J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED MAR. 12, 1908.

986,651. Patented Mar. 14, 1911.

3 SHEETS—SHEET 1.

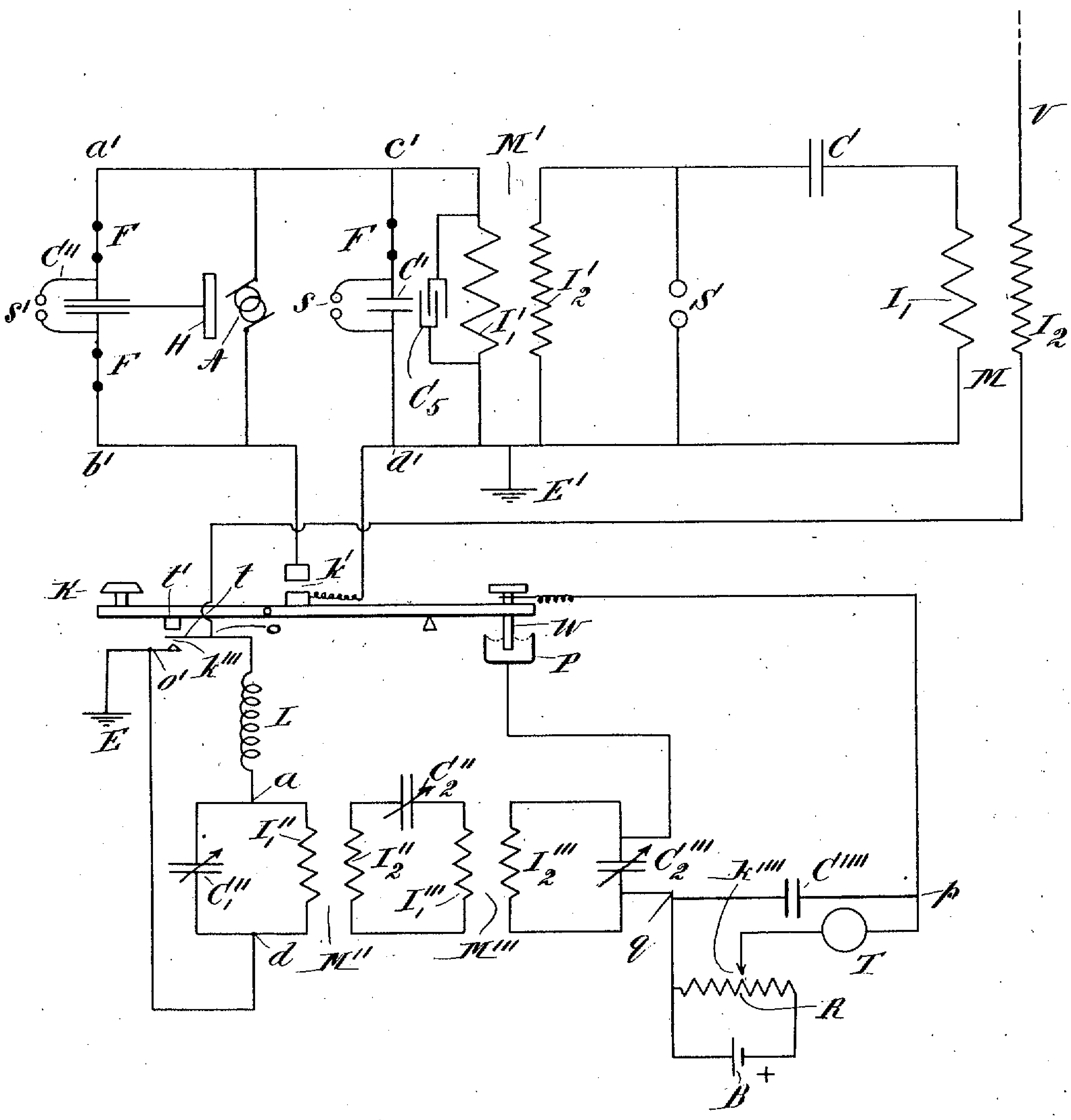

Fig. 1.

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3 SHEETS—SHEET 2.

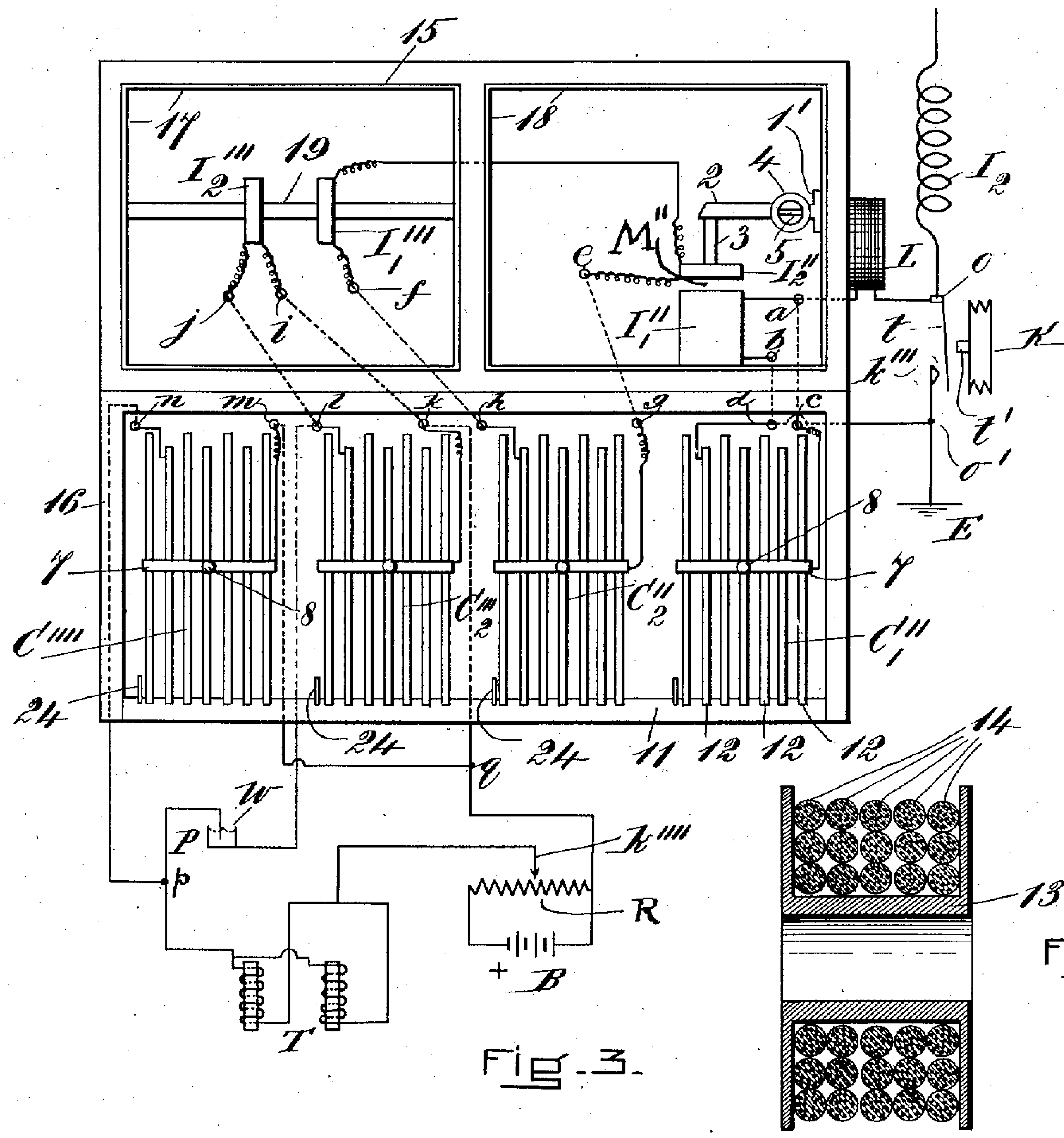

Fig. 3.

Fig. 2.

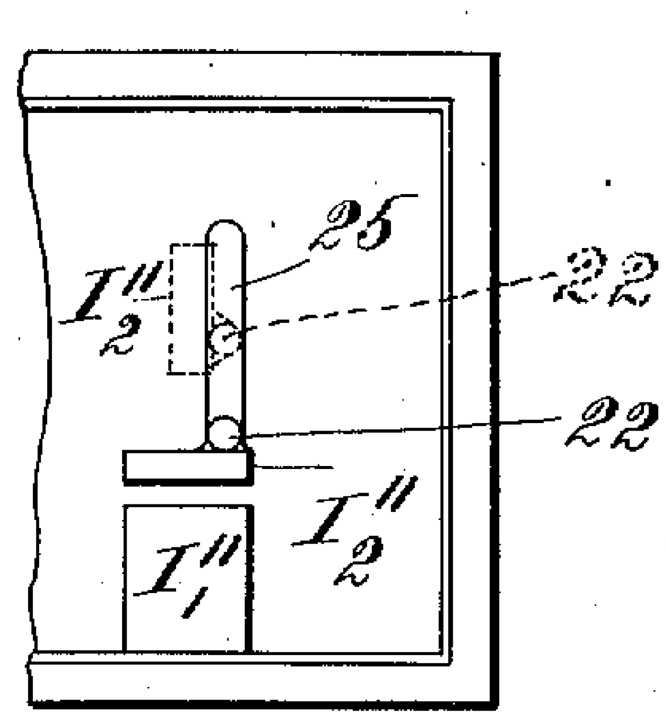

Fig. 3a.

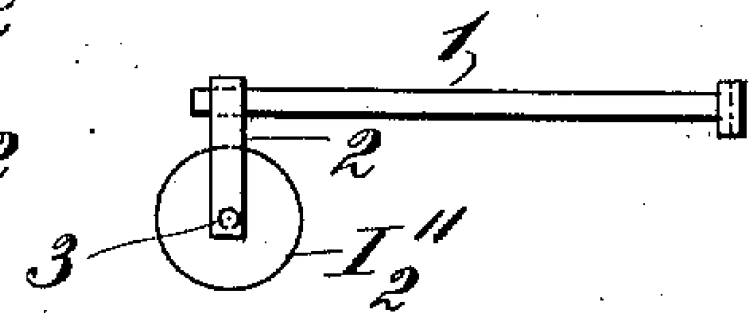

Fig. 5.

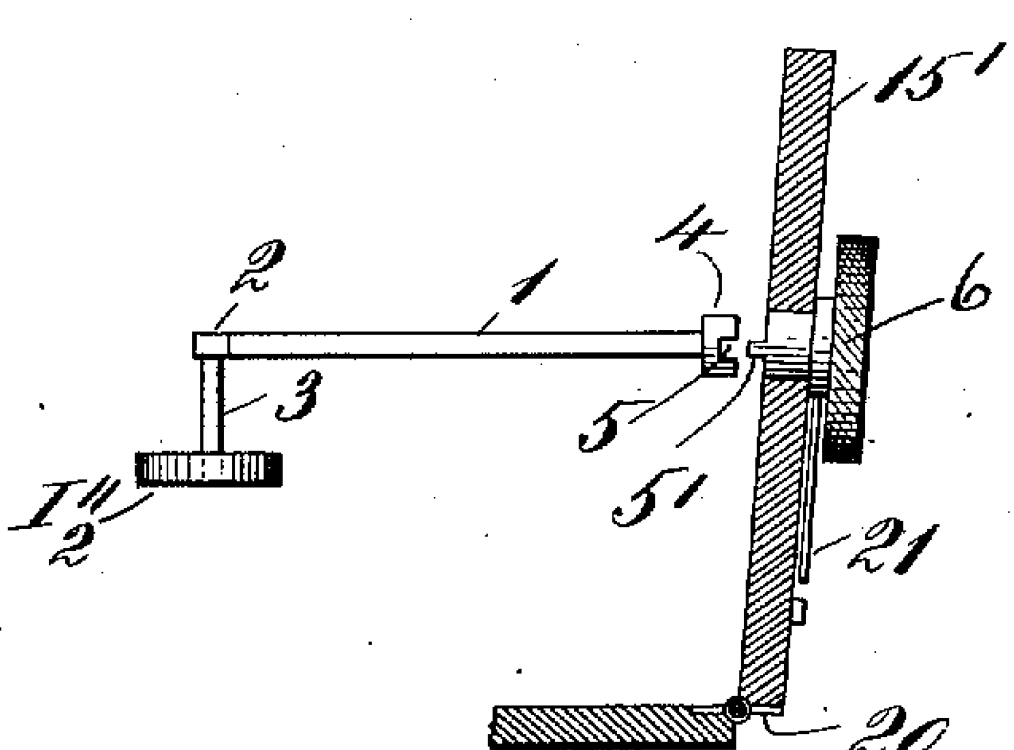

Fig. 4.

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3 SHEETS—SHEET 3.

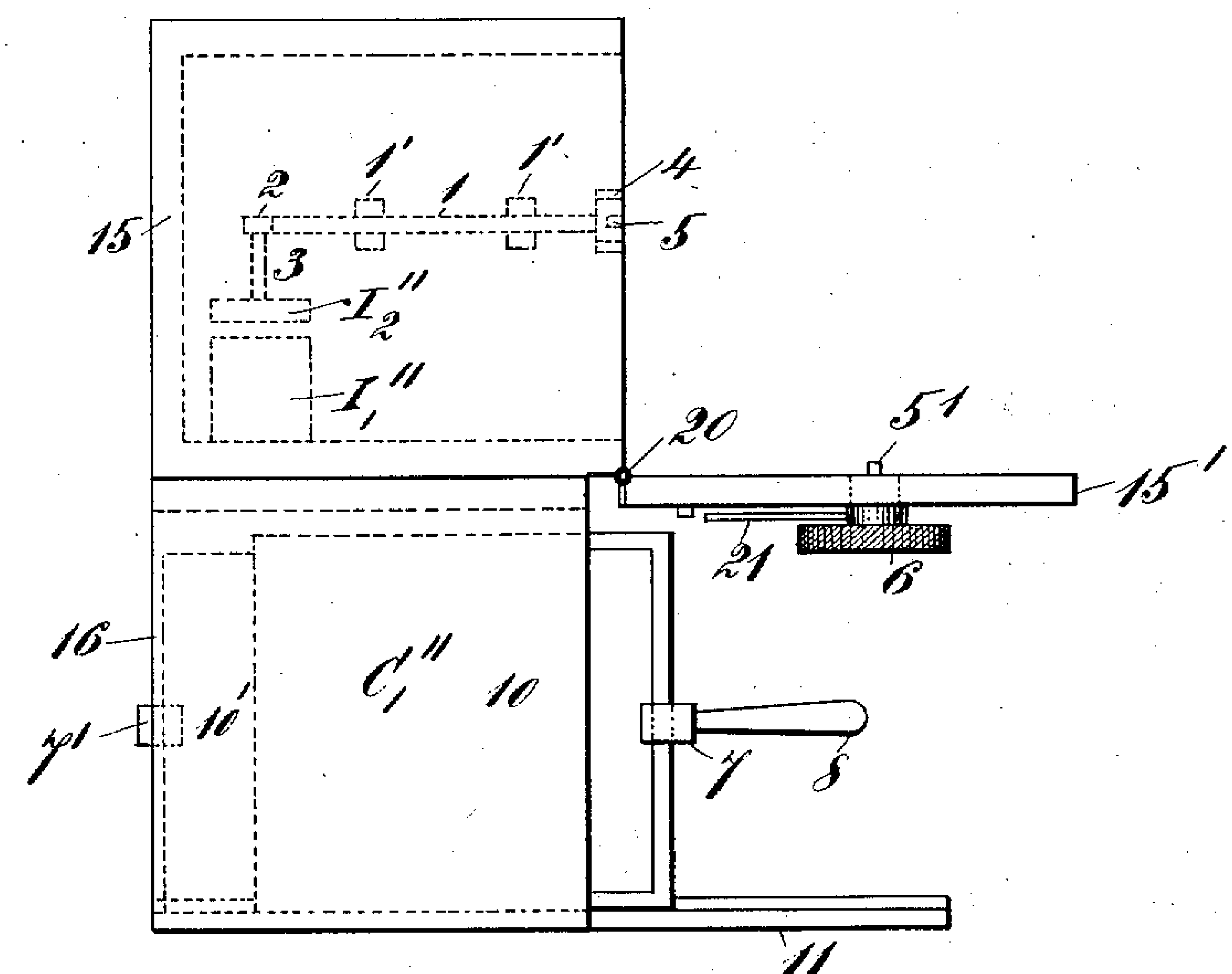

Fig. 6.

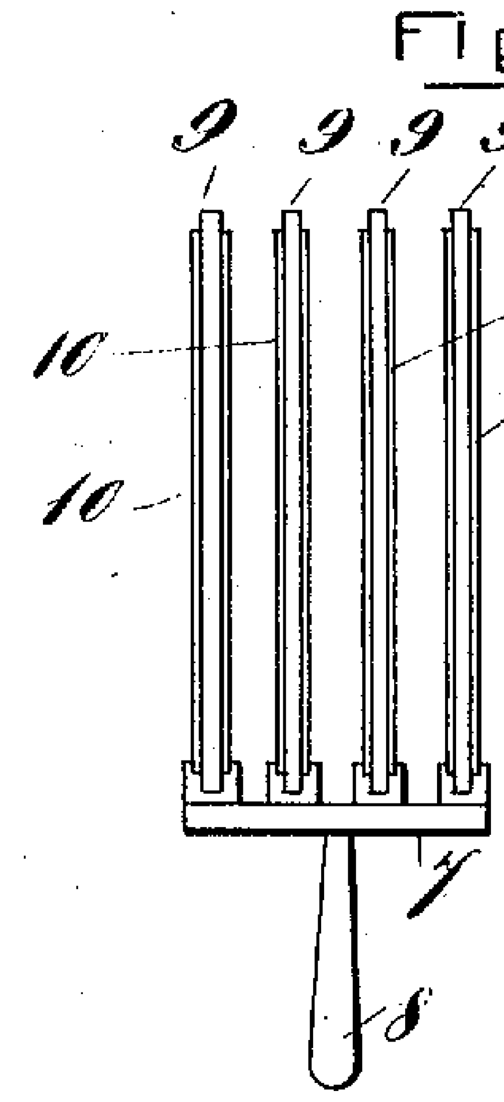

Fig. 7.

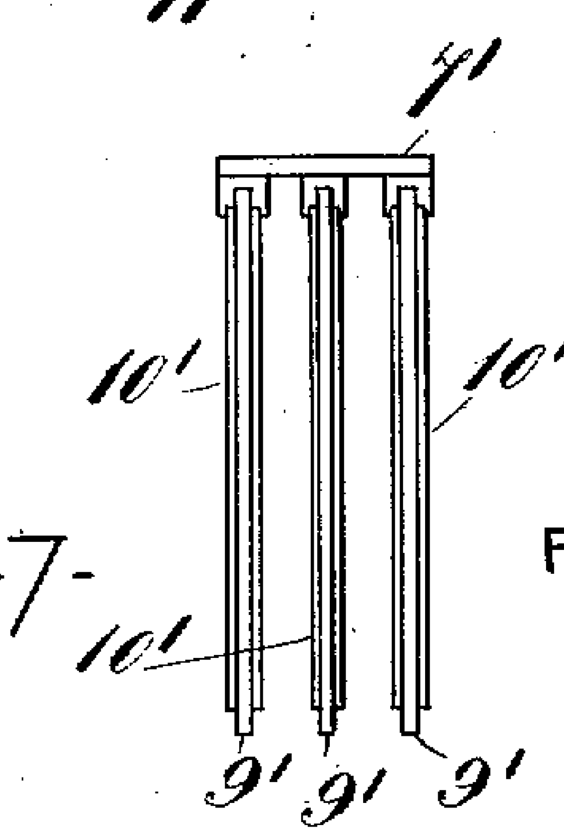

Fig. 8.

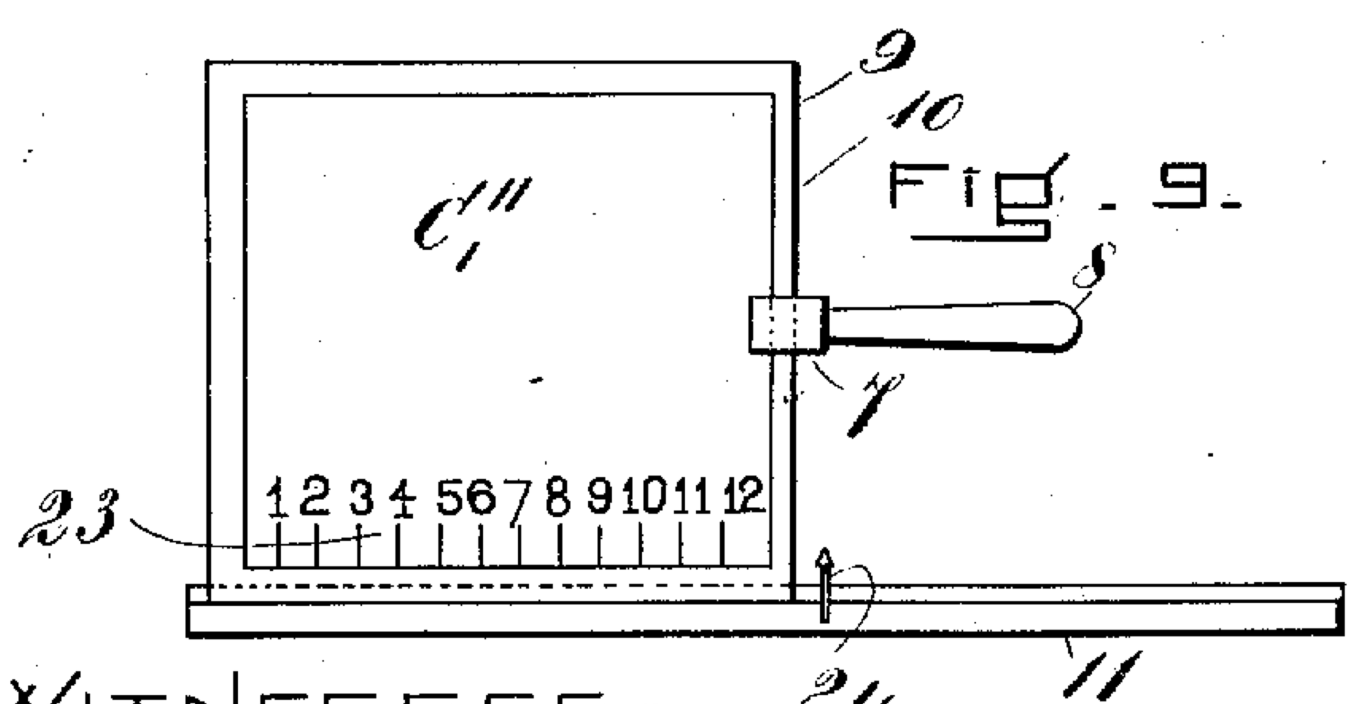

Fig. 9.

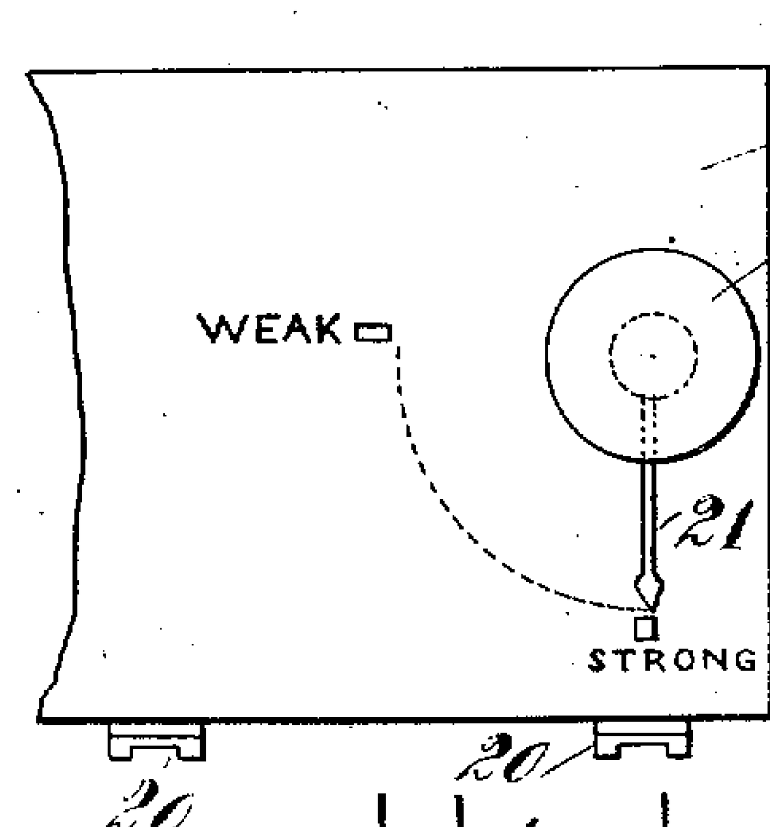

Fig. 10

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UNITED STATES PATENT OFFICE.

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SPACE TELEGRAPHY.

986,651. Specification of Letters Patent. **Patented Mar. 14, 1911.**

Original application filed February 27, 1906, Serial No. 303,213. Divided and this application filed March 12, 1908. Serial No. 420,590.

To all whom it may concern:

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

My invention relates to space telegraphy, and its objects are to provide certain novel circuit arrangements for space telegraph systems and to provide certain improved details of construction which may be employed in connection with the circuit arrangements disclosed in my prior Patents Nos. 714,756, dated December 2, 1902, and 767,994, dated August 16, 1904.

My invention may best be understood by having reference to the drawings which accompany and form a part of this specification and which illustrate certain apparatus and circuit arrangements embodying my invention; but it is to be understood that my invention is not limited to the particular embodiments thereof which are illustrated in said drawings, inasmuch as my invention may be subjected to a wide range of variation without departing from the principle thereof.

In the drawings, Figure 1 diagrammatically represents a combined transmitting and receiving space telegraph system; Fig. 2 is a sectional view of one form of coil that may be employed; Fig. 3 is a front elevation of one form of receiving set embodying my invention; Fig. 3ª is a fragmentary view of a modification of the receiving set shown in Fig. 3; Fig. 4 is a sectional view taken at right angles to the view shown in Fig. 3 with certain elements illustrated in Fig. 3 omitted, and showing the hinged cover of the receiving set casing which has been omitted from Fig. 3; Fig. 5 is a plan view of the transformer I''_2 and the means whereby the position of the same with respect to its primary may be regulated: Fig. 6 is an end view of the receiving set shown in Fig. 3 illustrating the hinged cover 15′ of the receiver casing which has been omitted from Fig. 3; Fig. 7 is a plan view of the movable condenser plates; Fig. 8 is a plan view of the stationary condenser plates; Fig. 9 is a side view of said movable plates, said plates being shown in front view in Fig. 3; and Fig. 10 is a front view of that portion of the hinged cover of the receiver set casing which closes that compartment thereof containing the transformer M″.

In the figures, A is an alternating-current generator; V is an elevated conductor; E E′ are earth connections; M M′ M″ M‴ are transformers, of which the primary and secondary windings respectively are I_1 I_1', etc., and I_2 I_2', etc.; C C′ C″, etc., are condensers; P is an oscillation responsive device herein shown as a Wollaston anode W in an electrolyte contained in a cup P; T is a telephone receiver or other suitable signal-indicating device; B is a battery; R is a resistance; S *s s′* are spark-gaps; L is an inductance; K is a key and F F are fuses.

In Fig. 1 the circuit S C I_1 is a sonorous or persistently oscillating circuit inductively associated with the elevated conductor system V I_2 E by means of the transformer M whose windings I_1 I_2 preferably are so spatially related as to render the period of said sonorous circuit practically independent of the electromagnetic constants of said elevated conductor system, as more fully explained in the aforesaid patents. The circuit containing the alternator A and the primary I'_1 of the transformer M′ is the primary power circuit, the energy of which is delivered at the desired tension to said sonorous circuit by means of said transformer.

For the purpose of protecting the armature windings of the alternator A, I connect the branch circuit *a′ b′* across the terminals of said alternator and connect one armature of the condenser C″ included in said circuit to the frame H of the alternator, so that any electrical oscillations which may be created in the primary power circuit by the reaction of the sonorous circuit thereon, will be prevented from creating a difference of potential between said armature windings and the metallic parts of the alternator which lie adjacent to said windings. In order to protect the condenser C″ from the effects of excessive oscillating potentials which may be developed between the points *a′* and *b′*, I connect a spark-gap *s′* across the terminals of said condenser. In order to protect the alternator from excessive currents which may be developed in the primary power circuit in case of condenser breakdown or arc at the spark-gap *s′* caused by the reaction of the sonorous circuit thereon or from any other cause I may connect a fuse F on either side of the condenser C″ in the branch a' b'.

A branch c' d' is connected across the terminals of the primary I'_1 of the transformer M′ and is connected to earth at E′. A spark-gap s is connected across the armatures of the condenser C′ which is included in said branch c' d'. By means of said branch c' d' and its connection to earth d' E′, the primary I'_1 of the transformer M′ and the armature of the alternator A are protected from excessive potentials or currents developed in the primary power circuit by the reaction thereon of the sonorous circuit S C I_1. For the purpose of further protecting said primary power circuit as above set forth from excessive currents a fuse F may be connected on one side of the condenser C′, but obviously is not needed on the earthed side thereof. Both condensers C′ and C″ should be so proportioned that each of the branches a' b' and c' d' should have for the frequency of the power current an impedance high as compared to its impedance for the frequencies of the oscillations developed in the sonorous or oscillating circuit.

The condenser C_5, shown in the present instance as connected across the terminals of the primary of the transformer M′, has its capacity so related to the inductance of the primary power circuit as to reduce the impedance of the primary power circuit for currents of the frequency developed therein by the alternator A and thereby increase the power factor of said circuit. Obviously the condenser C_5 may be arranged in other ways for effecting this result. It will of course be understood that, in general, the capacity of the condenser C_5 is larger than the capacity of either of the condensers C′ C″.

The elevated conductor is connected to the spring contact t at the point o and the contact member which coöperates with said contact t is connected to earth at E. Between the points o and o' the receiving system is connected and it will be apparent that upon the depression of the key K the projection t' presses the spring t into contact with its coöperating member and closes the contact k''' thereby short-circuiting the receiving system between the points o o' and thereby connecting the receiving system to the elevated transmitting conductor system V I_2 o t o' E at a point having practically zero potential to earth. It will be apparent also that the potential difference developed between the points o o' during transmission, even when currents of very large amplitude are developed in said elevated conductor system, will be negligibly small and will not develop in the receiving system currents of sufficient amplitude to injure the delicate parts thereof such as the coil L or the coils of the transformers M″ M‴. Simultaneously with, or before or after, the closure of the contact k''' the receiver is rendered inoperative by raising the Wollaston anode W out of the electrolyte contained in the cell P. It is immaterial whether the anode be raised out of contact with said electrolyte before or after the closure of the contact k''', all that is necessary being that both these operations occur prior to the closure of the contact k'.

I do not wish to limit myself to the particular means shown in Fig. 1 and described above for rendering the receiver inoperative, inasmuch as various other means may be employed for this purpose.

The elevated receiving conductor system consists of the elevated conductor *per se* V, the secondary I_2, the conductor connecting the latter to the point o, the inductance L, the parallel branch circuit C''_1 I''_1 and the conductor connecting the latter to earth at E. The electromagnetic constants of said parallel branch circuit are so proportioned that for a persistent train of waves of the frequency to which the resonant receiving circuit I_2''' C_2''' is attuned said parallel branch circuit will balance by its reactance the reactance of the rest of the elevated receiving conductor system, in which system it will be noted, the secondary I_2 operates merely as an inductance. The resonant weeding-out circuit C''_2 I''_2 I'''_1 may, if desired, be interposed between the parallel branch circuit and the resonant receiving circuit I'''_2 C'''_2 as more fully explained in my prior Patents Nos. 714,756, granted December 2, 1902 and 12,149, reissued August 25, 1903.

When electrical oscillations having the frequency to which the resonant receiving circuit is attuned are developed in said resonant receiving circuit, a maximum difference of potential exists across the terminals of the condenser C'''_2 which is one of the tuning elements of said resonant circuit, and therefore across the terminals of this condenser I connect the electrolytic receiver P in lieu of connecting said receiver in series with said resonant circuit. The apparent resistance of the electrolytic receiver P is large and if such receiver is connected in series with the resonant receiving circuit the selectivity of said circuit is considerably reduced. Furthermore the electrolytic capacity of said receiver is not quite constant so that by connecting an electrolytic receiver across a point of maximum potential development of said circuit and in shunt to a condenser of relatively large capacity, the receiver exerts a much less pronounced effect upon the selectivity of said circuit than when it is serially connected therewith. The signal-indicating device T and the variable resistance R, which resistance with the battery B and contact k'''' constitutes a potentiometer, may as shown be connected in series with the receiver P because the large distributed capacity inherent in these devices offers but little opposition to the flow of high frequency electrical currents therethrough. If desired, a condenser C'''' may be connected as shown across the terminals *p*, *q* of the device T and resistance R for the purpose of increasing the capacity of the receiver circuit and reducing the opposition of said circuit to the passage of high frequency currents therethrough.

It is often desirable, and for commercial operation it is necessary, that a receiving operator should be able to "break" the transmission from a distant station when he fails to understand a message or a portion thereof, and such operation of "breaking" is accomplished by the apparatus shown in Fig. 1 by the simple expedient of depressing the key K. By the depression of the key K the receiver is rendered inoperative, the receiving system is short-circuited by the closure of the contact *k'''* and the elevated transmitting conductor is connected directly to earth, and then by a further movement of the key K the primary power circuit is closed at *k'* thereby effecting the radiation of electromagnetic waves from the elevated conductor system. These waves are absorbed by the elevated receiving conductor system at the station from which signals are being transmitted to the receiving operator who is "breaking", and when the key at said transmitting station is in normal position the "break" signal may be read by the transmitting operator at said station between his own signal elements. For this purpose the operators retain the telephone T, which preferably is a head telephone, in position while sending and it will be obvious that the connection of the receiving system to the elevated conductor transmitting system at a point of zero potential during transmission will permit an operator so to retain the telephone T in position with safety. It is also to be noted that the telephone T being in a tertiary circuit is not conductively connected to the transmitting system at any time. It will be noted that the means operated by the sending device K for short-circuiting the receiving system between the points *o o'* are not connected either electrically or mechanically with said sending device.

In my United States Patents Nos. 714,756, dated Dec. 2, 1902, and 767,977, dated Aug. 16, 1904, I have discussed at length the advantages resulting from tuning coils having their kinetic energy large compared to their potential energy when the circuit in which such coil is included is supporting a current of the frequency to which said circuit is attuned, or having the length of conductor constituting the coils a fraction of half a wave-length of the potential or current along the coil—in other words having such length of conductor short compared to the half wave-length of the waves corresponding to the frequency to which the circuit including the coil is attuned.

In Fig. 2 I have shown in section one form of coil possessing the foregoing characteristics. This coil is formed of fine stranded wires which may be twisted together so as to form a cable 14 and said cable may be wound upon the spool 13. It is capable of demonstration that such a coil possesses, for a given inductance a much smaller distributed capacity and resistance than a coil formed of a single wire. In other words, a coil constructed as above described possesses a maximum electromagnetic time constant and a minimum electrostatic time constant so that, other things being equal, the persistence and selectance of a circuit including such coils are greatly improved.

In Fig. 3 is shown one of the numerous concrete embodiments of the circuit arrangements described in my prior patents, especially in United States Patent No. 767,994. In Fig. 3 the receiving set is identical as to its circuital arrangements with the receiving system shown in Fig. 1. The coil I_2, the spring *t*, its coöperating contact, the earth connection E and a portion of the key K are all shown diagrammatically in Fig. 3, as well as the receiver P, telephone T and potentiometer BR. The rest of the apparatus is shown in front elevation. This apparatus consists of a casing 15 divided into two compartments each lined with tin 17, 18, or other suitable conductor to eliminate as far as possible the effects of stray magnetic fields, and more particularly to prevent mutual inductance between coils I_1'' and I_2'''. As indicated in Fig. 4, and as shown in Fig. 6, the casing 15 is provided with a hinged cover 15' which also may be, and preferably is, lined with a conductor. In the right-hand compartment of the casing 15 the rod 1, mounted on the side of the casing by suitable supports 1', is provided at its outer end with a boss 4 provided with a slot 5 adapted to receive a projection 5' carried by the knurled head 6, so that when the cover 15', which is connected with the casing 15 by the hinges 20, is closed, the rod 1 may be rotated by means of said knurled head. Attached to the inner end of the rod 1 is the member 2 extending at right angles to the rod 1, and depending from said member 2 at right angles thereto is the rod 3 which carries the secondary winding I_2'' of the transformer M'' at its lower end. The primary coil I_1'' is secured in any suitable manner to the base of the compartment so that it will be directly under the secondary coil when the needle 21 which is secured to the head 6 points downward as shown in

Figs. 4 and 10. As the head 6 is turned in a clockwise direction so that the needle 21 approaches a horizontal position, the secondary I_2'' is rotated and carried away from its primary winding, and when said head is sufficiently rotated to bring the needle 21 to a horizontal position, said secondary will assume a position parallel to the axis of its primary and will be on the right of said axis because the member 2 and rod 3 are unequal in length. In this position the mutual inductance between the primary and secondary winding of the transformer M'' will be a minimum as indicated by the word "weak" printed on the cover 15', and when said secondary has the position shown in Figs. 3 and 6, said mutual inductance is a maximum as indicated by the word "strong" printed on said cover.

By virtue of the construction described above, it is possible to regulate the coefficient of coupling without opening the transformer compartment. Leads from the primary I_1'' pass through the holes *a b* in the back of the casing and one of them connects with the coil L while the other connects with one armature of the condenser C_1'' passing through the hole *d* in the back of the condenser casing. That lead from the primary I_1'' which connects with the coil L passes into the condenser casing through the hole *c* in the back thereof and connects with the other armature of the condenser C_1'', thereby closing the parallel branch circuit C_1'' I_1'' shown in diagram in Fig. 1. One terminal of the secondary I_2'' passes through the partition separating the two compartments of the receiving set casing and connects with the primary I_1''' of the transformer M''' while the other terminal of said secondary passes through the hole *e* in the back of the casing, enters the condenser compartment by the hole *g* and connects with one armature of the condenser C_2''. The lead from the other armature of said condenser passes out of the condenser casing by the hole *h*, enters the receiving set casing through the hole *f* and connects with the other terminal of the primary I_1''', thereby closing the resonant weeding-out circuit I_2'' C_2'' I_1''' shown in diagram in Fig. 1. The secondary I_2''' of the transformer M''' connects with the condenser C_2''' by leads which pass out of the receiving set casing by the holes *i j*, and which pass into the condenser casing by the holes *k l*, thereby closing the resonant receiving circuit. Across the terminals of the condenser C_2''' the circuit of the receiver P is connected, and the condenser C'''', if employed, is connected across that part of the receiver circuit containing the telephone T and the variable resistance R by leads which pass from the points *p q* into the condenser casing through the holes *m n*. The rod 19 which extends from one side to the other of the left-hand compartment of the receiving set casing supports the windings of the transformer M''' and affords a convenient means of producing a lateral variation of the spatial relation of said windings, which preferably are constructed in the manner shown in Fig. 2.

It is sometimes desirable to produce a much looser coupling between the resonant weeding-out circuit, if such circuit be employed, and the elevated conductor system or between the resonant receiving circuit, if the resonant weeding-out circuit be not employed, and the elevated conductor system, than could be produced conveniently by the means shown in Fig. 3, and such extremely loose coupling may be effected by the construction shown in Fig. 3ª. In Fig. 3ª the rod 22 is attached to the secondary I_2'' at a point on one side of the center thereof and is adapted to move vertically in the slots 25 with which the opposite sides of the casing are provided. To reduce the coefficient of coupling, the rod 22 is raised vertically and rotated so that the secondary I_2'' assumes a position directly in line with the axis of the primary I_1'', in which case there should theoretically be absolutely zero mutual inductance between the windings, but in which there is sufficient mutual inductance to permit an extremely persistent train of oscillations to energize the circuit in which the secondary I_2'' is included.

The construction of the condensers which I prefer to employ is shown in Figs. 3, 6, 7, 8 and 9. Each condenser consists of a series of stationary supporting plates 9' of any suitable insulating or conducting material, each carrying on both its sides a sheet of conducting material 10' conductively connected together by the metallic clip 7'. Each condenser comprises also a series of movable supporting plates 9, each carrying on both its sides in like manner a sheet of conductive material 10 connected together by the metallic clip 7 which is provided with a handle 8. The base 11 of the condenser casing is provided with grooves which receive the stationary supporting plates 9' and retain them properly separated, and which receive also the movable plates 9 and afford guide ways for the same. The supporting plates as will be obvious take no part in the condenser action, the dielectric of the condenser being the air which separates the conducting surfaces 10 10'. Each condenser may be provided with a scale 23 attached to one of the movable plates and coöperating with the pointer 24 attached to the base of the condenser casing. By the use of such condensers I am enabled to vary in a perfectly smooth and continuous manner the natural periods of the several circuits including the condensers and to quickly adjust the several circuits of the system to the frequency of the waves the energy of which is to be received.

This application is a division of my application Serial No. 303,213, filed February 27, 1906.

I claim,

1. In a space telegraph system, a resonant circuit attuned to the frequency of the waves the energy of which is to be received and including a condenser, and an electrolytic receiver connected in shunt to said condenser.

2. In a space telegraph system, a resonant circuit attuned to the frequency of the waves the energy of which is to be received, and an electrolytic receiver connected in shunt to a tuning element of said resonant circuit.

3. In a space telegraph system, a coil formed of stranded wire of lengths which are short compared to the half wave-length of the waves corresponding to the frequency to which the circuit including said coil is attuned.

4. In a space telegraph system, a circuit resonant to a given high frequency and including a coil formed of stranded wire, said coil having the amplitude of its potential energy small compared to the amplitude of its kinetic energy when supporting a current of said given high frequency.

5. In a space telegraph system, an elevated conductor, a parallel branch circuit serially connected therewith, a resonant weeding-out circuit associated with said parallel branch circuit, a resonant receiving circuit associated with said resonant weeding-out circuit and adjustable air condensers associated respectively with said parallel branch circuit, said resonant weeding-out circuit and said resonant receiving circuit.

6. In a wireless telegraph receiving set, a compartment lined with conducting material, a transformer located in said compartment, a member supporting one of the coils of said transformer and means whereby said member may be rotated.

7. In a wireless telegraph receiving set, a compartment provided with a hinged cover, a rod in said compartment carrying one of the coils of a transformer and means carried by said cover and coöperating with said rod whereby said rod may be rotated to vary the spatial relation of said coils.

8. In a wireless telegraph receiving set, a compartment lined with conducting material, a transformer located in said compartment and means extending through said compartment whereby the spatial relation of the windings of said transformer may be varied without opening said compartment.

In testimony whereof, I have hereunto subscribed my name this 4th day of March 1908.

JOHN STONE STONE.

Witnesses:

CHARLES C. KURTZ,

GEO. K. WOODWORTH.