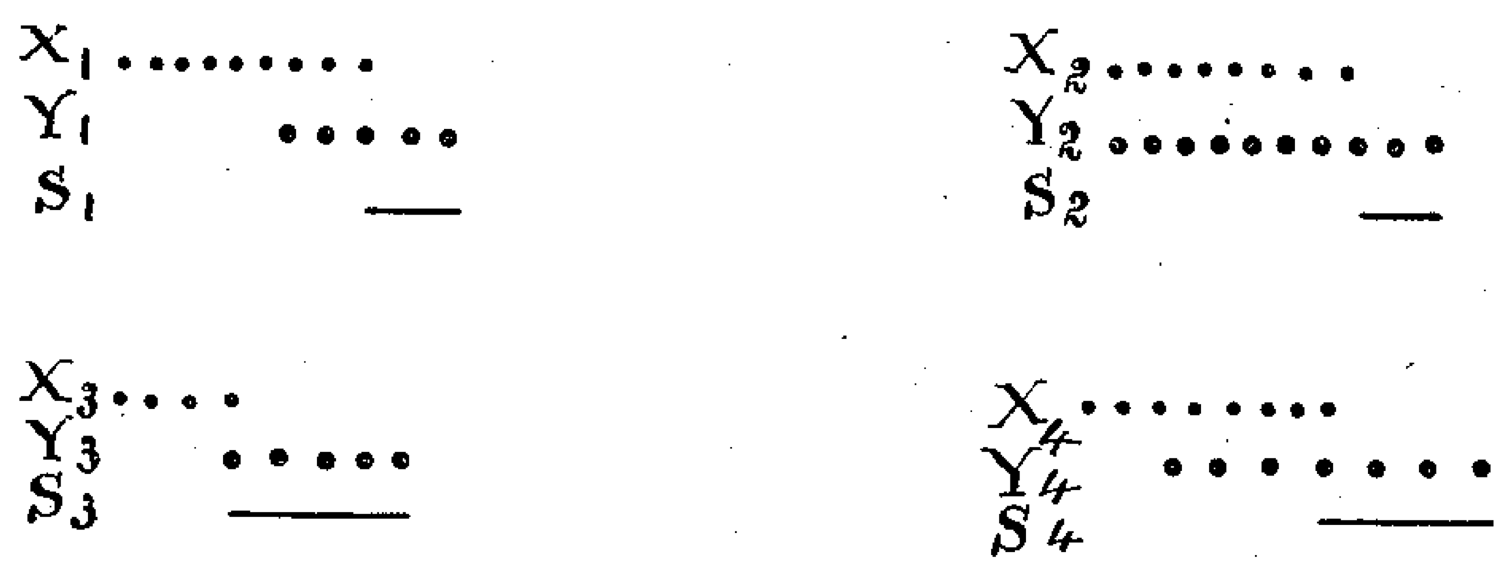

Fig. 1.

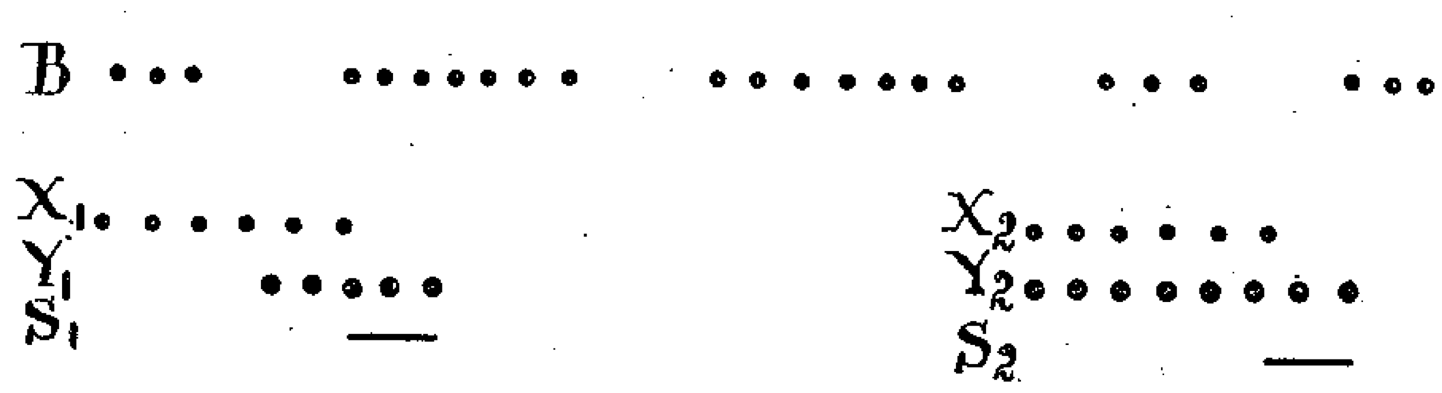

Fig. 1a

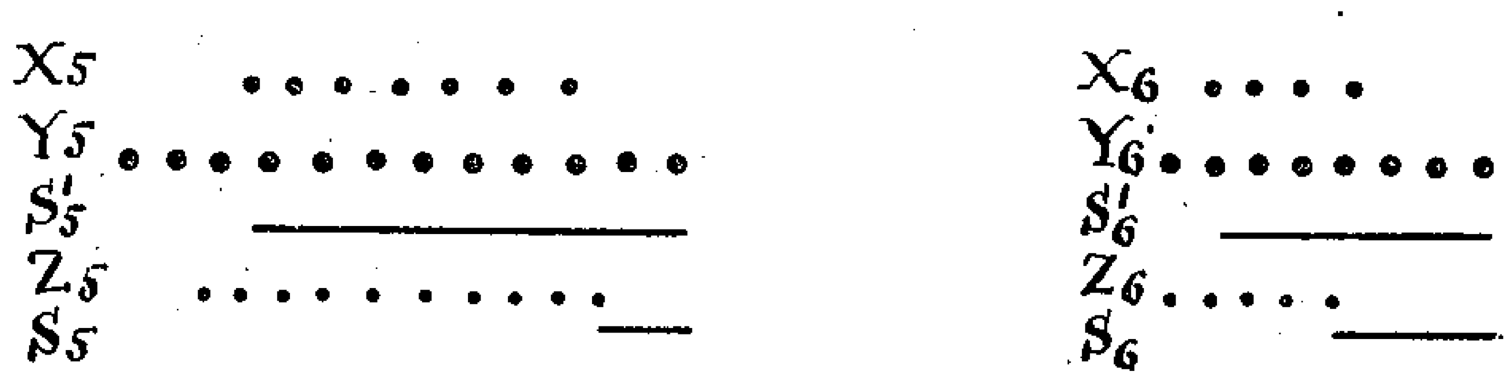

Fig. 2.

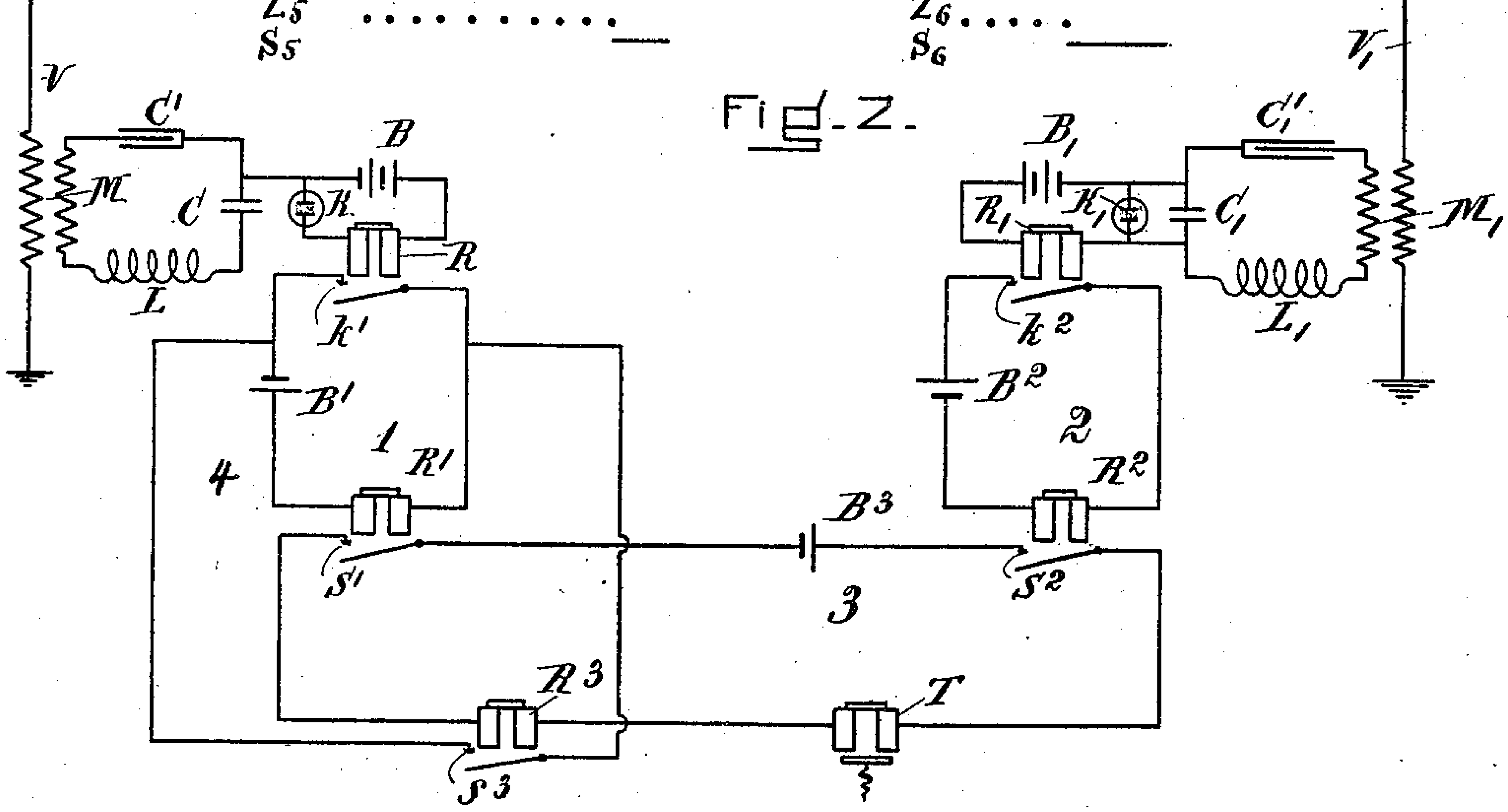

Fig. 3.

WITNESSES:

Brainerd T. Judkins

Georgia A. Higgins

INVENTOR:

John Stone Stone

by Alex. P. Browne

atty

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NO MODEL. 5 SHEETS—SHEET 2.

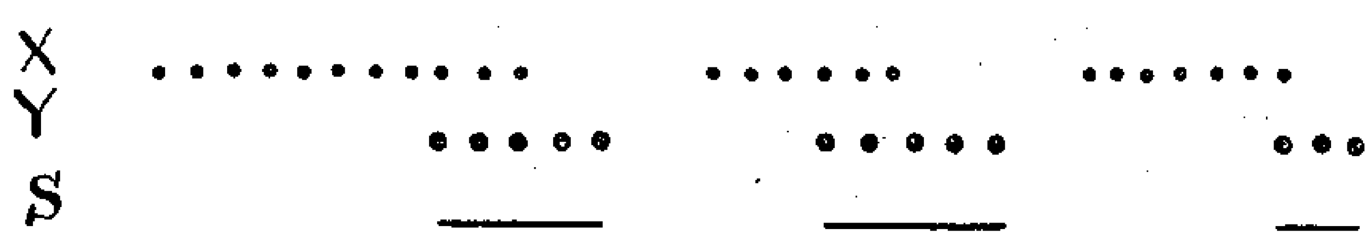

Fig. 4.

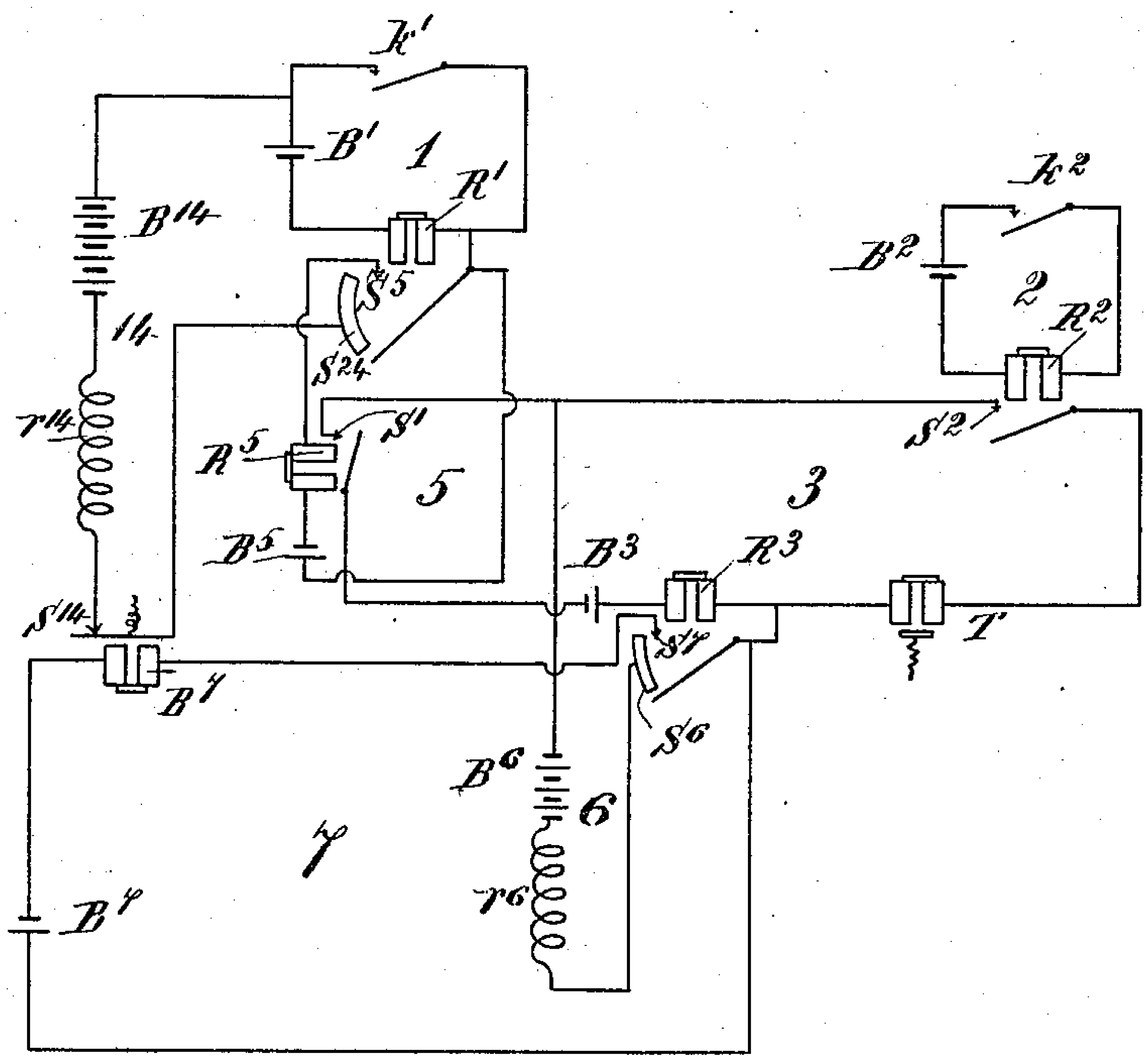

Fig. 5.

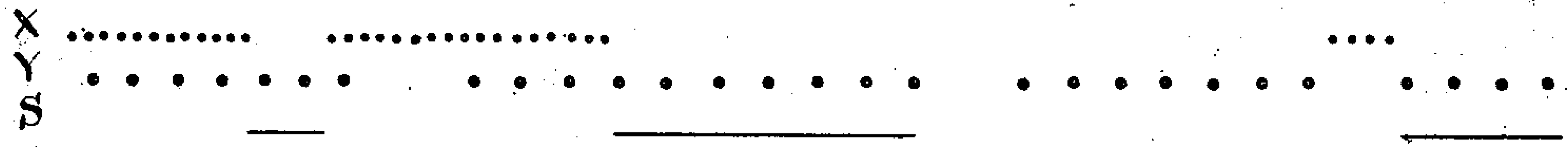

Fig. 6.

Witnesses:
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No. 725,636

PATENTED APR. 14, 1903.

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SPACE TELEGRAPHY.

APPLICATION FILED MAR. 12, 1903.

NO MODEL.

5 SHEETS—SHEET 3.

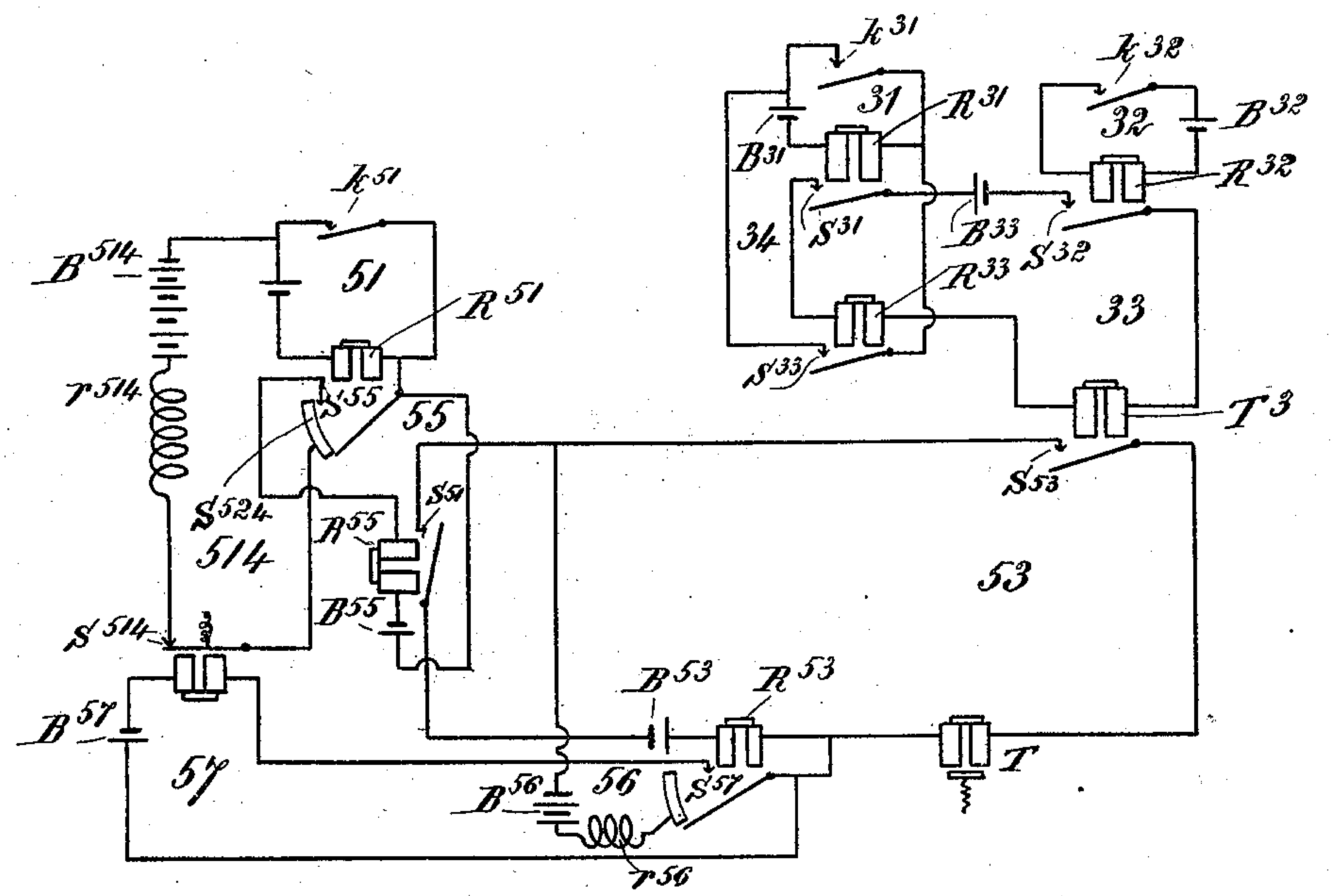

Fig-7

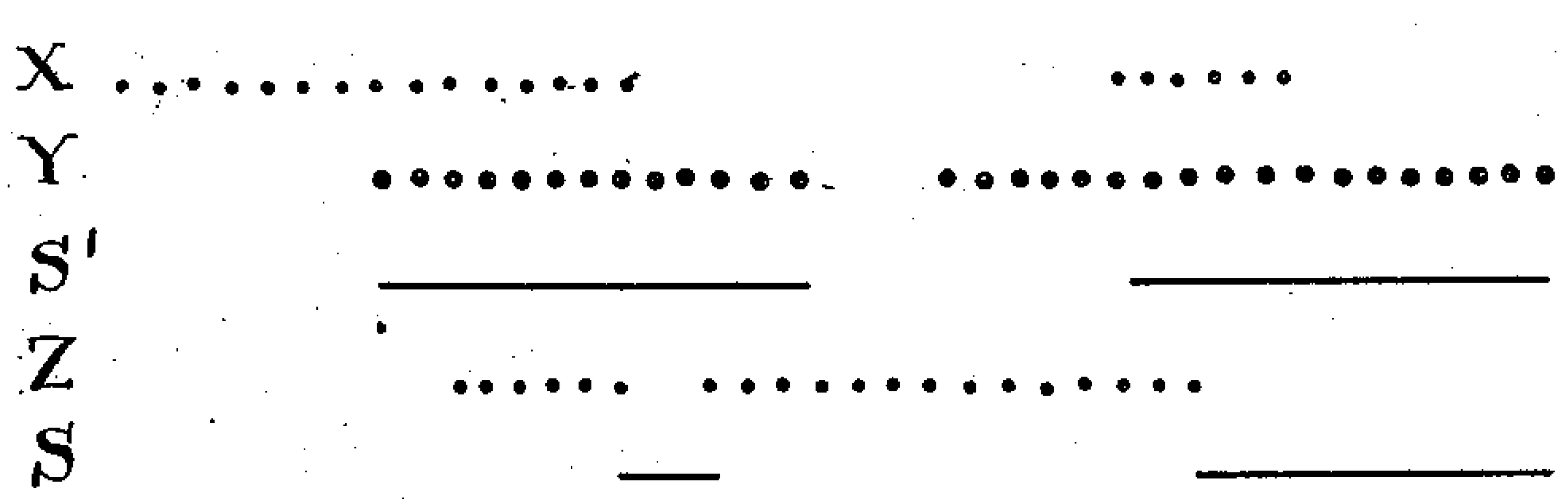

Fig-8-

WITNESSES:

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INVENTOR:

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No. 725,636. PATENTED APR. 14, 1903.

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SPACE TELEGRAPHY.

APPLICATION FILED MAR. 12, 1903.

NO MODEL. 5 SHEETS—SHEET 4.

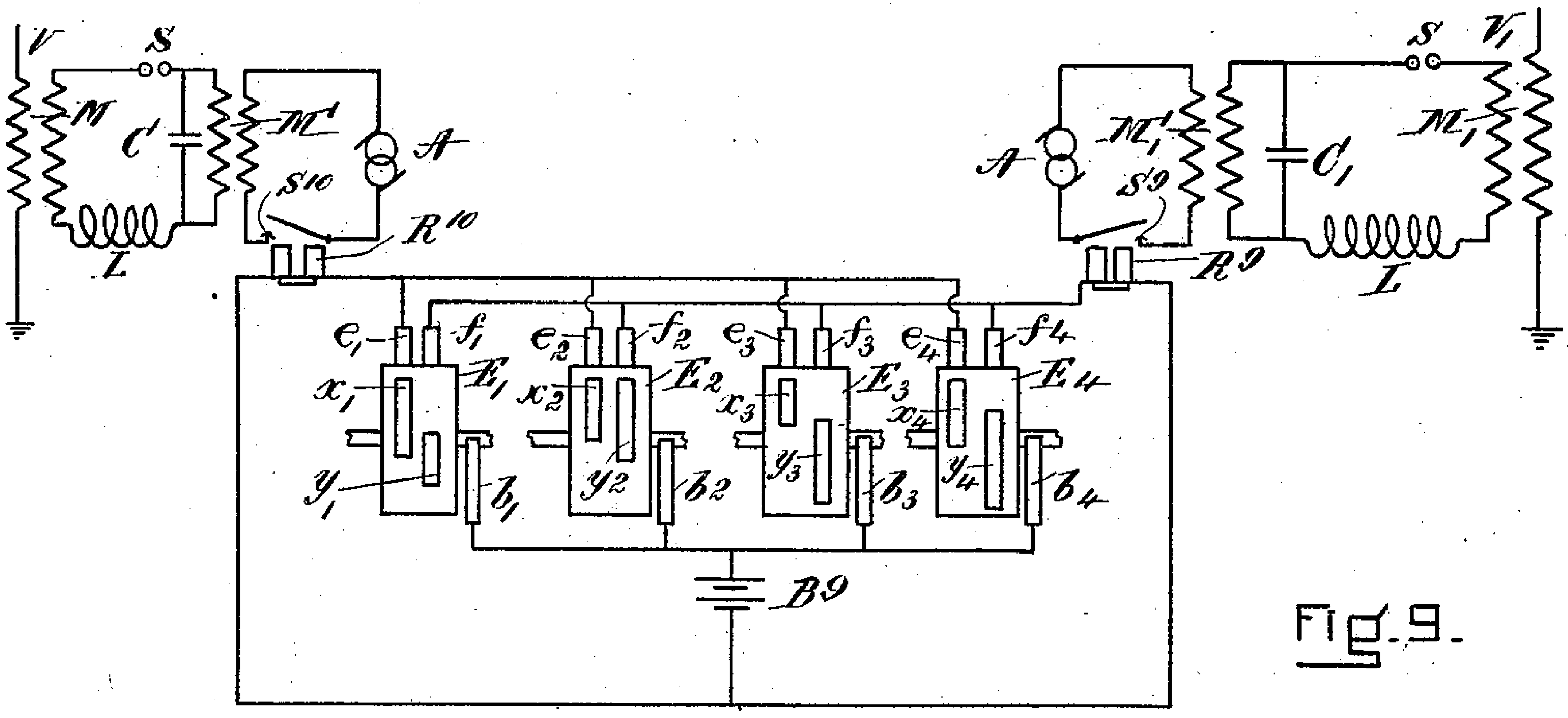


Fig. 9.

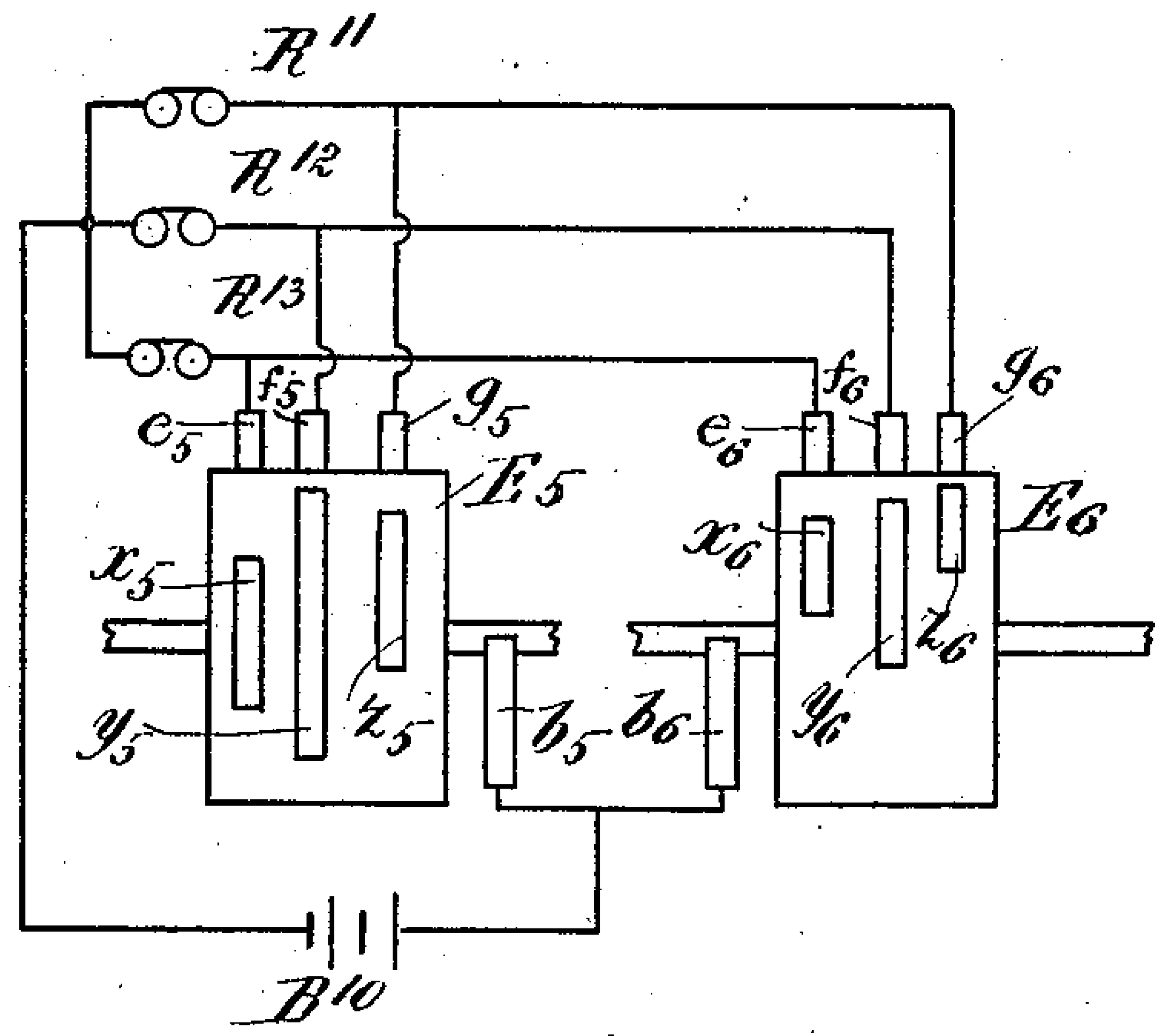
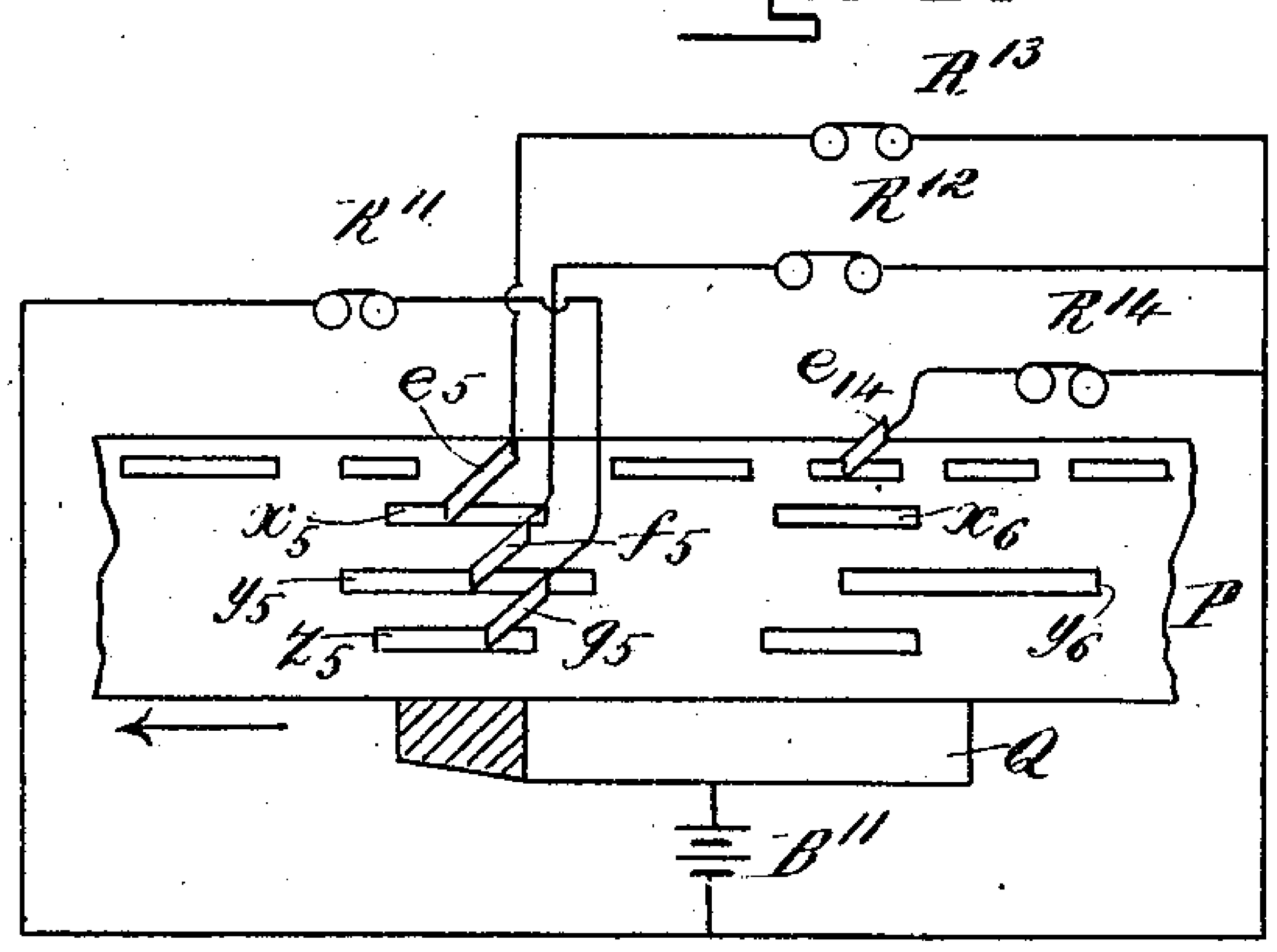


Fig. 10.



WITNESSES:

Brainerd T. Judkins

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Fig. 11.

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No. 725,636. PATENTED APR. 14, 1903.

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APPLICATION FILED MAR. 12, 1903.

NO MODEL. 5 SHEETS—SHEET 5.

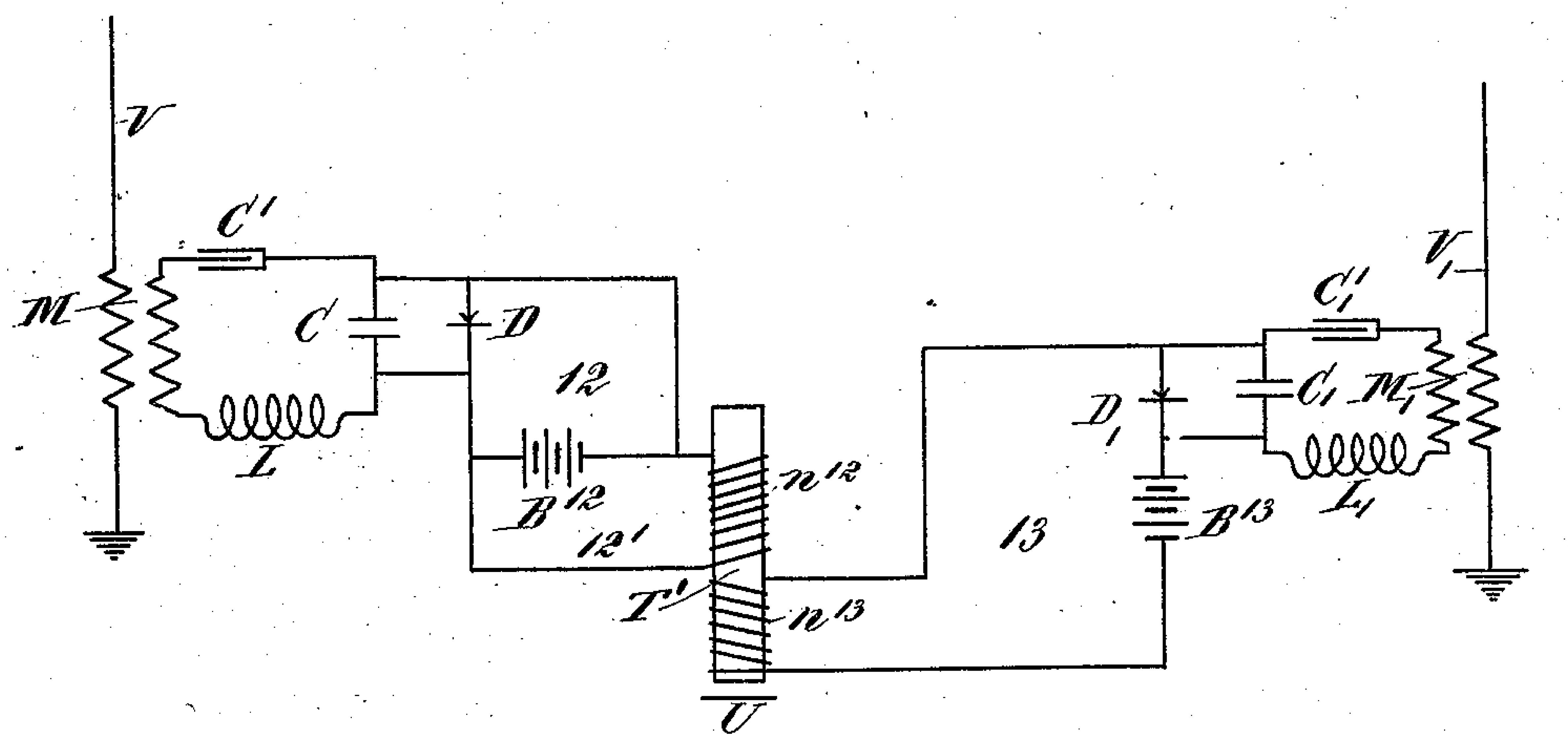

Fig. 12.

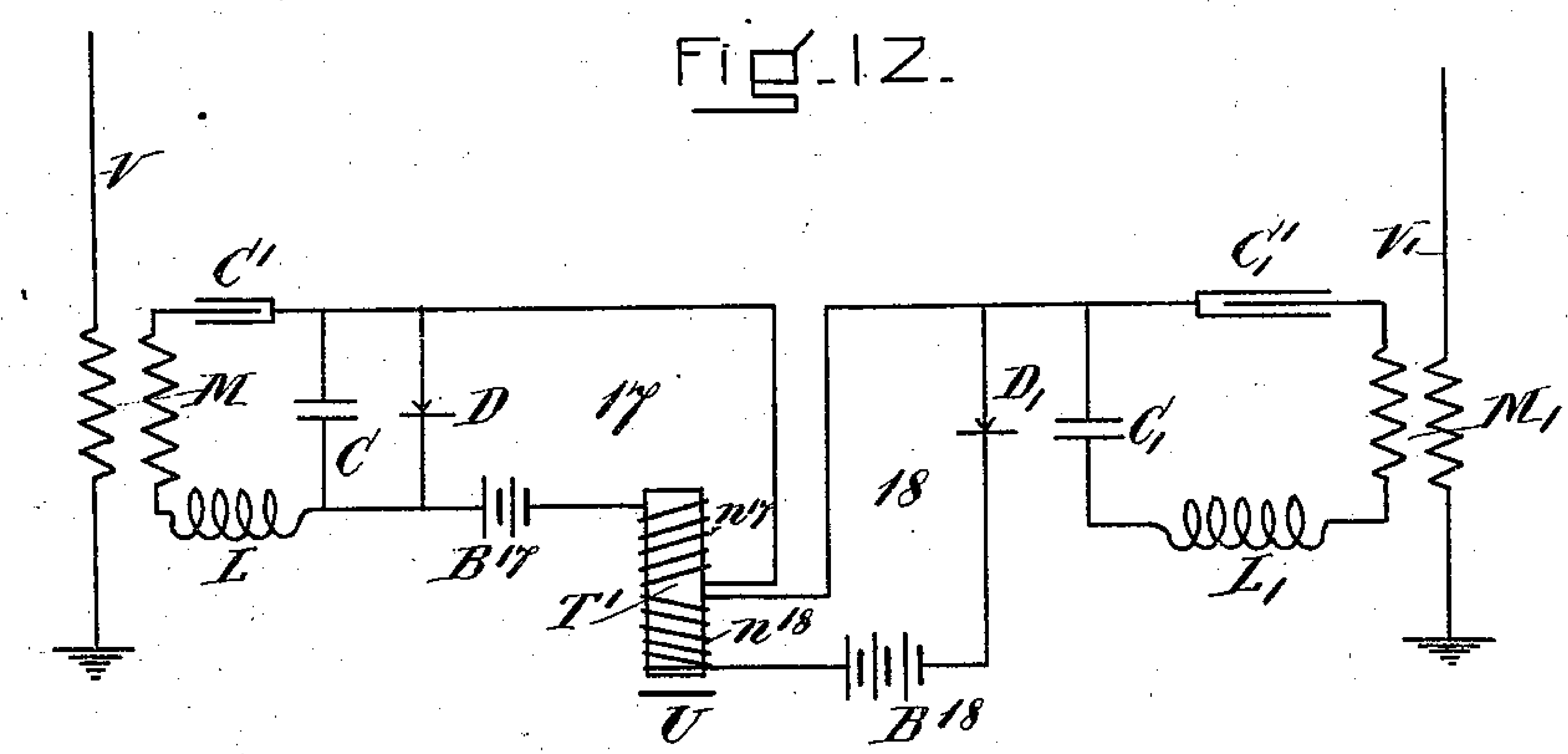

Fig. 14.

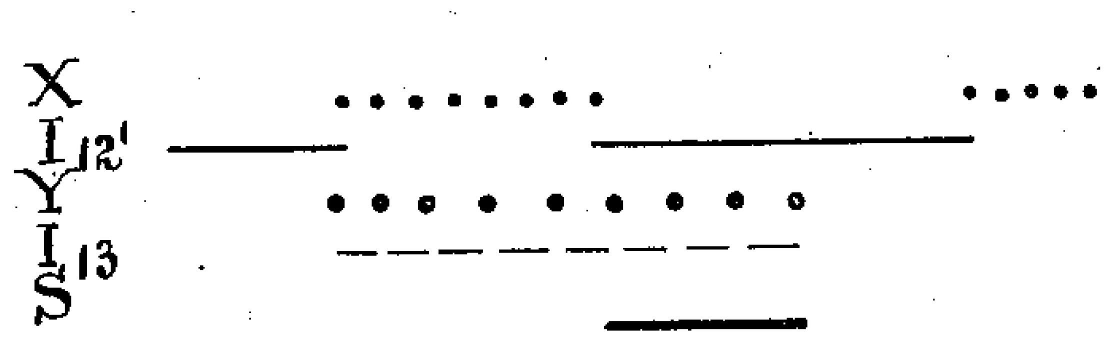

Fig. 13.

WITNESSES:

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INVENTOR:

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JOHN STONE STONE, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO STONE TELEGRAPH AND TELEPHONE COMPANY, OF PORTLAND, MAINE.

SPACE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 725,636, dated April 14, 1903.

Application filed March 12, 1903. Serial No. 147,384. (No model.)

To all whom it may concern:

Be it known that I, JOHN STONE STONE, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Space Telegraphy, of which the following is a specification.

My invention relates to wireless or space telegraphy, and more particularly to that form of space telegraphy in which the signals are transmitted by electromagnetic waves in the form of radiant energy, guided only by the surface of the earth or water over which they travel and in which the electric force is normal to the surface of the earth while the magnetic force is parallel to the surface of the earth.

My invention still more particularly relates to selective and multiple space-telegraph systems in which the signals to be selectively or separately received are transmitted by means of waves (preferably simple harmonic waves) which are differentiated from one another by their frequencies, times of vibration, or pitch and in which the reception of the energy of these waves each in a separate electric translating device is effected by resonant circuits each attuned to the frequency of the particular wave the energy of which it is intended to receive.

My invention still further relates to a system by which it shall be possible to transmit signals to a certain predetermined receiving-station to the exclusion of all other receiving-stations and by which it shall be possible to secretly as well as selectively transmit signals which are incapable of intelligible reception and translation by unauthorized parties.

Electromagnetic waves in which the electric force is normal to the earth's surface and in which the magnetic force is parallel to the earth's surface are best radiated from a conductor normal to the earth's surface and are best received upon a conductor also normal to the earth's surface, these facts being understood by those skilled in the art of wireless telegraphy to-day; but I have found that in order to produce simple harmonic waves it is highly desirable and, indeed, probably necessary to develop the waves by producing forced simple harmonic electric vibrations or oscillations in the radiating-conductor and that in order to receive the energy of the simple harmonic waves of one frequency in a particular translating device to the exclusion of like waves of different frequency it is necessary to associate with the receiving-conductor a resonant circuit or resonant circuits attuned to the particular frequency of the waves the energy of which is to be absorbed.

A method and apparatus for developing simple harmonic electromagnetic waves of desired frequency by producing forced simple harmonic electric vibrations or oscillations in a radiating-conductor have been fully set forth by me in two Letters Patent Nos. 714,756 and 714,831, dated December 2, 1902, and a method and apparatus for receiving the energy of simple harmonic waves of one frequency to the exclusion of the energy of like waves of different frequency are likewise set forth in said Letters Patent. In them is set forth a system of selective and multiple telegraphy in which the signals to be separately received are transmitted by simple harmonic waves which are differentiated from one another by their frequencies and in which the reception of the energy of these waves of different frequencies each in a separate electric translating device is effected by resonant circuits each attuned to the frequency of the particular waves the energy of which it is intended to receive.

The principal objects of the present invention may be realized with the apparatus described in said Letters Patent. For this reason no discussion of the methods and apparatus required to successfully accomplish the hereinbefore-mentioned selective and multiple space telegraphy need be given in the present specification, since reference may be had to the specifications of said Letters Patent.

The object of the present invention is, first, to make it practically impossible for an operator at a wireless or space telegraph station to receive intelligently a message not intended for his station, and, second, to make it practically impossible for an operator at a wireless or space telegraph station to confuse or render unintelligible a message passing between two other stations. To accomplish these results, I cause the message to be sent by two or more separate groups or trains of electromagnetic waves, (preferably simple harmonic electromagnetic waves,) the waves of each train having a frequency different from that of the waves of the other train or trains, and I may employ in conjunction with these trains of waves other trains of waves, which I may call "blind" trains, which are not received and are not intended to be received at the station to which the message is sent. I may also employ sets of trains of waves, each set being capable of intelligible reception and translation at a predetermined receiving-station only into an element such as a "dot" or "dash" of the Morse or other telegraphic code.

I may employ several sets of trains of waves, each set composed of trains of waves differing in frequencies, but the trains of waves of one set being of the same frequency as the corresponding trains of waves of another set, and I may so arrange the lengths and times of transmission of the several trains of waves of each set that although the effects of these component trains of waves on a receiver attuned to the frequency thereof are all different the combined effects of these component trains—that is, the effects of the sets of trains of waves on a particular receiving-station—are the same, and I may so arrange the trains and so adjust their lengths or times of duration that the signal received by a foreign station is just the opposite to that received by the particular station to which signals are to be transmitted.

The trains of signal-waves may be transmitted wholly or in part simultaneously or may be transmitted successively, so that the definite signals require for their intelligible reception either the wholly simultaneous or partially simultaneous or the successive reception of the waves of different frequency.

In application Serial No. 137,707, filed January 3, 1903, I have described a method of selectively and secretly receiving space-telegraph signals, and I have described several ways of accomplishing these results. In this specification I shall describe several forms of apparatus designed to transmit electromagnetic waves for secret and selective reception and also several forms of apparatus by which said waves may be so received.

A clear understanding of this invention will be had by having reference to the drawings, which accompany and form a part of the present specification. These drawings, however, show diagrammatically only simple forms of circuit arrangements by which my invention may be carried into effect and which are merely typical or illustrative forms of the same, which may be modified by those skilled in the art without departing from the spirit of my invention.

Figures 1, 1ª, and 2 are illustrative diagrams, each showing the relations of the trains of waves of different frequency to each other and the resultant signals, whereby a signal opposite in character to the intended signal is received by a foreign station attuned to the frequency of a single train of waves. Fig. 3 illustrates apparatus adapted to respond to signal-waves of two different frequencies, which may be called X and Y, such response beginning when the waves of frequency X overlap those of frequency Y and continuing afterward while those of the Y frequency persist, those of the X frequency having meanwhile ceased. Fig. 5 illustrates apparatus adapted to respond to signal-waves of two different frequencies—say X and Y—the response not beginning, however, until after the waves of frequency X have acted upon the receiving-station and have ceased after waves of Y frequency have begun and the intelligible response continuing thereafter until the waves of the Y frequency cease or until the waves of frequency X again begin to act. Fig. 7 illustrates apparatus adapted to respond to signal-waves of three different frequencies X, Y, and Z, X and Y being related as in Fig. 3 and their operative resultant and the Z frequency being related to the final resultant as X is related to Y in Fig. 5. Figs. 4, 6, and 8 are illustrative diagrams, each showing the relation of the waves of different frequency to each other and to the resultant signals as received by the circuit of the figure which precedes it. Fig. 9 illustrates apparatus for transmitting trains of waves related to each other as shown in Fig. 1 and which are adapted for intelligible reception and translation by the apparatus shown in Fig. 5. Fig. 10 illustrates apparatus for transmitting trains of waves related to each other as shown in Fig. 2 and which are adapted for intelligible reception and translation by the apparatus shown in Fig. 7. Fig. 11 illustrates another form of apparatus for transmitting waves related to each other as shown in Fig. 2. Fig. 12 illustrates a modified form of receiving apparatus employing self-restoring wave-detectors. Fig. 13 is an illustrative diagram showing the relation of the waves received by the system shown in Fig. 12 and the relation of the currents in the windings of the receiver to the resultant signal. Fig. 14 is another form of a receiving apparatus employing self-restoring wave-detectors.

In the drawings, B' and B^2, &c., indicate batteries.

k' k^2, &c., are contacts which are closed by the passage of groups or trains of waves of the character referred to.

R' R^2, &c., are relays each controlling a circuit-closing armature.

r' r^2, &c., indicate resistance in the circuit.

s' s^2, &c., are the contact-points with which the armatures controlled by the relays R' R^2, &c., make connection.

S in Figs. 4, 6, and 8 indicate the signals received by the translating device T and which are made up by currents of different frequencies X and Y or by their resultant S' and a current of a third frequency Z.

In Figs. 1, 1^a, 2, and 13, X_1 X_2, Y_1 Y_2, Z_5 Z_6, S_1 S_2, &c., indicate the lengths and the relative positions of the various trains of waves of the several frequencies and the resultant signals made up thereby.

The numerals refer to the various circuits.

V V_1 are elevated transmitting and receiving conductors.

M M_1 are oscillation-transformers.

s is a spark-gap.

C C_1 C' C'_1 are condensers.

L L_1 are inductances.

M' M'_1 are transformers.

A is an alternating-current generator.

K K_1 are coherers or other wave-detectors, and D D_1 are self-restoring wave-detectors.

I will now proceed to describe more in detail the apparatus shown in each figure, its mode of operation, and the result.

Referring first to Fig. 9, E_1 E_2, &c., are cylinders of insulating material carrying on their surfaces contact-strips x_1 y_1 x_2 y_2, &c., which are electrically connected to the shaft on which the cylinder is mounted, b_1 b_2, &c., are metal brushes making electrical contact with the shafts, and e_1 f_1, &c., are metal brushes adapted to contact the strips x_1 y_1, &c., when the cylinders are rotated. This rotation may be effected by any convenient means—such, for instance, as those shown in my application, Serial No. 147,383, filed on even date herewith. Upon the rotation of cylinder E_1 brush e_1 contacts strip x_1, thereby closing the circuit of relay R^{10} and causing the current from the battery B^9 to flow by way of b_1, the shaft, x_1, e_1, R^{10}, and back to the battery. The relay R^{10} thus energized closes the circuit of the alternator A and primary of the transformer M' at the point s^{10}, thus causing the radiation from the elevated conductor V of electromagnetic waves of frequency X as long as the brush e_1 continues in contact with strip x_1. The continued rotation of the cylinder brings the strip y_1 under the brush f_1, thus energizing the relay R^9, and thereby causing in like manner the radiation from conductor V_1 of electromagnetic waves of frequency Y as long as brush f_1 remains in contact with the strip y_1. Likewise by the partial rotation of the cylinders E_2 E_3 E_4 trains of waves of frequency X and Y are radiated, the lengths or times of duration being determined by the lengths of the various strips *x* and *y* on the surface of each cylinder and the periods of overlapping or coexistence of the said trains of waves being determined by the amount of overlapping of said strips, or, in other words, by the time in which two brushes *e* and *f* simultaneously contact strips *x* and *y*, respectively.

In Fig. 10 is shown an apparatus whereby the radiation of three trains of waves of frequency X, Y, and Z, each from a transmitting system such as shown in Fig. 9, is effected by the energization of the relays R^{11}, R^{12}, and R^{13}. It is to be understood, however, that instead of employing a separate elevated conductor for the radiation of trains of waves of each frequency I may employ a single elevated conductor having associated therewith a plurality of sonorous circuits, each capable of developing and impressing on said conductor electric oscillations of the desired frequency, as fully described by me in the Letters Patent hereinbefore referred to.

In Fig. 11 I have shown a modified form of controlling apparatus whereby the relays R^{11}, R^{12}, and R^{13} are energized for regulating the transmission of trains of waves of frequency X, Y, and Z related to each other as those trains of waves of like frequency radiated by a system controlled by the apparatus shown in Fig. 10. This energization of the relays is effected by means of a perforated strip P, which travels over a metallic block Q in the manner well known in the art of machine telegraphy. Here the brush e_{14} controls the relay R^{14} for the transmission of the blind waves above referred to.

In Fig. 1 I have shown a convenient arrangement of the trains of waves transmitted by the apparatus illustrated in Fig. 9, and in Fig. 2 I have shown a convenient and practical arrangement of the trains of waves radiated by a system which is controlled by the apparatus illustrated in Figs. 10 and 11.

In Fig. 1 the series of dots X_1 Y_1 represent the lengths or durations of the trains of waves of frequency X and Y radiated while the brushes e_1 and f_1, respectively, remain in contact with the strips x_1 and y_1; and consequently X and Y represent the times of duration of the currents developed in the resonant circuits attuned, respectively, to frequency X and Y. Likewise X_2 Y_2, X_3 Y_3, X_4 Y_4 represent the lengths or durations of the trains of waves of frequency X and Y radiated while the brushes e_2 and f_2, e_3 and f_3, e_4 and f_4, respectively, contact the strips x_2 y_2, x_3 y_3, x_4 y_4. X_1 X_2 X_4 are all preferably of the same length, and X_3 is one-half of this length.

Y_1 and Y_3 are of equal length, and Y_2 and Y_4 are of equal length; but Y_2 is twice the length of Y_1. I shall hereinafter describe an apparatus whereby the energy of these trains or groups of waves are so combined as to cause a translating device to produce signals of length or duration equal to S_1 S_2 S_3 S_4 when the four sets of trains of waves illustrated in Fig. 1 are transmitted. For the present it may be assumed that such signals are produced. It will be noted that there are two ways of transmitting a short signal or the dot of a telegraph code and likewise two ways of transmitting a long signal or a dash. It will also be noted that a foreign receiving-station which by means of an electrical siren or otherwise succeeds in ascertaining the frequency X or Y will receive signal indications entirely different from those received by the particular receiving-station which is provided with the receiving apparatus hereinafter described. For example, if the cylinders E_1 E_2 E_3 E_4 are partially rotated one after the other the station which is attuned to frequency X will receive a signal represented by dots and dashes arranged as follows: — — - —, and a station attuned to frequency Y will receive the signal - — - —, whereas the station provided with the apparatus hereinafter described will receive the signal - - — —. It is to be understood, however, that the arrangements of the trains of waves are merely illustrative of a few of the many ways which may be devised by those skilled in the art in practicing my invention for codifying the messages or for concealing from outside stations the real significance of the transmitted waves. I therefore do not desire to be limited to any of the particular arrangements herein described.

It will be noted that a convenient way of transmitting dots and dashes is to use trains X_2 Y_2 and X_3 Y_3, respectively, because X_2 and Y_2 being respectively twice as long as X_3 and Y_3 will give an outside station attuned to frequency X or Y signal indications exactly opposite to those received by the predetermined receiving-station. In this case a station attuned to frequency X will receive the signal — - and the one attuned to frequency Y will likewise receive the signal — -, while the predetermined station will receive the signal - —, or for sending dots and dashes trains X_2 Y_2 and X_4 Y_4, respectively, may be used. In this case a station attuned to frequency X will receive two signals of equal length, which may represent either dots or dashes, because the interpretation of the signal does not depend upon its absolute length or time of duration, but depends, of course, upon a comparison with another signal of a different length.

A station attuned to frequency Y will, like the station attuned to frequency X, receive two signals of equal length, whereas the predetermined station will receive the signal - —. If X_1 Y_1 and X_3 Y_3, respectively, are used for transmitting a dot and a dash, the station attuned to frequency X receives the signal — - and the station attuned to frequency Y receives two signals of equal length, whereas the predetermined station receives the signal - —.

In Fig. 1^a I have shown associated with the trains X_1 Y_1 and X_2 Y_2 groups or train of waves B of a different frequency, which may be called "blind" groups and which are not received and are not intended to be received at the station to which the message is sent. These blind groups of waves may be transmitted in an irregular manner calculated to resemble the waves of a real message, or, preferably, they may in whole or in part be utilized in transmitting the same message in duplicate to a set of instruments similar to those hereinafter described, but actuated by waves of a different frequency.

By the arrangements above described may be frustrated any attempt to interfere with the intelligible reception of the message by a device which will radiate waves of any desired frequency and which may after the manner of a siren give forth successively waves covering in frequency the entire range of frequencies employed in the transmission of the message, and in this way also may be frustrated any attempt to intercept and translate the message transmitted.

It now remains to describe the various systems whereby the trains of waves transmitted as above described or in any other convenient manner may be received and translated into intelligible messages.

In the apparatus shown in Fig. 3, k' k^2 are contacts adapted to be closed by the energization of the relays R R_1 in the coherer-circuits of the systems associated with the elevated conductors V V_1. The coherers are each shunted around a condenser C C_1 in the closed circuits C C' M L and C_1 C'_1 M_1 L_1, resonant, respectively, to the frequencies X and Y. The circuit 1 includes the battery B', relay R', and the circuit 2 includes the battery B^2 and relay R^2. These relays R' and R^2 when energized operate, respectively, upon their armatures to close the contacts s' and s^2 in circuit 3, which includes the battery B^3, the sounder, or other appropriate translating device T and the relay R^3, adapted to control an armature in circuit 4, which is a shunt-circuit around the battery B' and relay R' of circuit 1 and close the contact s^3, completing the shunt-circuit. After the contact s^3 has been made the shunt-circuit 4 is effective to continue the energization of the relay R' when the contact k' has been broken and so maintain the contact at s' in circuit 3, accomplishing this by means of a battery B' and relay R', which then becomes part of the circuit 4. It will be seen that the translator T does not receive its signal until both contacts s' and s^2 have been closed by reason of the passage of appropriate currents to close the contacts k' and k^2; but if contact k' is broken thereafter it does not cause the breaking of any contact in the receiving-circuit 3 until after the contact k^2 is also broken, because the contact s', which is in the first instance made by current in circuit 1, is maintained by circuit 4 until such time as contact is broken at k^2, when contact breaks at s^2, and hence relay R^3 becomes dead, causing the breaking of contact at s^3, and hence contact at s', through the demagnetizing of relay R'. The relations of the several currents in this case are indicated in Fig. 4, from which it will be seen that the signals represented at S are caused by current Y after current X has closed contact at k', after which current X may cease.

Referring now to Fig. 5, I show an apparatus in which the signals to be translated are caused by an apparatus which is set first by the passage of current X, then simultaneously therewith by the passage of current of frequency Y, the actual signal, however, being given only by the current Y after the current X has ceased, as indicated in Fig. 6. In this case, as before, we have two circuits 1 and 2, each containing contacts k' k^2, adapted to be closed by currents X and Y, respectively, which actuate relays like relays R′ and R^2 of Fig. 3, and we have also the translator-circuit 3, containing the translating apparatus T, the relay R^3, and the battery B^3. In this case there is also a shunt-circuit about the battery B′ and relay R′, which, as it differs from the shunt 4 in Fig. 3, I will call circuit 14. This circuit includes a battery B^{14} more powerful than the battery B′ and also contains a resistance r^{14} and a contact at s^{14} normally closed, the armature closing it being under the influence of a relay R^7, forming part of the circuit 7, to be described below. This circuit 14 is closed by contact at s^{24}, caused by an armature under the influence of relay R′ and remains closed after the same armature has closed circuit 5, as below described. Turning to circuit 3, its contacts are at s' and s^2, the contact at s' being caused by the operation of an armature controlled by a relay R^5 in circuit 5, which circuit contains also a battery B^5 and is made by the closing of contact s^5 by the armature controlled by relay R′, being the same armature which controls circuit 14, as above described, the closing of the circuit 5 taking place in the manner below described after circuit 14 has been closed without breaking that circuit. Circuit 6 is a shunt-circuit and is closed at s^6 by the armature controlled by relay R^3 in circuit 3. This shunt-circuit contains a battery B^6 more powerful than the battery B^3 in circuit 3, circuit 6 also containing a resistance r^6. Another circuit 7, carrying the relay R^7, which controls the contact s^{14} in circuit 14, is closed at s^7 by a further movement of the armature controlled by the relay R^3, which makes this contact without breaking circuit 6. In this case the current of X frequency closes contact at k', which energizes relay R′, and hence closes contact at s^{24}, closing circuit 14. When thereafter current of frequency X ceases, so that contact k' is broken, the heavier battery B^{14} in the shunt-circuit 14 energizes the relay R′, so that it still further attracts its armature and closes contact at s^5, thus completing the circuit 5, energizing relay R^5, and thus closing contact at s' in the circuit 3. This puts circuit 3 in condition to receive signals given by currents of Y frequency through the operation of contact k^2; but, as will be understood, it is only after current of X frequency has ceased that this situation exists, and thereafter if while currents of Y frequency are closing contact k^2 currents of X frequency again pass the battery B^{14} in shunt-circuit 14 no longer so energizes the relay R′ that it holds the contact s^5, but relieves it to the extent that the contact s^{24} is maintained, thus breaking the circuit 5. In a somewhat similar manner the apparatus is cleared when the current Y has ceased by use of a shunt-circuit 6 and the circuit 7 as follows: When circuit 3 is completely closed, the relay R^3 being energized causes the contact s^6 to be closed, thus closing the shunt-circuit 6; but when contact k^2 is broken the more powerful battery B^6 energizes relay R^3, so that it attracts its armature still farther and makes contact s^7. Thus circuit 7 is closed and attracts its armature, which breaks contact at s^{14}, and hence clears the circuit. The signals in this case are indicated in Fig. 6, where it will be seen that the signal itself is given by means of current of frequency Y only when a current of frequency X has preceded it and ceased.

In Fig. 7 I have still another arrangement of circuits to the same end operating by means of what may be termed "compounding" signals, as will be understood from Fig. 8, where currents of X frequency are shown as operating first to enable currents of Y frequency to accomplish their work by energizing a suitable relay, which corresponds to the translator T in Fig. 3, the signal which would result from this effect being indicated by the line S′, which in turn is effective upon the translator T only after the currents of Z frequency have energized this circuit and have ceased, the result being signal S.

In order to more easily trace out the circuits in Fig. 7, the circuits and corresponding parts therein which are taken from Fig. 3 are indicated by the prefix 3, and the circuits and corresponding parts which are taken from Fig. 5 are indicated by the prefix 5.

To consider first the portion of the diagram Fig. 7 which is taken from Fig. 3, 31 and 32 are circuits corresponding to circuits 1 and 2 in Fig. 3, circuit 33 being a circuit corresponding to the circuit 3, which in Fig. 3 contains the translator, but which in this figure contains relay T^3, 34 being its shunt-circuit.

The portion of the circuits of Fig. 7 taken from Fig. 5 comprises the circuit 51, corresponding to the circuit 1 of Fig. 5, the circuit 514 corresponding to circuit 14 of Fig. 5, and the circuits 55, 56, and 57 correspond to the various circuits numbered 5, 6, and 7 in Fig. 5. The translator T is in the receiving-circuit 53, which corresponds to the circuit 3 of Fig. 5. Without following out the exact operations in detail which take place in the apparatus shown in this diagram Fig. 7 it will be noted that the contact s^{53} is only closed when the relay T^3 is energized and that this takes place only under such circumstances as would energize the translator T in Fig. 3. The translator T can of course only be energized when circuit 53 is closed. The sequence of operations in this case comprises, first, the closing of contact k^{31} by current X, then the closing of contact k^{32} by current Y, so that both contacts s^{31} and s^{32} are closed, completing the circuit 33, the closing of circuit 33 through T^3 also causing the closing of the contact s^{33}, so that thereafter the contact k^{31} may be broken at any time. The closing of circuit 33 causes the closing of contact s^{53}, and thus circuit 53 when contact s^{51} has been closed through the passing of current of Z frequency by contact k^{51}. In other words, in its operation the apparatus of Fig. 3 in this case is used not to operate a translator, but instead to operate a relay to close a translator-circuit, and the translator is therefore operated under precisely similar circumstances as the translator in Fig. 5.

In Fig. 2 I have shown a convenient arrangement of the lengths and time relations of the trains of waves of frequencies X Y Z, transmitted by a system which is controlled by the apparatus illustrated in Figs. 10 and 11 and which are adapted to operate the receiving system shown in Fig. 7. In this figure the trains of waves X_5 Y_5 Z_5 are respectively double the length of the trains X_6 Y_6 Z_6, so that a receiver attuned to any of the frequencies X Y Z will receive the signal — -, whereas the signal received by a system such as shown in Fig. 7 will be just opposite in character—viz., - —.

It is sometimes desirable to avoid the use of relays, because of the necessary delicate adjustments, and it is sometimes desirable to avoid the use of an apparatus necessary to restore a coherer to its normal sensitive condition. In Figs. 12 and 14 I have illustrated systems designed to be operated by two trains of waves of frequency X and Y, related, as shown in Fig. 1, and transmitted by such an apparatus as is illustrated in Fig. 9. It is to be understood, however, that it requires only slight changes, which may be made by any one skilled in the art, to modify the systems shown in Figs. 12 and 14 so that they will respond to three trains of waves of frequency X Y Z, related as above described. In these Figs. 12 and 14, D D_1 are coherers or wave-detectors, comprising a steel point in contact with an aluminium or carbon plate, or, indeed, any metallic member in contact with carbon. Wave-detectors of this character are well known in the art and form no part of my invention. If desired, other forms of wave-detectors—such, for example, as electrolytic anticoherers, which have the property of automatic restoration to a normal sensitive condition after the passage of a train of waves and which are also well known in the art—may be used. The circuit 12 contains the detector D and the battery B^{12}. Shunting the terminals of the battery B^{12} is the circuit 12′, which contains the winding n^{12} of a telephone-receiver T′. Circuit 13 contains the detector D_1 and the battery B^{13} and also the winding n^{13} of said telephone-receiver. The windings n^{12} and n^{13} are so disposed that their ampere-turns have an additive effect on the core of the receiver. Normally there is no appreciable current flowing in the winding n^{13}, because of the high resistance of the detector D_1, and the current of the battery B^{12} normally flows through the circuit 12′, containing the winding n^{12}, but does not flow in the circuit 12, because of the high resistance of the detector D. It is well known in the art of telephony that a magnetic telephone-receiver is more sensitive if the core is a permanent steel magnet or if it is a soft-iron core and maintained in a magnetized condition by a solenoid and a battery. By proper adjustment the telephone T′ remains silent even when current flows through the winding n^{13} unless the current of battery B^{12} flows in the winding n^{12}. Normally, therefore, the diaphragm U will vibrate if a train of waves of Y frequency is absorbed by conductor V_1. If, however, waves of X frequency are absorbed by conductor V, thus reducing the resistance of detector D, so that the current of battery B^{12}, or the greater part thereof, flows into circuit 12 instead of energizing the core by flowing through winding n^{12}, and if at this same time the resistance of detector D_1 is reduced by waves of frequency Y, no sound will be produced by the telephone, because the current flowing in winding n^{13} is insufficient to cause the vibration of diaphragm U unless the core is already magnetized by current flowing in winding n^{12}.

Referring to Fig. 13, $I_{12'}$ represents the current normally flowing in circuit 12′, X represents the duration of the trains of waves of frequency X, I_{13} represents the current flowing in the circuit 13, Y the duration of waves of frequency Y, and S the duration of the signal produced by the telephone. It will be observed that as soon as waves of frequency X are received the current $I_{12'}$ ceases and that as soon as waves of frequency Y are received current I_{13} begins to flow. The telephone remains silent, however, or at least produces very little sound until current $I_{12'}$ begins to flow again, and this occurs as soon as waves of frequency X cease. It is thus seen that it is only during the periods of overlapping of the currents $I_{12'}$ and I_{13} that the diaphragm U vibrates. This is not the preferred form of my invention, because normally the telephone will produce sound when waves of a single frequency Y are absorbed; but this is a system, nevertheless, by which signals may be secretly received in the manner above set out in connection with the receiving systems hereinbefore described, because while any system attuned to either frequency X or Y receives indications of a certain length this system will receive a signal of a different length—namely, the signal S.

In Fig. 14 the circuit 17 contains the detector D, battery B^{17}, and winding n^{17} of the telephone-receiver T′, and circuit 18 contains the detector D_1, battery B^{18}, and winding n^{18} of said telephone-receiver. Here the ampere-turns of the windings n^{17} and n^{18} are opposed to each other in their effect on the core of the receiver and are so adjusted that when waves of frequency X and Y are simultaneously received the effect on the receiver is *nil.* The telephone responds, however, when the energy of waves of frequency X or the energy of waves of frequency Y is separately absorbed. When trains of waves of frequency X and Y are transmitted, as indicated in Fig. 1, the receiver is silent until the cessation of one of the trains of waves—as, for instance, the waves of frequency X—and then the diaphragm vibrates as long as the waves of frequency Y continue. This is not the preferred form of my invention, because, as pointed out in connection with Fig. 12, waves of a single frequency X or Y may operate the receiver; but it is, nevertheless, an apparatus by which signals may be secretly received in the manner hereinbefore set forth, because the indication is always of a different length from that of either of the trains of waves received and is equal in duration to the duration of a train of waves of one frequency, as Y, after the train of waves of another frequency, as X, has ceased.

I claim—

1. At a space-telegraph station, a plurality of systems each adapted to transmit electromagnetic waves of a different frequency, a plurality of devices associated with each system for regulating or controlling the transmission of electromagnetic waves therefrom and each adapted to cause the transmission of a set of trains of electromagnetic waves made up of a plurality of trains of electromagnetic waves of different frequencies, the several sets differing from each other in the length and in the time relation of their component wave-trains, in combination with an apparatus at a receiving-station comprising means for absorbing the energy of said sets of waves and means for causing the energy of the resulting electric oscillations to effect the production of intelligible signals each differing in length or duration from the length or duration of any of the trains of waves of any of said sets.

2. At a space-telegraph station, a plurality of systems each adapted to transmit electromagnetic waves of a different frequency and means for effecting the transmission of two different sets of trains of electromagnetic waves, said sets being capable of reception and translation into signals differing in length or duration, such as the "dots and dashes" of a telegraph code, at a predetermined receiving-station only, and each set containing a plurality of trains of electromagnetic waves of different frequency so arranged that the length or duration of any train of waves of the set representing the shorter signal, as the "dot," is greater than the length or duration of the trains of waves of the same frequency of the set representing the longer signal, as the "dash," whereby a foreign station attuned to the frequency of any one train of electromagnetic waves will receive signal indications opposite in meaning from those received by said predetermined receiving-station.

3. In a system of space telegraphy, a transmitting apparatus comprising means for transmitting a plurality of overlapping trains of electromagnetic waves, which differ from each other in frequency and in their times and cessation, in combination with a receiving system.

4. At a space-telegraph station, a plurality of systems each adapted to transmit electromagnetic waves of a different frequency, in combination with controlling means for effecting the transmission by said systems of a plurality of overlapping trains of waves differing from each other in frequency and in their times of cessation.

5. At a space-telegraph station, a plurality of systems each adapted to transmit electromagnetic waves of a different frequency, in combination with controlling means for effecting the transmission by said systems of a plurality of overlapping trains of waves differing from each other in frequency, in length or duration and in their times of cessation.

6. In a space-telegraph receiving apparatus, the combination of two or more self-restoring wave-detectors operating conjointly to control an electric translating device for producing intelligible signals differing in length or duration from the length or duration of the response of any one of said wave-detectors.

7. In a space-telegraph receiving apparatus, two or more circuits each resonant to electromagnetic waves of a different frequency and each adapted to absorb the energy of the waves of the frequency to which it is attuned to the exclusion of the energy of waves of a different frequency and two or more self-restoring wave-detectors each controlled by one of said resonant circuits and operating conjointly to control an electric translating device.

8. In a system of space telegraphy, an apparatus adapted to transmit a plurality of trains of electromagnetic waves differing from each other in frequency and in their times of cessation and an electric translating device at a receiving-station adapted to be actuated during the entire period of discontinuance of the energy of one of said trains of waves to produce a signal at said station only.

9. In a system of space telegraphy, an apparatus adapted to transmit a plurality of trains of electromagnetic waves differing from each other in frequency and in their times of cessation and an apparatus at a receiving-station, comprising an electric translating device and means for effecting energization of the same during the period of time elapsing between the times of cessation of said trains of waves.

10. In a system of space telegraphy, an apparatus adapted to transmit a plurality of trains of electromagnetic waves differing from each other in frequency and in their

times of cessation and an electric translating device at a receiving-station adapted to be actuated during the entire period of discontinuance of the energy of one of said trains of waves to produce a signal at said station only, and means for transmitting trains of waves of a different frequency, which are not intended to affect the translating device.

11. In a system of space telegraphy, an apparatus adapted to transmit a plurality of trains of electromagnetic waves differing from each other in frequency and in their times of cessation, and an apparatus at a receiving-station, comprising an electric translating device and means for effecting energization of the same during the period of time elapsing between the times of cessation of said trains of waves, and means for transmitting trains of waves of a different frequency, which are not intended to affect the translating device.

12. In a space-telegraph receiving apparatus, a plurality of receiving systems each responsive to electromagnetic waves of a different frequency, a normally open local circuit containing an electric translating device, a plurality of circuit-closers, each controlled by the energy of the electromagnetic waves received by one system, for closing the local circuit and thereby effecting the operation of the electric translating device, and means for maintaining the closure of the local circuit after the opening of one of said circuit-closers.

13. In a space-telegraph receiving apparatus, a plurality of receiving systems, each responsive to electromagnetic waves of a different frequency, means, actuated by the energy of a train of electromagnetic waves of one frequency, for putting the apparatus in condition for producing a signal, and means, actuated by the energy of a train or trains of electromagnetic waves of different frequency, for effecting the production of the signals immediately upon the cessation of the first-mentioned train of electromagnetic waves.

14. In a space-telegraph receiving apparatus, a plurality of receiving systems, each responsive to electromagnetic waves of a different frequency, means, actuated by the energy of a train of electromagnetic waves of one frequency, for putting the apparatus in condition for producing a signal, and means, actuated by the energy of a train or trains of electromagnetic waves of different frequency, for effecting the production of the signals immediately upon the cessation of the first-mentioned train of electromagnetic waves, and means for restoring the apparatus to its normal condition upon the cessation of the last-mentioned train or trains of electromagnetic waves.

In testimony whereof I have hereunto set my hand this 4th day of March, 1903.

JOHN STONE STONE.

Witnesses:
ALEX. P. BROWNE,
GEORGIA A. HIGGINS.