No. 725,634. PATENTED APR. 14, 1903.

J. S. STONE.

ART OF WIRELESS OR SPACE TELEGRAPHY.

APPLICATION FILED JAN. 3, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

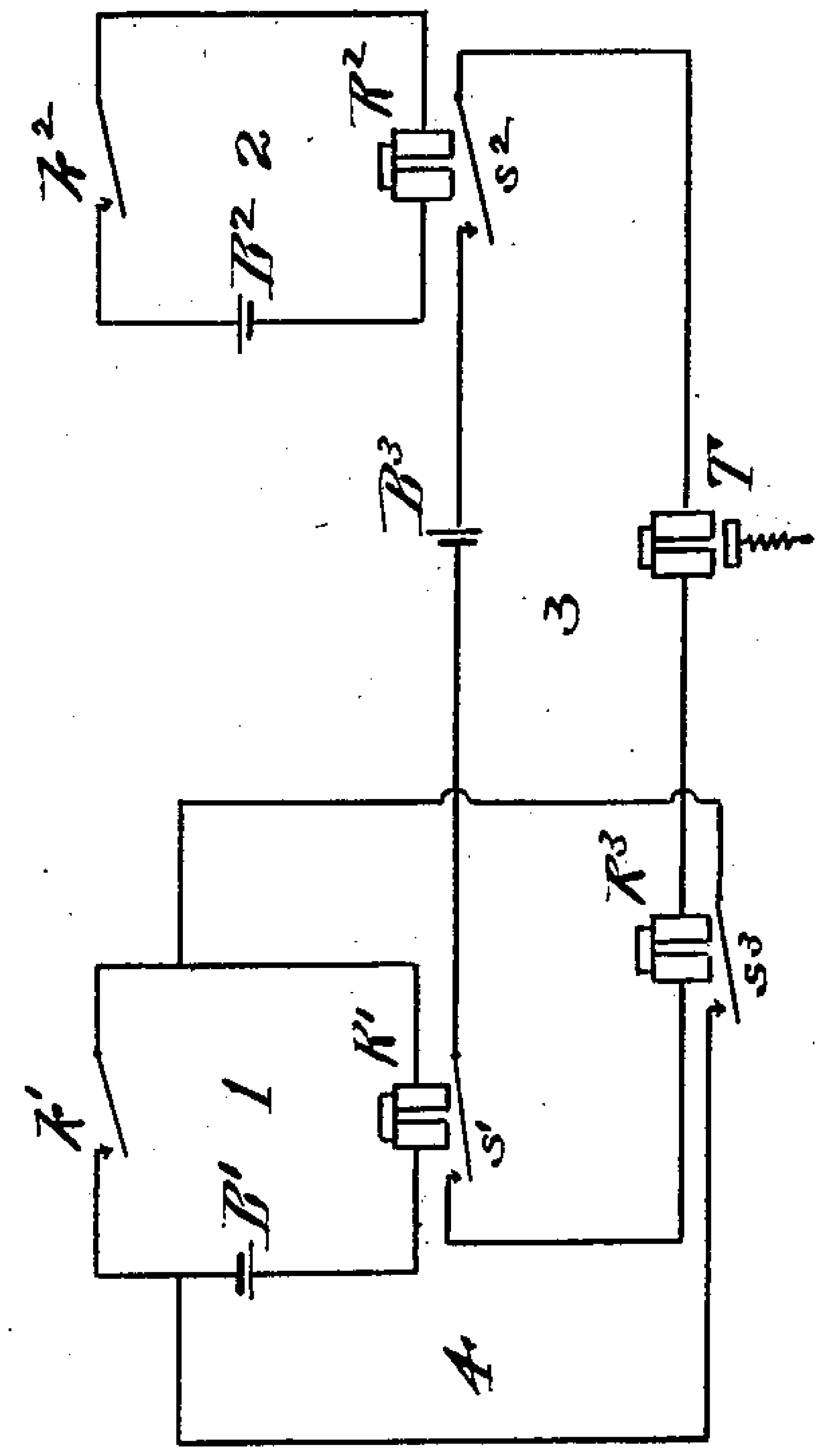

Fig. 3.

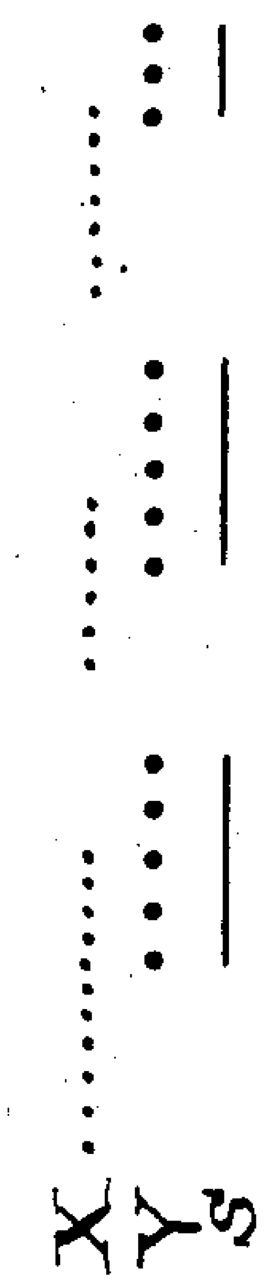

Fig. 4.

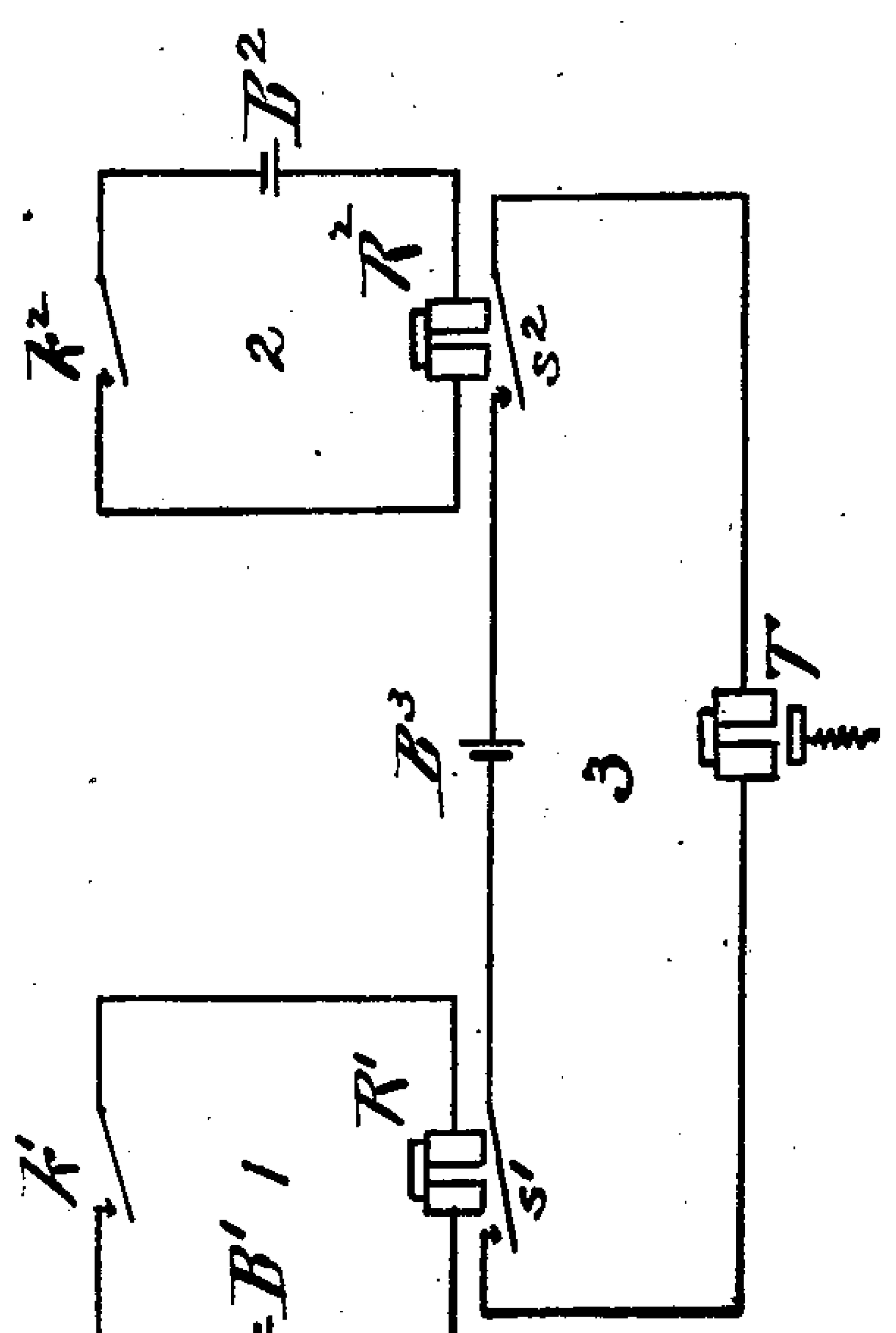

Fig. 1.

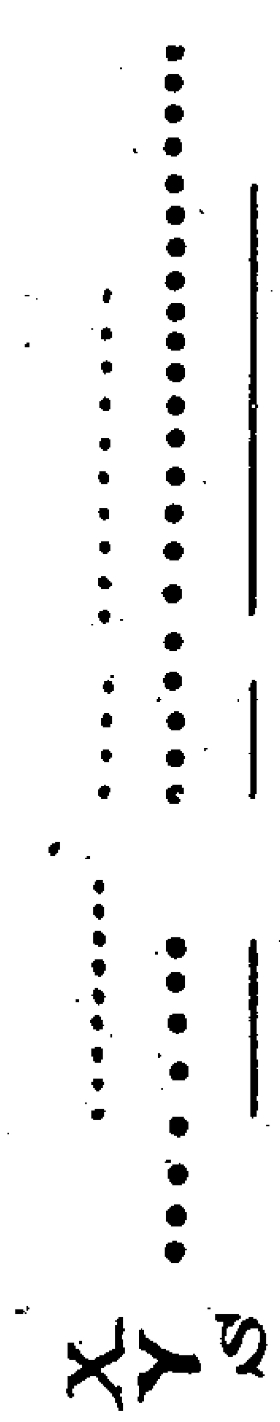

Fig. 2

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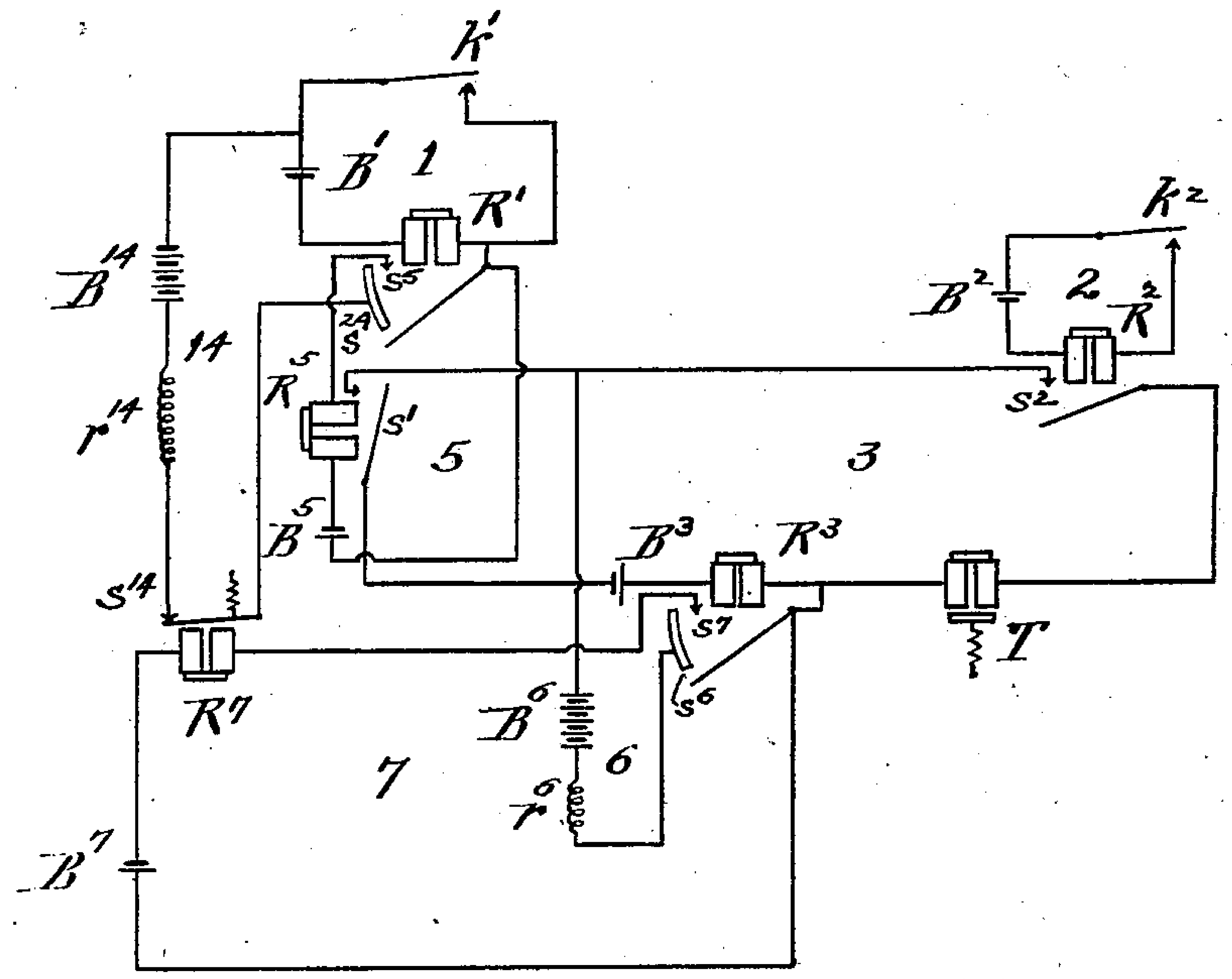

Fig. 5.

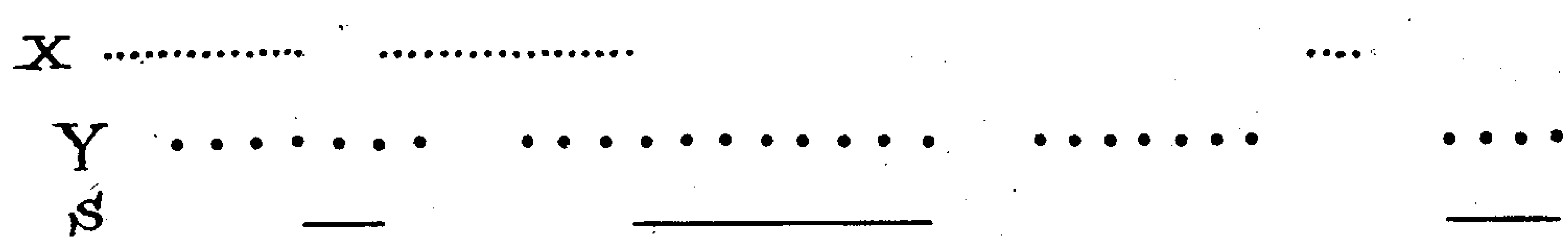

Fig. 6.

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NO MODEL. 4 SHEETS—SHEET 3.

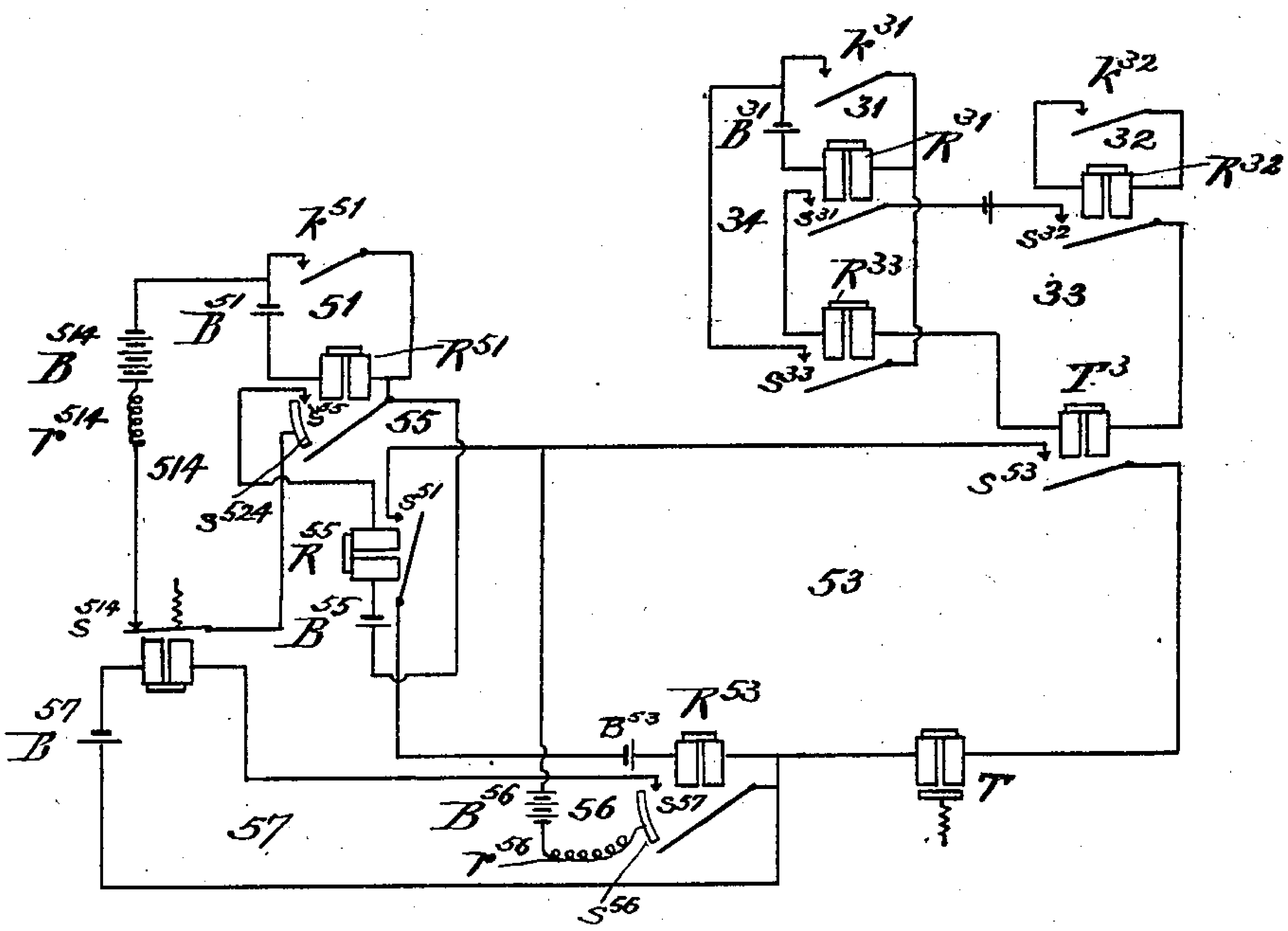

Fig. 7.

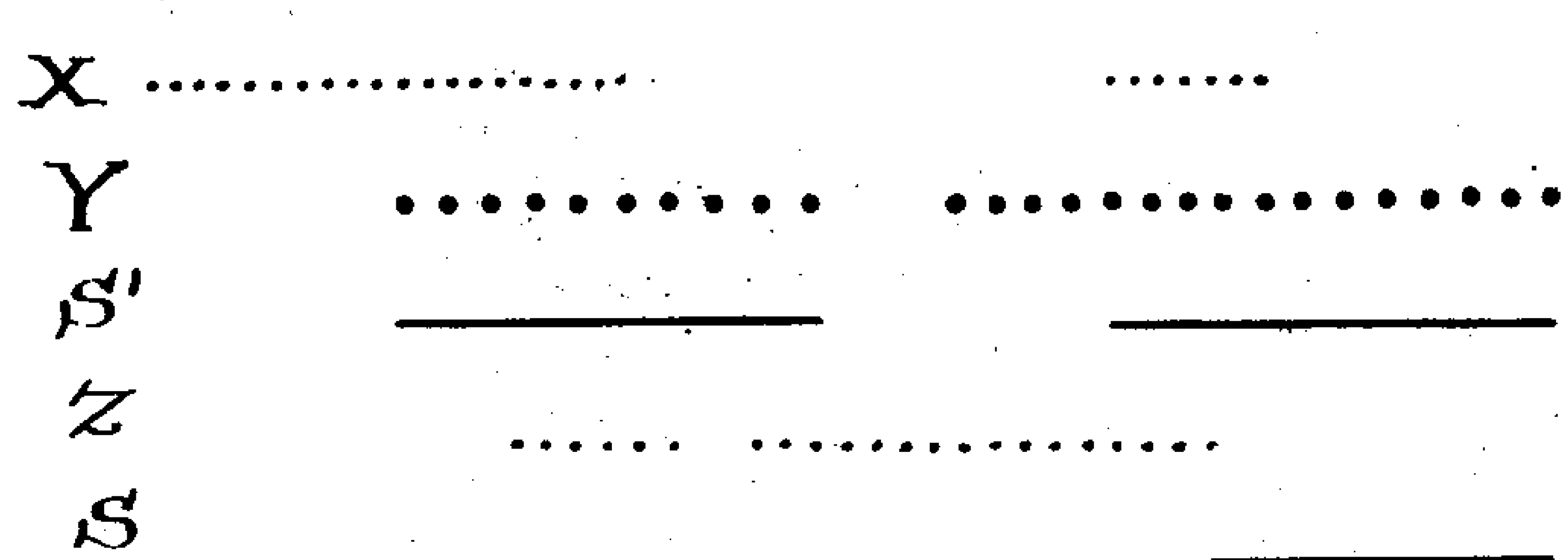

Fig. 8.

WITNESSES

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NO MODEL. 4 SHEETS—SHEET 4.

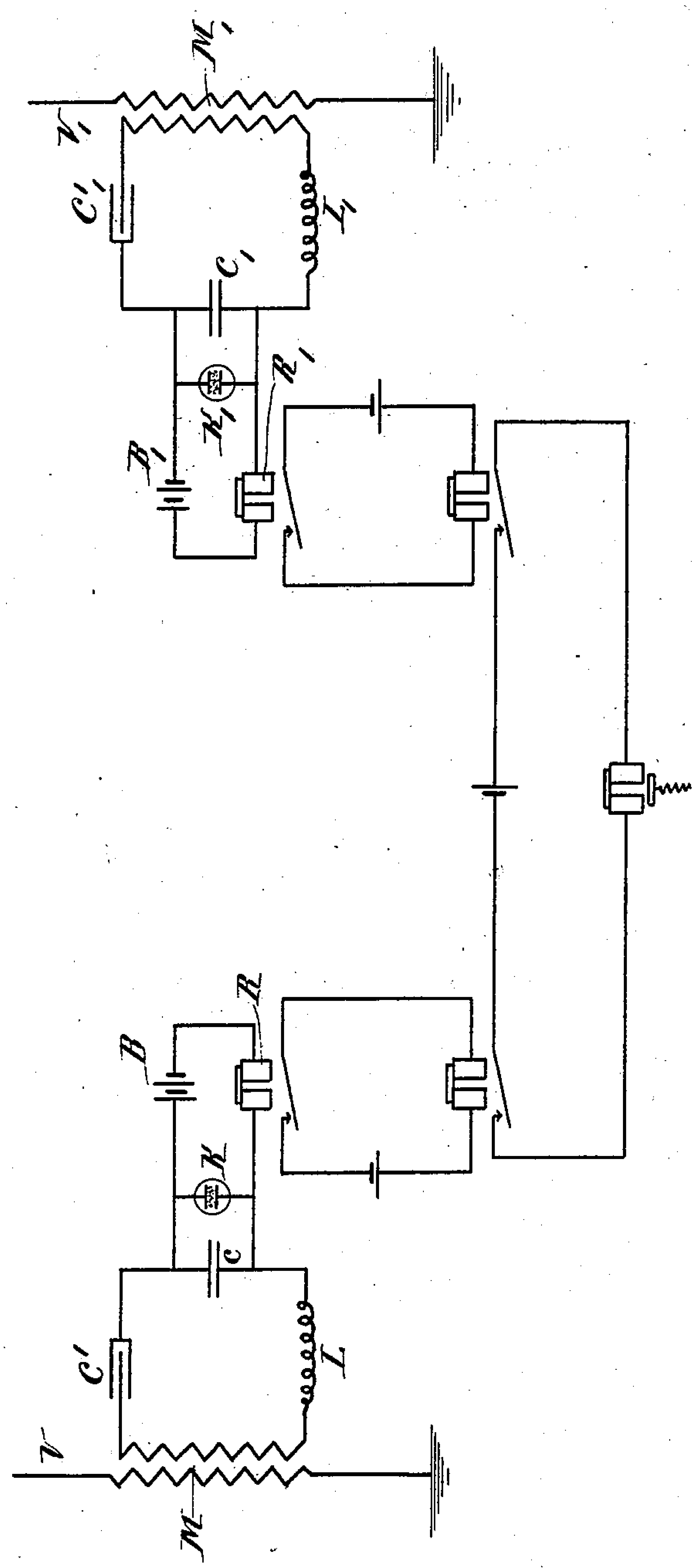

Fig. 9.

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Jeremiah Toomey

INVENTOR:

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asso. atty.

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

UNITED STATES PATENT OFFICE.

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

ART OF WIRELESS OR SPACE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 725,634, dated April 14, 1903.

Application filed January 3, 1903. Serial No. 137,707. (No model.)

To all whom it may concern:

Be it known that I, JOHN STONE STONE, of Cambridge, in the county of Middlesex and State of Massachusetts, have invented a new and useful Improvement in the Art of Wireless or Space Telegraphy, of which the following is a specification.

My invention relates to the art of wireless or space telegraphy, and more particularly to that form of space telegraphy in which the signals are transmitted by means of 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 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 those 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.

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 being facts well understood by those most 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 in the radiating-conductor and that in order to receive the energy of simple harmonic waves of one frequency in a particular translating device to the exclusion of the energy 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 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 of 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 means of 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 intelligibly 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 simple harmonic waves, the waves of each group having a frequency different from that of the waves of the other group or groups, and I may employ in conjunction with these groups of waves other groups of waves, which I may call "blind" groups, which are not received and are not intended to be received at the station to which the message is sent. The groups of signal-waves may be transmitted wholly or in part simultaneously or may be transmitted successively, so that definite signals may require for their intelligible reception either the wholly-simultaneous or partially-simultaneous or the successive reception of the waves of different frequency.

A clear understanding of the 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, the invention being broader than the mere apparatus and being of such a character as to be capable of practical embodiment in a great variety of ways.

Figure 1 illustrates apparatus adapted to respond to signal-waves of two frequencies, which may be called X and Y, simultaneously received, but not to signal-waves of either of these frequencies separately received. Fig. 3 illustrates apparatus adapted to respond to signal-waves of two different frequencies 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 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 frequencies being related to the resultant as X is related to Y in Fig. 5. Figs. 2, 4, 6, and 8 are illustrative diagrams, each showing the relations of the waves of different frequencies to each other and to the resultant signals as received by the circuits of the figure which precedes it. Fig. 9 is a diagram illustrating the manner of associating the system shown in Fig. 1 with the receiving system of my Letters Patent No. 714,756. In the figure, V V_1 are vertical wires, M M_1 transformers, C C' C_1 C'_1 condensers, L L_1 inductance-coils, K K_1 coherers or other receiving devices, B B_1 batteries, and R R_1 relays. The wires V V_1 may both be supported by the same pole, or a single vertical wire may be employed, as in Figs. 14, 15, and 17 of Patent No. 714,756. The manner of associating the systems illustrated in Figs. 3, 5, and 7 is substantially identical with the manner of associating the system shown in Fig. 1 with the receiving system.

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

k' k^2 k^3 are contacts which are closed by the passage of groups of waves of the character referred to.

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

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

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

S in Figs. 2, 4, 6, and 8 indicates the signals received by the translating instrument 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.

The numerals refer to the various circuits.

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

Referring first to Fig. 1, k' k^2 are contacts in circuits 1 and 2, respectively, adapted to be closed, respectively, by the passage of trains or groups of simple harmonic waves of different frequencies—say X and Y, respectively. The circuit 1 includes the battery B' and relay R', and the circuit 2 includes the battery B^2 and relay R^2. The relays R' and R^2 when energized operate, respectively, upon their armatures to close the contacts s' and s^2 in the circuit 3, which includes the battery B^3 and sounder or other appropriate translating device T. It will be seen on inspection that the circuit 3 is not closed, and hence the translating device T cannot operate unless both contacts s' s^2 are closed. Hence either the contact k' or contact k^2 may be closed without causing the closing of the circuit 3, and hence without operating the translating device T. It is only when these contacts are closed simultaneously that there is any resulting signal. This is indicated in Fig. 2, where the line of dots X is representative of the effect of the current of frequency X and Y is representative of the effect of the current of frequency Y. Here it will be seen that only where the representations of currents X and Y overlap is the signal S produced.

In the apparatus shown in Fig. 3 we have circuits 1 and 2 identical in character with circuits 1 and 2 in Fig. 1, and we have a receiving-circuit 3 corresponding generally with circuit 3 in Fig. 1, but having in addition a relay R^3, adapted to attract an armature which is in a shunt-circuit 4 around the battery B' and relay R' of circuit 1 and close contact s^3, completing the shunt-circuit. After the contact s^3 has been made this 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 the battery B′ and relay R′, which then become part of circuit 4. In this case, as in Fig. 1, the translator T does not receive its signal until both contacts s' and s^2 have been closed by reason of the passing of appropriate currents to close contacts k' and k^2; but in this case if contact k' is broken thereafter it does not cause the breaking of any contact in receiving-circuit 3 until 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 the existence of circuit 4 until such time as the 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 the current X has closed contact k', after which current X may cease.

Referring now to Fig. 5, I show a method 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 the passage of current Y, the actual signal, however, being given only by the current Y after the current X has ceased, as is 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, and we also have translator-circuit 3, containing the translating apparatus T and like the modified form of the circuit 3 in Fig. 3. In this case also there is a shunt-circuit about the battery B′ and relay R′, which as it differs from shunt 4 in Fig. 3 I will call circuit 14. This circuit includes a battery B^{14}, more powerful than the battery B′ in circuit 1, 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 a 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 circuit 5 taking place in the manner below described after circuit 14 has been closed and 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 relay R^3, which makes this contact without breaking circuit 6. In this case the passing of currents 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 circuit 5, energizing relay R^5, and thus closing contact at s' in circuit 3. This puts circuit 3 in condition to receive signals given by current 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 circuit 5. In a somewhat similar manner the apparatus is cleared when current Y has ceased by use of a shunt-circuit 6 and circuit 7, as follows: When circuit 3 is completely closed, the relay R^3 being energized causes contact s^6 to be closed, thus closing the shunt-circuit 6; but when the contact k^2 is broken the more powerful battery B^6 energizes relay R^3, so that it attracts its armature still further 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 Y frequency only when a current of X frequency has preceded it and ceased.

In Fig. 7 we have a still further arrangements 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 operating first to enable currents of Y frequency to accomplish their work by energizing a suitable relay which corrresponds with 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 current Z has energized this circuit and has ceased operation, 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 of 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 T, but which in this figure contains a 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 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 with 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 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 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 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 of 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 thereafter operated under precisely similar circumstances as the translator in Fig. 5.

The blind groups of waves hereinbefore mentioned 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 described above, but actuated by groups of waves of different frequencies. In this way 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.

In describing the diagrams shown in the drawings I do not mean to limit myself to the apparatus therein shown or the methods described, as it will be obvious to any one skilled in the art that my method may be carried out by other forms of circuits, which will readily suggest themselves.

What I claim as my invention is—

1. A method of receiving wireless-telegraph signals which consists in employing groups or trains of simple harmonic electromagnetic waves of different frequencies to coöperate in affecting an electric translating device and thereby producing intelligible signals as described.

2. A method of receiving wireless-telegraph signals which consists in employing groups or trains of simple harmonic electromagnetic waves of different frequencies to coöperate in affecting an electric translating device and thereby producing intelligible signals, and simultaneously transmitting another group or groups of such waves also of different frequencies without affecting said translating device.

3. The method of receiving wireless-telegraph signals, which consists in absorbing the energies of a plurality of groups or trains of electromagnetic waves of different frequencies, transmitted simultaneously or otherwise, the groups or trains of electromagnetic waves of one frequency being of different length or duration from the length or duration of a group or train of electromagnetic waves of a different frequency, and causing the several energies of the resulting electric oscillations to coöperate in affecting an electric translating device and thereby producing intelligible signals.

4. The method of receiving wireless-telegraph signals, which consists in absorbing the energies of a plurality of groups or trains of electromagnetic waves of different frequencies, transmitted simultaneously or otherwise, the groups or trains of electromagnetic waves of one frequency being of different length or duration from the length or duration of a group or train of electromagnetic waves of a different frequency, and causing the several energies of the resulting electric oscillations to coöperate in affecting an electric translating device and thereby producing intelligible signals, and simultaneously transmitting another group or train of electromagnetic waves, also of different frequency, without affecting the said translating device.

5. The method of receiving wireless-telegraph signals, which consists in absorbing the energies of a plurality of groups or trains of electromagnetic waves of different frequencies, transmitted at predetermined intervals of time but coexisting throughout a definite portion of their durations, and producing by the coöperation of the energies of the resulting electric oscillations, intelligible signals during the periods of time in which a plurality of groups or trains of electromagnetic waves of different frequencies are coexistent and during those periods only.

6. The method of receiving wireless-telegraph signals which consists in absorbing the energies of a plurality of groups or trains of electromagnetic waves of different frequencies, transmitted at predetermined intervals of time but coexisting throughout a definite

portion of their durations, and effecting the energization of an electrical translating device by the coöperation of the energies of the resulting electric oscillations during the periods of time in which the several energies are coexistent, and during those periods only, and thereby producing intelligible signals.

7. The method of receiving wireless-telegraph signals which consists in absorbing the energies of a plurality of groups or trains of electromagnetic waves of different frequencies and effecting the energization of an electric translating device by, and during the continuance of, the energy of the resulting electric oscillations of a train of electromagnetic waves of one frequency, only after the energy of a train of electromagnetic waves of another frequency has been absorbed, and independently of the continuance of the last-mentioned train of electromagnetic waves.

8. The method of receiving wireless-telegraph signals, which consists in absorbing the energies of a plurality of groups or trains of electromagnetic waves of different frequencies and producing by the energies of the resulting electric oscillations intelligible signals during the periods of discontinuance of the trains of electromagnetic waves of one of the several frequencies.

9. The method of receiving wireless-telegraph signals, which consists in absorbing the energies of a plurality of groups or trains of electromagnetic waves of different frequencies, causing the energy of the resulting oscillations of one group or train of electromagnetic waves of one frequency to put a receiving apparatus in condition for producing a signal and causing the energies of the resulting electric oscillations of a plurality of groups or trains of electromagnetic waves of different frequencies to coöperate to complete the actuation of the receiving apparatus by and upon the cessation of the first-mentioned group or train of electromagnetic waves.

10. The method of receiving wireless-telegraph signals which consists in absorbing the energies of a plurality of groups or trains of electromagnetic waves of different frequencies, causing the energies of the resulting electric oscillations of the said group or trains to coöperate to put a receiving apparatus in condition for producing a signal, absorbing the energy of a group or train of electromagnetic waves of a different frequency and producing a signal by and upon the cessation of said last-mentioned group or train of electromagnetic waves.

11. The method of receiving wireless-telegraph signals, which consists in operating an electric translating device by the coöperation of a plurality of groups or trains of electromagnetic waves of different frequencies, transmitted simultaneously or otherwise, the groups or trains of electromagnetic waves of one frequency being of different length or duration from the lengths or durations of the groups or trains of electromagnetic waves of different frequencies, and thereby producing intelligible signals at a predetermined receiving-station only.

12. The method of receiving wireless-telegraph signals at a predetermined receiving-station only, which consists in absorbing the energies of a train of electromagnetic waves of one frequency and causing the energy of the resulting electric oscillations to effect a change in the condition of the receiving apparatus, then absorbing the energy of a train of electromagnetic waves of a different frequency and causing the energy of the resulting electric oscillations to effect another change in the condition of the receiving apparatus, and finally producing a signal by causing the cessation of the first-mentioned train of electromagnetic waves to effect a further change in the condition of the receiving apparatus.

13. The method of receiving wireless-telegraph signals at a predetermined receiving-station only, which consists in causing the energization of an electric translating device during unequal periods of time by the coöperation of a plurality of groups or trains of electromagnetic waves of different frequencies, the groups or trains of waves of one frequency all being of the same length or duration, but of a different length or duration from that of the group or trains of electromagnetic waves of another frequency, and thereby producing signals of different lengths or durations corresponding to the elements, "dots and dashes" of the Morse or other telegraphic code.

14. The method of receiving wireless-telegraph signals at a predetermined receiving-station only, which consists in absorbing the energies of groups or trains of electromagnetic waves of different frequencies, the groups or trains of electromagnetic waves of one frequency being of different length or duration from the lengths or durations of the groups or trains of electromagnetic waves of different frequencies and causing the energy of the resulting electric oscillations to effect, during the periods of their coexistence, the energization of an electric translating device for periods of time corresponding to the elements, "dots and dashes," of the Morse or other telegraphic code.

15. The method of receiving wireless-telegraph signals, which consists in absorbing the energies of groups or trains of electromagnetic waves of different frequencies all the groups or trains of the several frequencies being of equal length or duration, and causing the energy of the resulting electric oscillations, by their unequal periods of coexistence to effect the production of signals of unequal lengths or times of duration corresponding to the elements, "dots and dashes," of the Morse or other telegraphic code, at a predetermined receiving-station only.

16. The method of receiving wireless-telegraph signals which consists in absorbing the energies of groups or trains of electromagnetic waves of different frequencies, the groups or trains of the electromagnetic waves of one frequency being of different length or duration from the length or duration of the groups or trains of electromagnetic waves of a different frequency, and causing the energy of the resulting electric oscillations by their coöperation to effect the production of signals of different lengths or durations from the lengths or durations of the said groups or trains of electromagnetic waves.

In testimony whereof I hereunto set my name this 23d day of December, 1902.

JOHN STONE STONE.

Witnesses:

JOHN TUDOR GARDINER,

GEORGE O. G. COALE.