No. 725,635 PATENTED APR. 14, 1903.

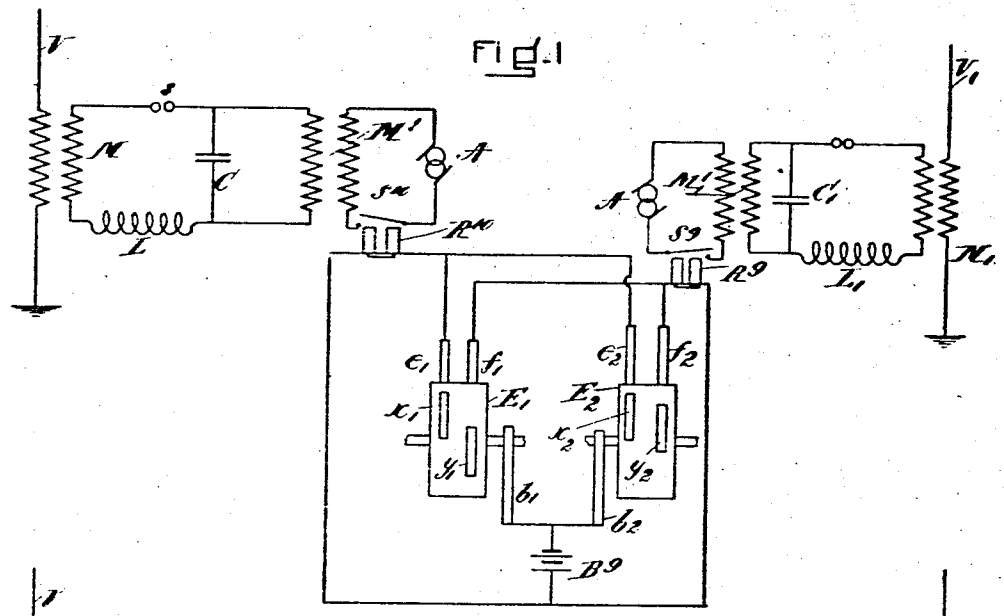
J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED MAR. 12, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1



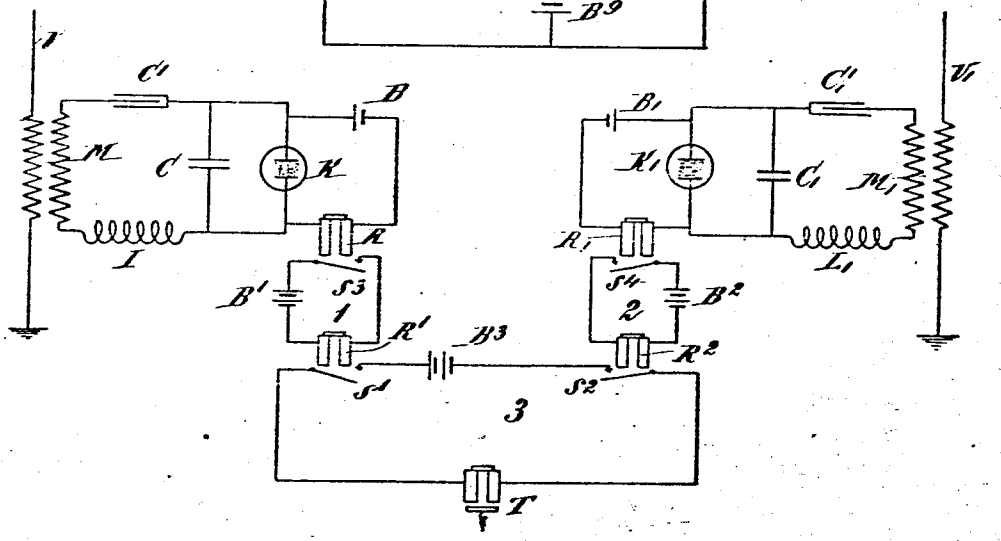


Fig. 2.

WITNESSES:
Brainerd T. Jadwin
Georgia A. Higgins

INVENTOR
John Stone Stone
by Allen P. Browne
atty

(1)

RADIANT ENERGY.

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NO MODEL. 3 SHEETS—SHEET 2.

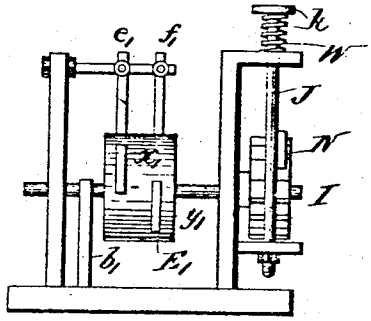

Fig. 3.

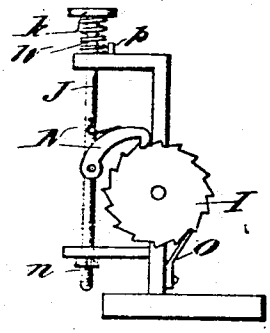

Fig. 4.

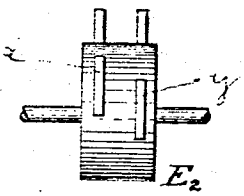

Fig. 5.

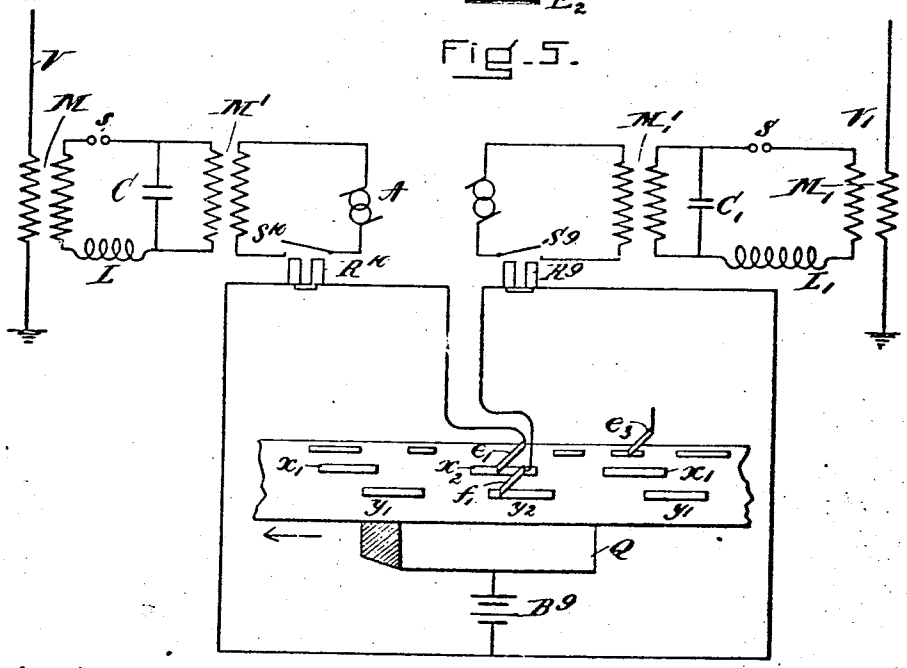

Fig. 6.

WITNESSES:
Brainerd T. Judkins
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INVENTOR
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THE WARREN PETERS CO. PHOTO-LITHO., WASHINGTON, D. C.

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SPACE TELEGRAPHY.

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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 7.

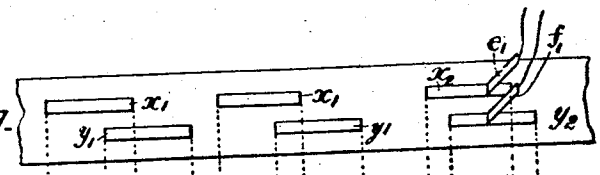
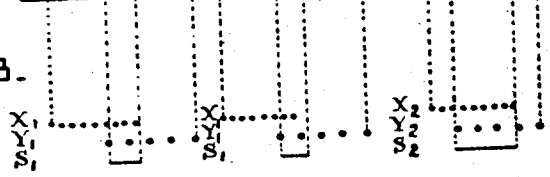


Fig. 8.



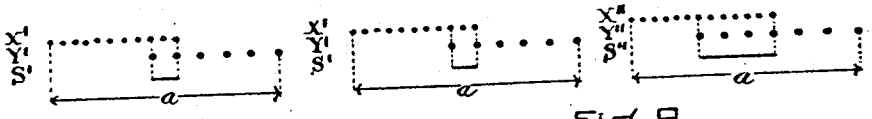
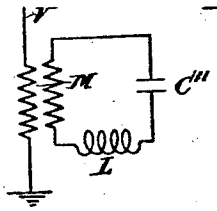


Fig. 9.

Fig. 10.



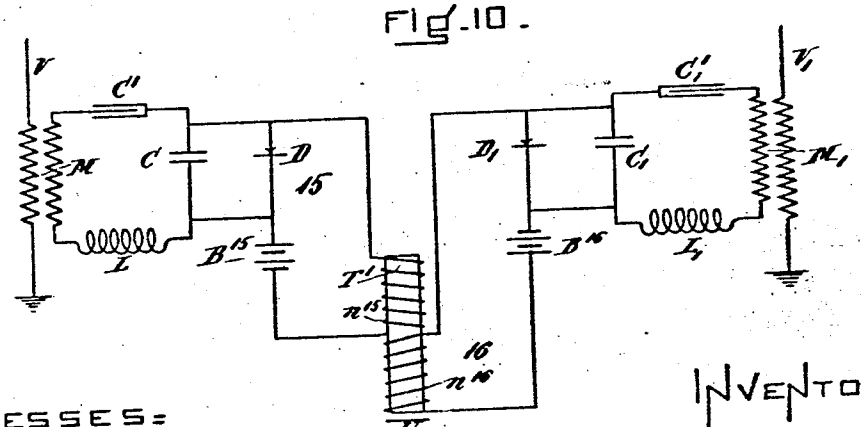


Fig. 11.

WITNESSES:

Bramwell T. Jenkins

Georgia A. Higgins

INVENTOR:

John Stone Stone

By Alex. P. Browne

atty

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. 725,635, dated April 14, 1903.

Application filed March 12, 1903. Serial No. 147,383. (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.

Electromagetic 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 trains of waves all of which have the same frequency if I space the transmitting-conductors relatively to the wave lengths of these waves, so that a receiving-conductor in the vertical plane determined by the transmitting-conductors will receive certain predetermined signals due to the mutual reinforcement of the transmitted waves in this plane, while systems not in this plane will be unable to intelligently receive the said signals.

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.

Figure 1 illustrates apparatus adapted to transmit signal-waves of two frequencies, which may be called X and Y. Fig. 2 illustrates apparatus adapted to respond to signal-waves of two frequencies X and Y during the periods in which they overlap or are coexistent, but not to signal-waves of either of these frequencies separately received. Figs. 3, 4, and 5 illustrate details of apparatus for controlling the transmission of the signal-waves X and Y. Fig. 6 illustrates another form of transmitting apparatus. Fig. 7 illustrates the perforated paper strip used in the transmitting apparatus shown in Fig. 6. Figs. 8 and 9 are illustrative diagrams each showing the relations of the trains of waves of different frequencies to each other as transmitted and received and the resultant signals as received. Figs. 10 and 11 are modified forms of the receiving apparatus.

In the drawings, B B', &c., represent batteries.

s' s^2, &c., are contacts which are closed by the relays R R', &c.

S indicates the signals received by the translating instrument T and which are made by currents of different frequency X and Y.

The numerals refer to the various circuits.

A is an alternating-current generator.

M' M'_1 are transformers; C C_1 C' C'_1, condensers; M M_1, oscillation-transformers; s, a spark-gap; V V_1, elevated transmitting or receiving conductors, and K K_1 coherers or other wave-detectors, which experience a decrease in resistance when a difference of potential is developed at their terminals.

D D_1 are self-restoring wave-detectors.

C'' is a condenser telephone-receiver, and T' is a magnetic telephone-receiver.

L L_1 are inductances.

Referring now to Figs. 3, 4, and 5, E_1 E_2 are cylinders, of insulating material, carrying on their surfaces contact-strips x, y and rotatable by the engagement of the spring-pressed pawl N with the ratchet-wheel I upon the depression of the key k at the upper end of the plunger J. This plunger is retracted by the coil-spring W, and when it is retracted the spring o prevents the retrograde movement of the ratchet-wheel I. The stroke of the plunger J is regulated by the stop p and the nut n. Brushes e and f bear on the cylinders and make electrical contact with the strips x and y, respectively. Brush b makes electrical contact with the shaft on which the cylinder E is mounted, and to this shaft the contact-strips x and y are permanently connected. The cylinder is adjusted so that the brushes e and f do not touch either contact-strip. Then upon the depression of the key k the strips pass under and make electrical contact with the brushes successively, the brushes being simultaneously in contact each with its respective strip for a certain period of time as the strips overlap. In cylinder E_1 this period of time is that required for transmitting a "dot" of the Morse or other telegraphic code, and in cylinder E_2 this time is that required for a code "dash." It will be seen that the strips x_1 y_1 x_2 y_2 may be and preferably are all of equal length, but that the length by which they overlap is different, the overlapping of the strips x_2 y_2 of the cylinder E_2 preferably being twice that of the strips x_1 y_1 of cylinder E_1.

The actual transmitting mechanism, except for the overlapping of the contact-strips, is well known in the art of machine telegraphy and constitutes no part of my invention.

In the apparatus illustrated in Fig. 1 the two cylinders E_1 and E_2 are shown connected to the transmitting system hereinbefore mentioned by brushes e_1, f_1, e_2, f_2, b_1, and b_2. To transmit a signal represented by a dot, the cylinder E_1 is rotated by the hereinbefore-de-

scribed means. The brush e_1 contacts with strip x_1, and the relay R^{10}, energized by current from the battery B^9 flowing to brush b_1, the shaft on which the cylinder is mounted, strip x_1, brush e_1, to the relay, and back to the battery, attracts its armature and closes the circuit of the alternator A and the primary of the transformer M' at contact s^{10}. A train of electromagnetic waves of frequency X is then radiated by the elevated conductor V as long as the brush e_1 is in electrical contact with the strip x_1. Continuing its rotation, the cylinder brings strip y_1 into contact with brush f_1, which closes the circuit containing the relay R^9 and the battery B^8, thus causing the radiation of electromagnetic waves of frequency Y from elevated conductor V_1 as long as brush f_1 remains in contact with strip y_1. Several sets of strips x_1 and y_1, x_2 and y_2 are preferably placed on each cylinder, so that upon the retraction of the plunger J by the spring W another set is ready to be brought into contact with the brushes e and f by another depression of the key k.

In Fig. 6 the trains of waves are transmitted by the passage, in the direction indicated by the arrow, of a perforated strip of paper over a block of conducting material in the manner well known in the art of telegraphy and which forms no part of my invention. Here the circuits of the relays are closed by the contact of the bruses e_1 and f_1 with the platen Q. The brush e_3 is connected to a relay similar to relays R^9 and R^{10} for controlling transmission of the blind waves above referred to.

In Fig. 7 is shown the relation of the perforations in the paper, and in Fig. 8 the relations of the trains of waves X and Y, which relation is identical with that of the trains of waves transmitted by the apparatus shown in Fig. 1.

Briefly stated, by the apparatus shown in Figs. 1 and 6 trains of waves which differ from each other in frequency and in order of transmission are radiated from the vertical conductors. All these trains may be and preferably are of the same length or duration, but overlap for unequal periods of time. Thus the trains transmitted by the rotation of cylinder E_1 in Fig. 1 overlap for a short period of time, (indicated in Fig. 8 by S_1,) while the trains of waves transmitted by the rotation of cylinder E_2 overlap for a longer period of time, preferably twice as long, as shown in Fig. 8 by S_2. The lengths of these periods of overlapping may conveniently be proportionate to the time required to transmit a dot and a dash of a telegraph-code. The trains of waves, however, may be of unequal length.

It will now be observed that a foreign receiving-station tuned to the frequency either of the X or Y trains will receive merely a set of indications, all of which are of equal length and which will consequently be incapable of intelligible translation.

In Fig. 2 is illustrated apparatus by means of which the energy of the trains of waves of different frequency transmitted as described above may be absorbed each by a separate system resonant to one frequency and the energy of the resulting electric oscillations combined to energize the translating device T during the periods in which the wave-trains overlap or are coexistent and for lengths of time proportionate to the code dots and dashes. The elevated conductor and its associated resonant circuit and relay-circuit have been fully described in my Letters Patent hereinbefore set forth. s^3 and s^4 are contacts adapted to be closed by the passage of trains of waves of different frequency X and Y, respectively. The circuit 1 includes a battery B' and relay R', and circuit 2 includes the battery B^2 and relay R^2. These relays R' and R^2 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 upon inspection that the circuit 3 is not closed, and hence the translating device T cannot operate unless both contacts s' and s^2 are closed. Hence either contact s^3 or s^4 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. 8, 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 current of frequency Y. Here it will be seen that only when the representations of currents X and Y overlap is the signal S produced, an overlapping for a certain period producing a dot, as S_1, and an overlapping for a longer period producing a dash, as S_2.

The coherer (shown at K K_1 at Fig. 2) is of the common tube and filings type. Such coherers, as is well known, require specially-adapted apparatus for effecting their restoration to a normal sensitive condition after the passage of electromagnetic waves. In Fig. 11 I have illustrated my secrecy system when used in connection with wave-detectors of another well-known type—as, for example, contacts of aluminium and steel with a steel point resting on an aluminium plate. Such a form of coherer is readily decohered by a slight jar of the sounder or telegraph-relay commonly employed in connection with it to produce audible or tape-recorded signals. Other forms of wave-detectors, commonly called "anticoherers," may also be employed. All of these forms of wave-detectors are well known in the art and constitute no part of my invention.

The circuits 15 and 16 of the wave-detectors D and D_1 contain, respectively, the battery B^{15} and the winding n^{15} of the telephone-receiver T' and the battery B^{16} and the winding

n^{16} of said telephone-receiver. The windings are so disposed that their ampere-turns are additive in their effect on the core of the receiver. The reception of a train of waves of one frequency, as X, will cause a certain amount of current to flow through the winding n^{15}, and likewise the closure of the circuit 16 by waves of frequency Y will cause a certain amount of current to flow in winding n^{16}, but by proper adjustment the magnetic flux resulting from the energization of either winding is insufficient to cause the attraction of the diaphragm U, which requires for its attraction the combined effect of the windings. Thus it will be readily apparent that the telephone will produce sound only when both trains of waves X and Y are simultaneously received—that is, during their periods of overlapping or coexistence.

I may dispose the transmitting-conductors V V_1 a multiple of a half-wave length of the transmitted wave apart, as described by my Patent No. 716,136, dated December 16, 1902, and thus obtain a mutual reinforcement of the radiated waves in the plane of the said conductors. Then if a quantitative wave-detector is placed in said plane it can be adjusted to respond only to the energy of two trains of waves simultaneously received. Such a quantitative wave-detector I have described in my Patents Nos. 714,756 and 714,834—namely, a condenser telephone-receiver in a resonant circuit and which utilizes the potential energy of the oscillations developed in said resonant circuit. A receiving system embodying such a receiver is illustrated in Fig. 10, in which C″ is a condenser telephone-receiver. However, I may use instead of this condenser-receiver any other quantitative wave-detector—as, for example, one operated by the kinetic energy of the electric oscillations developed in a resonant circuit or one operating upon changes in the dissipative resistance of a fine wire. With such a transmitting and receiving system if trains of waves all of the same frequency are radiated and if these trains of waves are so related in time of emission that they overlap for different periods of time, the receiving system will respond only during these periods of overlapping, as indicated by S′, S′, and S″ in Fig. 9. Another receiving system not in the plane of the transmitting-conductors will receive indications of different length, because outside this plane the periods of overlapping are of different length, due to the fact that the phase relation of the waves is different. A receiving system outside of the plane of the transmitting-conductors, or one within this plane and not so carefully adjusted as the receiver designed to receive the waves, or one which is not quantitative in its action will receive signals of lengths represented by the lines *a* in Fig. 9, which are all equal to the combined lengths of the trains X′ Y′ minus the periods of overlapping. These signals, if made all of the same length, by regulating the length of the trains X′ Y′, as shown, are of course incapable of intelligible translation.

Although I have illustrated and described a separate elevated conductor for radiating and receiving electromagnetic waves of one frequency, it is to be understood that I may employ a single elevated conductor associated with a plurality of sonorous or resonant circuits, as fully described in my Letters Patent hereinbefore referred to.

I claim—

1. In a system of space telegraphy, an apparatus adapted to transmit a plurality of overlapping trains of electromagnetic waves, differing from each other in frequency and in order of transmission, in combination with means, at a receiving-station, adapted to be actuated only by the coöperation of the energies of said overlapping trains of electromagnetic waves for producing intelligible signals at said receiving-station only.

2. In a system of space telegraphy, an apparatus adapted to transmit a plurality of overlapping trains of electromagnetic waves, differing from each other in frequency, in length or duration and in order of transmission, in combination with means, at a receiving-station, adapted to be actuated only by the coöperation of the energies of said overlapping trains of electromagnetic waves for producing intelligible signals at said receiving-station only.

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 order of transmission, 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 order of transmission.

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 order of transmission.

6. In a system of space telegraphy, an apparatus adapted to transmit a plurality of overlapping trains of electromagnetic waves, in combination with means, at a receiving-station, actuated only by the coöperation of the energies of said overlapping trains of electromagnetic waves for producing intelligible signals differing in length or duration from the length or duration of any of said overlapping trains of electromagnetic waves and equal in length or duration to the length

or duration of the periods of overlapping thereof.

7. In a system of space telegraphy, an apparatus adapted to transmit a plurality of sets of overlapping trains of electromagnetic waves, means for regulating or controlling the periods of overlapping of the trains of electromagnetic waves making up each set, and means, at a receiving-station, actuated only by the coöperation of the energies of said overlapping trains of waves for producing intelligible signals of length or duration equal to the length or duration of the periods of overlapping of the trains of waves.

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 order of transmission but coexisting throughout a definite portion of their durations, a plurality of systems at a receiving-station, each designed to absorb the energy of a train of electromagnetic waves of one frequency to the exclusion of the energy of trains of electromagnetic waves of other frequencies, and means actuated by, and during the period of coexistence of, the energies of the resulting electric oscillations, for producing intelligible signals at said receiving-station only.

9. In a system of space telegraphy adapted to transmit, by means of electromagnetic waves, signals which will be intelligible at a predetermined receiving-station only, a transmitting apparatus comprising means for transmitting a plurality of trains of electromagnetic waves, no single one of said trains of electromagnetic waves being capable of intelligible reception or translation, in combination with a receiving system.

10. In a system of space telegraphy, an apparatus adapted to transmit a plurality of sets of trains of electromagnetic waves, each set consisting of a plurality of trains of electromagnetic waves, differing from each other in frequency and in order of transmission but coexisting throughout a definite portion of their durations, the period of coexistence of the trains of electromagnetic waves in one set being different from the period of coexistence of the trains of electromagnetic waves in another set, means, at a receiving-station, for absorbing the energies of the trains of electromagnetic waves making up the said sets and means operated by, and during the unequal periods of coexistence of, the energies of the electric oscillations resulting from the trains of electromagnetic waves of each set, for producing intelligible signals of unequal length or duration corresponding to the elements, "dots and dashes," of the Morse or other telegraphic code.

11. In a system of space telegraphy, a transmitting apparatus comprising means for transmitting a plurality of trains of electromagnetic waves, no single one of said trains of electromagnetic waves being capable of intelligible reception or translation, in combination with means at a receiving-station for selecting and combining the energies of said trains of waves and thereby producing intelligible signals by the coöperation of the said energies.

12. 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 order of transmission but coexisting throughout a definite portion of their durations, and means, at a receiving-station, actuated by the coöperation of the energies of said trains of electromagnetic waves for producing intelligible signals differing in length or duration from the length or duration of any one of said trains of electromagnetic waves.

13. In a system of space telegraphy, a plurality of systems at a transmitting-station, each adapted to transmit trains of simple harmonic electromagnetic waves of a different frequency, a plurality of systems at a receiving-station, each adapted to absorb the energy of simple harmonic electromagnetic waves of one of the frequencies transmitted to the exclusion of the energy of like waves of different frequency, and an electric translating device associated with said systems at the receiving-station and adapted to be energized for the production of intelligible signals, only by the coöperation of the energy of the waves absorbed by each receiving system.

14. In a system of space telegraphy, a plurality of systems at a transmitting-station, each adapted to transmit trains of simple harmonic electromagnetic waves of a different frequency, a plurality of resonant circuits at a receiving-station, each attuned to the frequency of a different one of the trains of waves transmitted and an electric translating device adapted to be energized for the production of intelligible signals, only by the coöperation of said resonant circuits.

15. In a space-telegraph receiving apparatus, a plurality of resonant circuits, each attuned to a different frequency and each adapted to absorb the energy of simple harmonic electromagnetic waves of the frequency to which it is attuned to the exclusion of the energy of like waves of different frequency, and an electric translating device adapted to be energized for the production of intelligible signals, only by the coöperation of said resonant circuits.

16. In a system of space telegraphy, a plurality of receiving systems, each adapted to absorb the energy of simple harmonic electromagnetic signal-waves of one frequency to the exclusion of the energy of like waves of different frequency, in combination with means associated with said receiving systems and adapted, only by the coöperation thereof, to produce intelligible signals.

17. In a system of space telegraphy, an apparatus adapted to transmit a plurality of

overlapping trains of electromagnetic waves, differing from each other in frequency and in order of transmission, in combination with means, at a receiving-station, adapted to be actuated only by the coöperation of the energies of said overlapping trains of electromagnetic waves for producing intelligible signals at said receiving-station only and means for transmitting trains of waves of a different frequency, which are not intended to affect the receiving means.

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.