No. 763,893. PATENTED JUNE 28, 1904.

W. S. HOGG.

WIRELESS TELEGRAPHY.

APPLICATION FILED SEPT. 22, 1902.

NO MODEL. 2 SHEETS—SHEET 1.

FIG. 1.

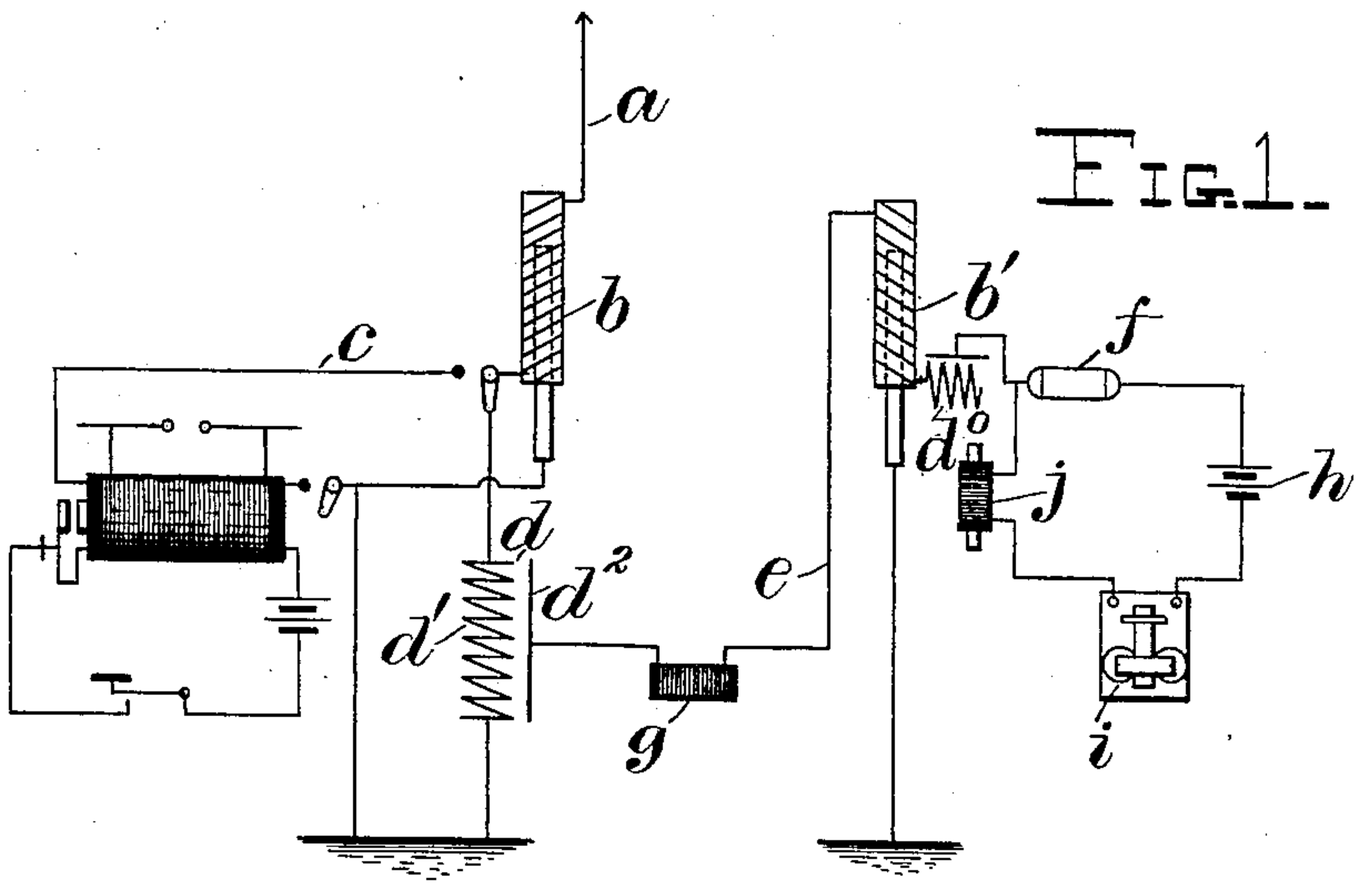
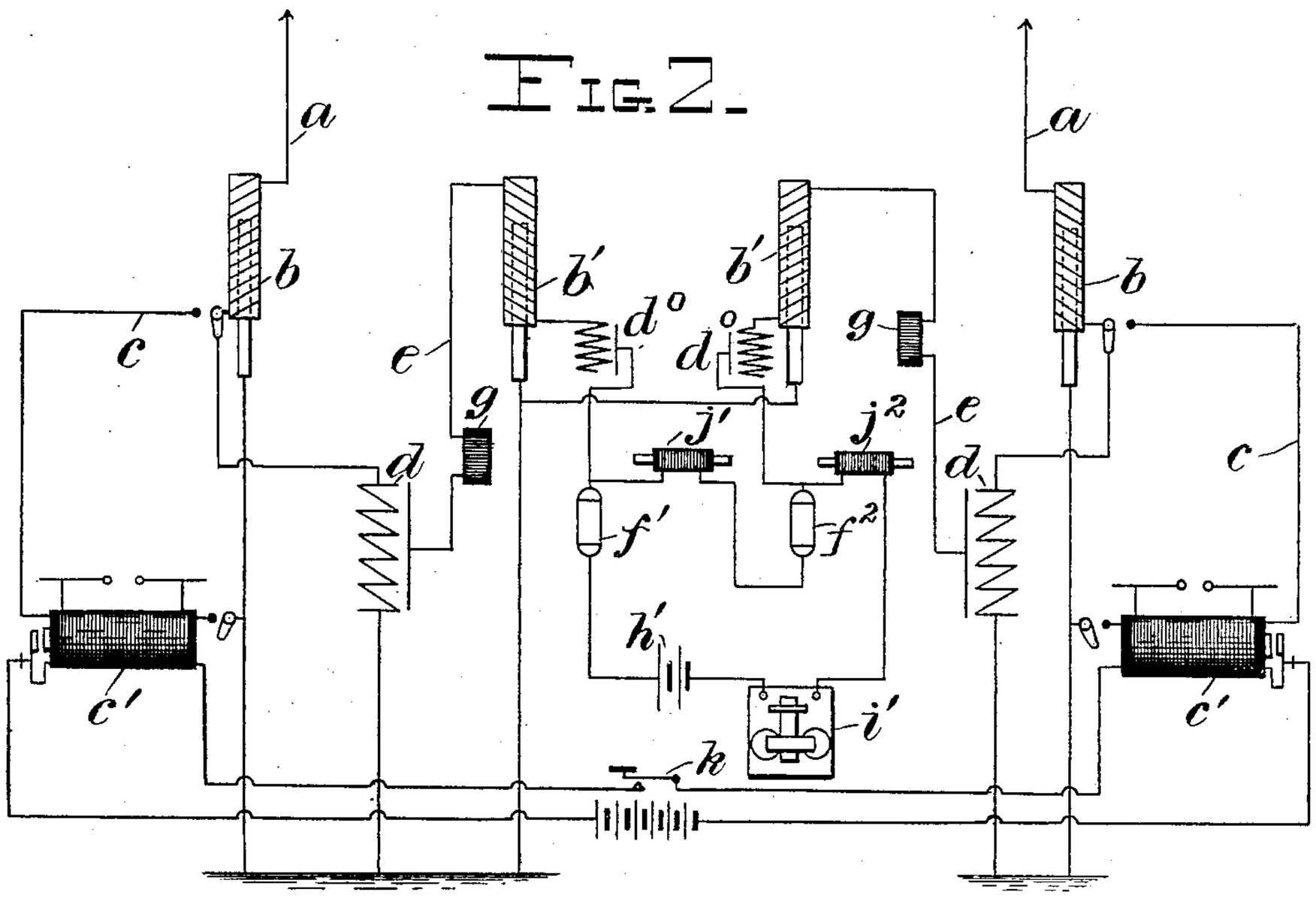


FIG. 2.



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NO MODEL. 2 SHEETS—SHEET 2.

Fig. 3.

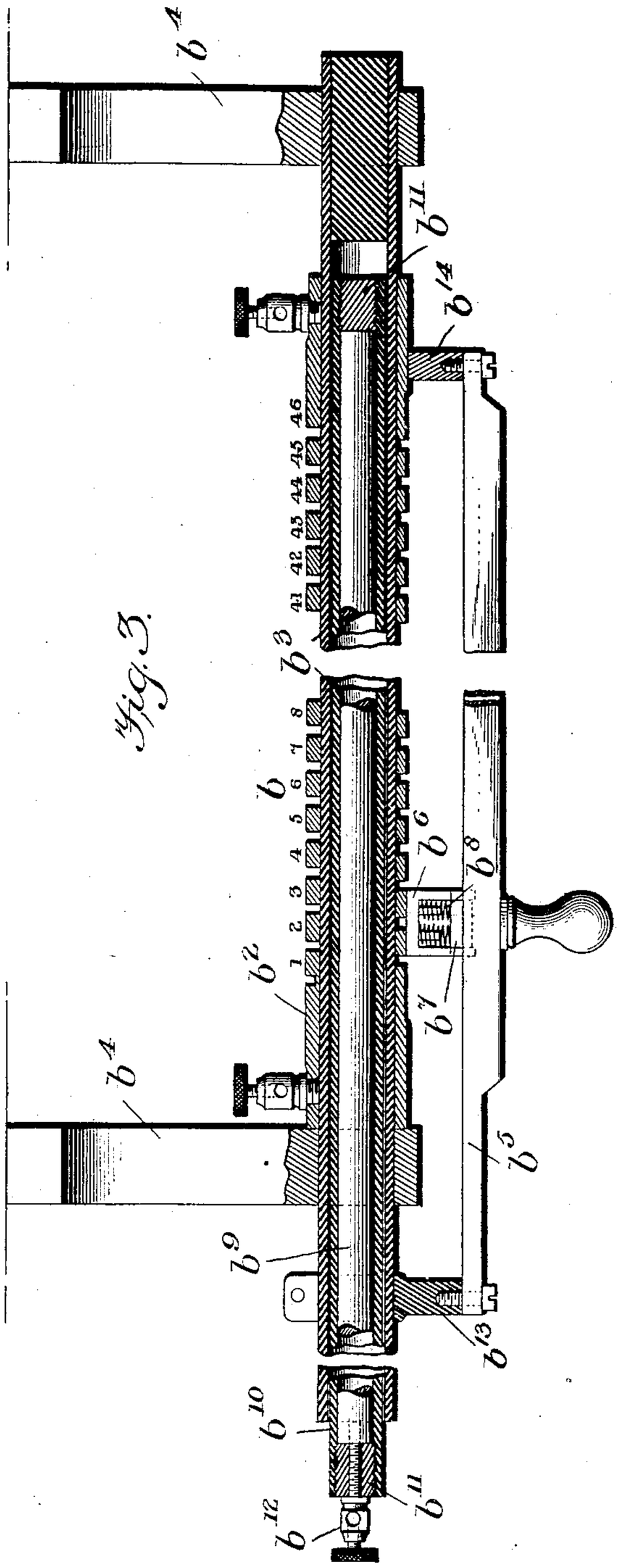
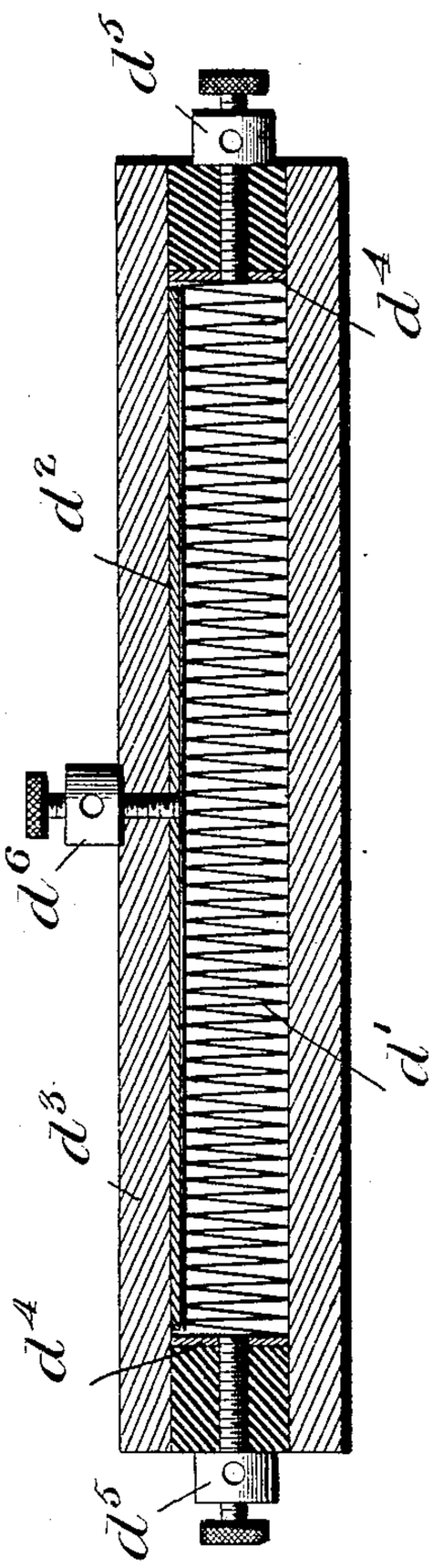


Fig. 4.



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No. 763,893. Patented June 28, 1904.

UNITED STATES PATENT OFFICE.

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WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 763,893, dated June 28, 1904.

Application filed September 22, 1902. Serial No. 124,395. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM STETSON HOGG, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Wireless Telegraphy, (Case B;) and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in wireless telegraphy, and more especially to that class of wireless-telegraph systems in which the receiving-circuit is tuned to oscillate in syntony with the transmitting-circuit by giving the respective circuits practically the same inductance, capacity, and resistance, so that the receiving-circuit will respond only to oscillations set up by a correspondingly-tuned transmitter.

My invention further relates to improvements in those systems of wireless telegraphy which employ in receiving a main aerial circuit and a coherer-circuit receiving its electrical energy from said aerial circuit or vertical wire and attuned to oscillate in syntony with said aerial. In this case my invention relates especially to the means for conveying the electrical energy from the aerial to the coherer circuit.

The objects of my invention are, first, to provide improved means for tuning circuits of the above character; second, to provide improved means for taking the energy off the aerial wire and impressing it on the coherer-circuit, whereby the actual distance of transmission with a given source of electrical energy and length of aerial wire is increased, and by the same means to prevent atmospheric discharges from affecting the coherer or equivalent instrument, and, third, to provide means for the prevention of interference from outside sources by transmitting simultaneously two or more trains of waves of different frequencies.

In carrying out the first of the above-mentioned objects my invention consists in the employment of a combined variable self-induction and capacity device by which the self-induction and capacity of the circuits to be attuned may be varied simultaneously and its employment in combination with the tuned circuit, as hereinafter described.

In carrying out the second of the above-named objects my invention consists in providing novel means for conducting the electrical energy from the aerial circuit to the circuit whose oscillation period is attuned to that of the aerial circuit, the said means comprising an electrostatic intensifier connecting the aerial circuit to the attuned circuit which contains the coherer or its equivalent. In tuned circuits of this character it has been the practice prior to this invention to convey the electrical energy from the aerial wire to the coherer-circuit either by connecting the coherer-circuit to the aerial wire direct or by means of a transformer having its primary connected in the aerial circuit and its secondary in the coherer-circuit.

My invention differs from either of the foregoing methods in that I take the energy off the aerial wire by electrostatic induction, and the device that I employ for this purpose is of such a character as to greatly intensify the oscillations induced in the coherer-circuit and at the same time prevents atmospheric discharges from affecting the coherer.

In carrying out the object of my invention, which has to do with the prevention of interference from outside sources, my invention consists in employing two or more aerial wires each tuned to a different period and each having its induced attuned receiving-circuit, in each of which circuits is connected a separate coherer or its equivalent. These coherers are then so connected that each will be responsive only to its corresponding attuned waves, while all act to close a common battery-circuit which operates a suitable receiving instrument. This battery-circuit, however, will be operative only when all coherers act.

My invention consists, further, of the novel features and combination of parts herein de-

scribed, and pointed out in the accompanying claims.

In order to more fully describe my said invention, reference will be had to the accompanying drawings, in which—

Figure 1 is a diagram illustrating the case in which I attune a receiving-circuit having a single receiver of electrical oscillations, such as a coherer, and a single aerial wire. Fig. 2 is a diagram illustrating the case in which I employ two or more aerial wires and syntonize by two or more trains of waves. Fig. 3 represents in longitudinal section a combined variable-capacity and self-induction tuning device, and Fig. 4 a cross-section of the receiving-intensifier.

Similar letters refer to similar parts throughout the several views.

In the following description reference will be had first to that portion of my invention which relates to the attuning of a single receiving-circuit having a single receiving instrument, such as a coherer, and with which I use a single aerial wire for sending out and receiving the waves. Referring to Fig. 1, which illustrates this form of my invention, *a* represents the vertical or aerial wire, and *b* a tuning device connected in circuit between the inductorium and the wire *a* and comprising a variable-capacity and self-induction device consisting of an outer metal spiral in which is adapted to slide an iron core, with a dielectric between the core and the spiral. This tuning device *b* is provided with arbitrary scales and indices which designate the amount of capacity and self-induction. One of these tuning devices is shown in detail in Fig. 3 and will be hereinafter more fully described. By sliding the iron core in and out of the outer spiral and by short-circuiting different convolutions of the spiral tube of this tuning device the capacity and the self-induction of the vertical-wire circuit may be varied and its oscillation period thereby made to correspond to that of the circuit *c* of the oscillator. Moreover, by means of the indices of this tuning device all other stations with similar devices and like apparatus will be enabled to communicate by adjusting the tuners to proper points. These tuning devices may be made standard instruments and secrecy attained by the use of a suitable code reading in terms of the scale graduations.

A tuned transmitting-circuit and a tuner varying slightly from the tuner *b* are fully described in my pending application, filed March 4, 1902, and serially numbered 96,675.

In the circuit of the aerial wire *a* and its tuner *b* I connect an intensifier *d* and connect also to this intensifier the wire *e*, forming a part of the circuit to be tuned, so that its oscillations will correspond to those of the wire *a*. Connected in the circuit *e* is the coherer or its equivalent *f*.

The above-mentioned intensifier consists of a zigzag plate of tin-foil d', coated with paraffin paper or other suitable dielectric, and a metal collector-plate d^2, the whole being incased in a suitable box d^3. (See Fig. 4.) The zigzag plate d' (see Fig. 1) is connected in series between the earth and the outer spiral of the tuner *b*, while the collector-plate d^2 is connected to the receiving-circuit *e* to be attuned. The electric waves, possibly by their dynamic effect in traversing the plate d' of the intensifier, act inductively and set up in the collector-plate d^2 intensified vibrations, which reach the coherer through the circuit *e*. This intensifier by thus increasing the electromotive force of the oscillations which act on the coherer renders a given piece of apparatus capable of receiving signals from much longer distances than would otherwise be the case, and while I am aware of the fact that others have sought to accomplish this result they have done so in a different way—viz., by the use of an induction-coil connected in the circuit of the vertical wire and acting as a step-up transformer. The intensifier herein described is quite different from an induction-coil and is much simpler and easier to make. Moreover, the arrangement of the intensifier herein shown eliminates atmospheric and interference effects, allowing the atmospheric discharge to go to earth without affecting the coherer.

The tuning of the circuit *e* is accomplished by adding to it an amount of self-induction equal to the self-induction of the wire *a* together with the self-induction of the transmitting-tuner *b* and a capacity which is self-regulating, the latter being done by connecting the receiving instruments in circuit with the induction-plate of the intensifier d^0. An ordinary condenser, though, can be placed in circuit and its capacity made equal to that of the aerial wire. I accomplish this by adding to the circuit *e* a self-induction *g* equal to that of the wire *a* and tuner b' similar in every respect to the tuner *b* and having its self-induction index adjusted to the mark corresponding to that of the tuner *b*. The iron cores of both tuners are connected to the earth, as shown. The circuit *d* being thus attuned, the coherer will respond only to oscillations for which the transmitting-circuit or aerial wire are tuned.

Connected around the coherer *f* and battery *h* in the usual manner are the relay, sounder, or other receiver *i* and choking-coil *j*.

In sending, the tuner *b* is disconnected from the receiving-circuit and is connected to the oscillator by the switches, as shown, from which it will be seen that while sending the intensifier *d* is cut out of circuit. It would therefore appear that owing to the capacity of the intensifier and its connections the aerial circuit would have a different oscillation period when employed in receiving than when em-

ployed in sending, thereby disturbing the syntony. It is known, however, that absolute syntony between the transmitting and receiving circuits is not essential, the apparatus becoming inoperative only when the divergence of the frequency of the oscillations is very great. In cases where the introduction of the intensifier into the aerial circuit renders the divergence of the frequency between the transmitted and received oscillations great enough to interfere with the working of the system I may provide for this by adjusting the transmitting-tuner so that its capacity and self-induction will be equal to that of the receiving-tuner plus that of the intensifier. This may be done by giving the sending-tuner upon each adjustment a lead over that of the receiving-tuner equal to the capacity of the intensifier. For example, if without the intensifier in circuit with the tuners both circuits have the same self-induction and capacity with the rods of the respective tuners adjusted to the same indices when the intensifier is in circuit with one of the tuners the rod of the sending-tuner would be inserted into the spiral to such an extent as to allow for the extra capacity of the receiving-circuit due to the intensifier.

While syntony may be effected reasonably well in the case in which a train of waves is sent out by and received on a single aerial wire, greater efficiency may be attained by employing two or more aerial wires and sending out a plurality of trains of tuned waves. The latter method is more efficient owing to the readiness with which extraneous electric waves of different period will cause a sensitive receiver to respond. This method of synchronizing by two or more trains or waves is illustrated in Fig. 2 and consists in employing two or more aerial wires each having its respective tuned transmitting-circuit and two or more induced tuned receiving-circuits, one for each of the said transmitting-circuits, a coherer or its equivalent for each of said induced tuned circuits, each coherer responsive only to the wave of its corresponding tuned circuit, and a battery-circuit common to all of the coherers, but operative only when all coherers have been acted upon by their respective tuned waves.

Referring to the drawings, Fig. 2, f' and f^2 represent, respectively, the coherers or their equivalents located in a circuit common to all and including a battery h' or its equivalent. This coherer battery-circuit includes also the choking-coils j' j^2 and the receiving relay, sounder, or other receiving instrument i'. Each of these coherers is connected to its respective tuned circuit e, and each of these circuits is connected inductively through an intensifier d to the circuit of its corresponding vertical wire a, the tuning of the circuits e e with their vertical-wire circuits being accomplished in exactly the same manner as described with reference to Fig. 1.

The operation is as follows: By means of the tuners b b the circuit of the vertical wires a a are attuned to a certain pitch, but independently of each other—that is to say, one of the wires a is tuned to send out a train of waves of a predetermined periodicity, while the other wire a is also tuned to send out a train of waves of a predetermined periodicity, but not necessarily the same as the train from the first-mentioned wire. The receiving-circuits e e are then attuned, as described with reference to Fig. 1, to their respective aerial wires. A wave therefore received on the left-hand aerial wire a will traverse the tuner b and pass through the zigzag plate d' of the intensifier d on the left into earth. This will set up an intensified oscillation in the plate d^2, and consequently in the circuit e, which oscillation will be received by the coherer f', but owing to the choking-coil j' cannot pass to the coherer f^2. Likewise a tuned wave received upon the vertical wire a on the right will set up a vibration in the tuned circuit e on the right, which vibration will be received by the coherer f^2, but cannot affect the coherer f' on account of the choking-coil j^2. Both coherers having been operated by their respective tuned circuits will close the coherer battery-circuit and operate the local instrument i'. Upon this same principle I may employ a large number of vertical wires and respective tuned circuits and coherers therefor without departing from the spirit of my invention.

The question of increasing the number of aerial wires and tuned circuits is merely one of duplication, since each coherer is operated by a circuit the same in every respect as the single aerial-wire arrangement shown in Fig. 1.

Reference will next be had to the specific construction of some of the apparatus that I employ in carrying out my invention, and first to the variable capacity and self-induction tuning device b.

A device quite similar to the one herein described is fully described and claimed broadly in my application hereinbefore referred to, the present device differing from the former one only in details of construction and in the employment of an iron core instead of a spiral tube movable in and out of the outer spiral. This device is shown in detail in Fig. 3, where b^2 represents the outer metal spiral, which consists, preferably, of a brass tube cut spirally from a certain distance from each end. This spiral is mounted fast on a tube b^3, of glass, hard rubber, or other suitable dielectric, which is held in suitable supports b^4 b^4. A metal slide-bar b^5 is mounted at its ends upon supports b^{13} and b^{14}, the former mounted upon the tube b^3 and the latter upon one end of the spiral tube b^2. These supports b^{13} and b^{14} may either be both

of metal and the support b^{13} insulated from the bar b^5 or the support b^{13} may be made entirely of insulating material, as shown. Adapted to slide on the bar b^5 is a suitable contact-maker, consisting of a contact-block b^6, mounted in a sliding support b^7 and held against the outer surface of the spiral tube by suitable springs b^8. A suitable handle is provided for moving the contact-maker along the spiral. The function of this contact-maker is to short-circuit adjacent convolutions of the spiral coil b^2, and thus vary the self-induction of the circuit which traverses it and which is to be tuned. Each convolution of this spiral is numbered or otherwise properly designated. I have shown them numbered from 1 to 46. Therefore if one tuner is set so that its contact short-circuits coils 6 7 the tuner of the circuit to be tuned must have its contact set on coils 6 and 7. The self-induction of the two circuits, so far as the tuner is concerned, will therefore be the same. The capacity of the tuner is varied by means of the iron rod b^9, which is adapted to slide in and out of the spiral b^2. This core is surrounded by a tube b^{10}, of glass, hard rubber, or other suitable dielectric, closed at each end by proper plugs of insulation b^{11} and provided with a suitable binding-post b^{12}. As the capacity of the tuner is varied by adjusting the core in and out of the spiral, this core is provided with an arbitrary series of marks along the length of its tube to indicate the extent to which it is withdrawn or pushed into the spiral tube. By this means a similar instrument may be set so as to have the same capacity by setting its core to a corresponding mark. I do not, however, limit the system of syntonizing herein described to this specific form of tuner, as I may also use the form shown and described in my application above referred to.

A specific form of the intensifier is shown in Fig. 4 and is constructed as follows: I take a thin conductor, such as a piece of tin-foil, and entirely inclose it in paraffin-paper cemented to its surface. This tin-foil is then folded in a zigzag fashion in folds of about one-half inch in depth to the largest number practicable, the larger the number of folds the greater the intensity effect. After being thus folded it is placed in a flat wooden or other insulating box d^3. The extreme ends of the tin-foil are laid bare and make contact with metal plates d^4 d^4, to which connect the binding-posts d^5 d^5. Melted insulating-wax or paraffin is then poured into all the crevices of the folded sheet and contacts. A metal collector-plate d^2 is then placed over the thin layer of wax over the top edges of the folded sheet and connected to a suitable binding-post d^6. This device I find allows an atmospheric discharge to go to ground without affecting the coherer; but other electric waves, presumably by their dynamic effect, cause an accumulation of high-tension electricity at the sharp corners of the zigzag member, and such electricity acts by induction on the collector-plate until the difference of potential is sufficient to act on the coherer or other receiving instrument. The vibration thus set up in the collector-plate is, moreover, greatly intensified, and thus acts to increase the effect in distance of the electric wave, as has been hereinbefore pointed out.

While I have thus described a specific form of intensifier, I may modify this form within considerable limits without departing from the spirit of my invention, and I intend that the claims for said intensifier shall cover all possible modifications of the broad idea involved.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In wireless telegraphy, the combination with an aerial circuit, of a tuner, comprising a combined variable self-induction and capacity device for varying the oscillation period of said circuit, a receiving-circuit, and means for attuning said receiving-circuit to said aerial circuit.

2. In wireless telegraphy, the combination with an aerial circuit, of a combined variable self-induction and capacity device for varying the oscillation period of said circuit, a receiving-circuit, and a similar device for attuning the said receiving-circuit to the said aerial circuit.

3. In wireless telegraphy, the combination with an aerial circuit, of a combined variable self-induction and capacity device for tuning said circuit, a tuned receiving-circuit inductively connected to the said aerial circuit, a self-induction connected in said circuit equal to that of the aerial wire, and a combined variable self-induction and capacity device similar to that of said aerial circuit and also connected in said receiving-circuit.

4. In wireless telegraphy, the combination with a tuned aerial circuit, of a receiving-circuit attuned to the said aerial circuit, and an electrostatic intensifier connecting the two circuits.

5. In wireless telegraphy, the combination with a tuned aerial circuit, of a conductor having a series of points, and connected in said circuit, a collector-plate located near said conductor-points and in inductive relation thereto and a receiving-circuit connected to said collector-plate and attuned to said aerial circuit.

6. In wireless telegraphy, the combination with a local coherer-circuit, of two or more coherers connected therein, a separate differently-tuned circuit actuating each coherer, means whereby each coherer responds only to its attuned wave, and local apparatus operated by the coherer-circuit.

7. In wireless telegraphy, the combination with two or more receivers of electrical oscillations, of two or more differently-tuned receiv-

ing-circuits one for each of said receivers, a local circuit including all of said receivers, and apparatus located in said local common circuit and operative only when each receiver is operated by its attuned wave.

8. In wireless telegraphy, the combination with two or more coherers, of two or more differently-tuned receiving-circuits, one for each of said coherers, a coherer-circuit common to all coherers, means in said circuit for confining to each coherer the waves of its respective attuned circuit, and a receiving instrument operated by said coherer-circuit.

9. In wireless telegraphy, the combination with two or more coherers, of two or more differently-tuned receiving-circuits one connected to each of said coherers, a coherer-circuit common to all of said coherers, choking-coils connected in said coherer-circuit and acting to confine to each coherer the waves of its corresponding attuned circuit, and a receiving instrument operated by said coherer-circuit and operative only when all of said coherers act.

10. In wireless telegraphy, the combination with two or more independently-tuned aerial circuits, of a separate receiving-circuit for each of said aerial circuits and each tuned to its corresponding aerial circuit, of a separate coherer for each of said receiving-circuits, a coherer-circuit common to all of said coherers, means in said coherer-circuit for confining to each coherer the waves of its corresponding attuned circuit and a receiving instrument operated by said coherer-circuit and operative only when all of said coherers are actuated.

11. In wireless telegraphy, a tuning device, comprising an outer spiral surface, an iron rod movable in and out of said spiral, a dielectric separating said rod and spiral surface, and means for varying the self-induction of said device by short-circuiting the turns of said spiral.

12. In wireless telegraphy, a tuning device consisting of a spiral metal surface, an iron rod movable in and out of said spiral surface for varying the capacity of the device, a dielectric separating said rod and said spiral surface, means for short-circuiting the turns of said spiral for varying the self-induction of said device, and indices for indicating the relative amount of capacity and self-induction of said device.

13. In wireless telegraphy, a tuning device consisting of a spiral metal surface, an iron rod movable in and out of said spiral surface for varying the capacity of the device, a dielectric separating said rod and said spiral surface, a sliding contact for short-circuiting the turns of said spiral for varying the self-induction of said device, and indices for indicating the relative amount of capacity and self-induction of said device.

14. In wireless telegraphy, an intensifier comprising a conducting-plate having a plurality of pointed surfaces and a collector-plate located in inductive relation to said points.

15. In wireless telegraphy, an intensifier, comprising a zigzag non-inductive metallic insulated member, a collector-plate located close to the points of said non-conductive member and separated therefrom by insulation, and a case inclosing said plate and zigzag member.

16. In wireless telegraphy, an intensifier comprising a thin metallic plate folded to form a plurality of points, and covered with insulation, of a collector-plate located near the said points and in inductive relation thereto, a case inclosing both of said plates and means for effecting electrical connection through said core with each of said plates.

17. In wireless telegraphy, an intensifier, comprising a sheet of tin-foil folded zigzag fashion and coated with insulation, a metal collector-plate placed against the points of said zigzag sheet and insulated therefrom, a case inclosing both said sheet and plate, and means for forming electrical connection with said sheet and plate.

18. In wireless telegraphy, an intensifier comprising a series of insulated conducting-surfaces, and a collector-plate located in inductive relation to the edges of said conducting-surfaces.

19. In space telegraphy, the combination with two signal-receiving devices adapted to be operated by different sets of waves, of a signal-indicating device included in the circuit of both receiving devices.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM STETSON HOGG.

Witnesses:

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