No. 711,445. Patented Oct. 14, 1902.

H. SHOEMAKER.

ART OF TRANSMITTING INTELLIGENCE.

(Application filed Sept. 23, 1902.)

(No Model.) 2 Sheets—Sheet 1.

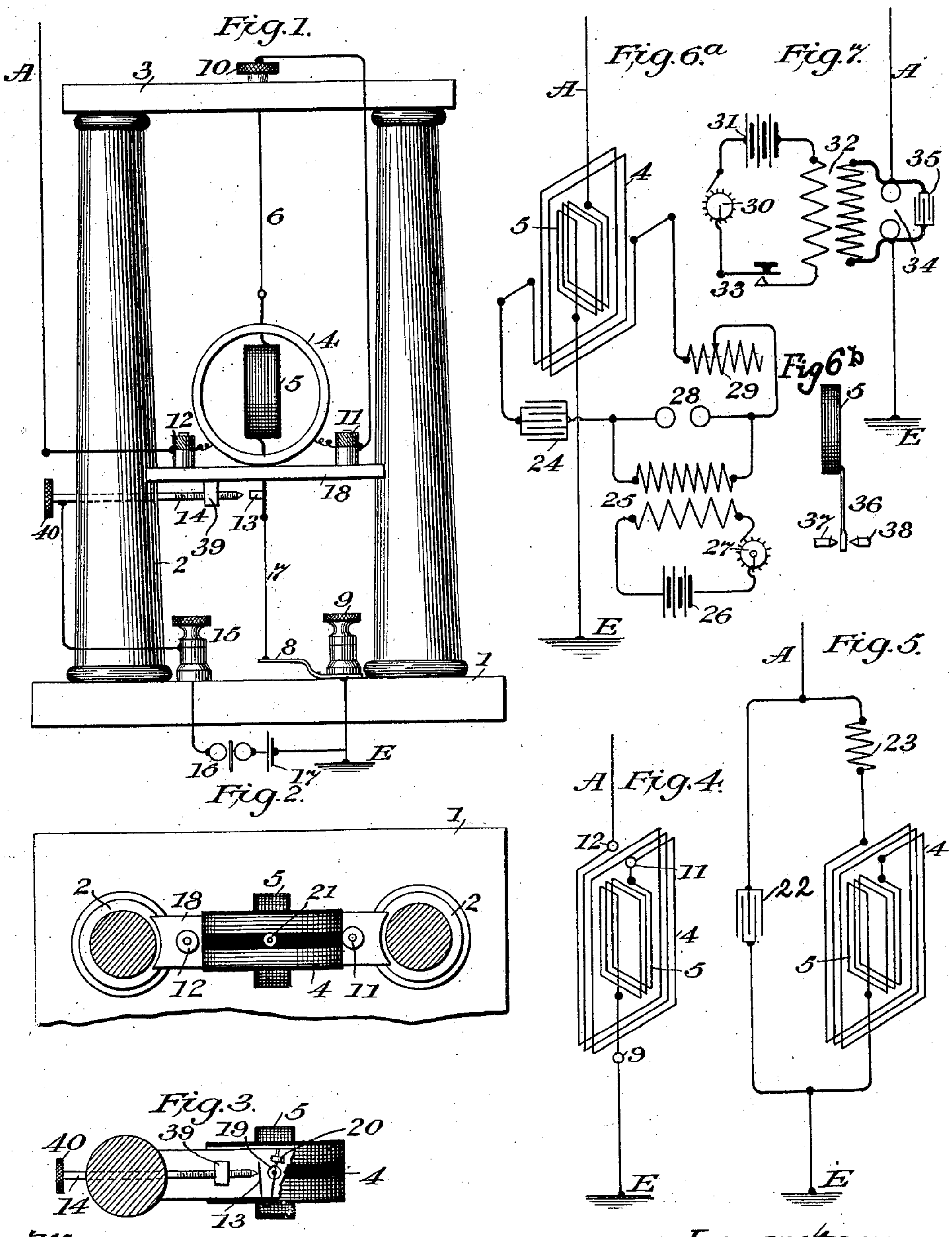

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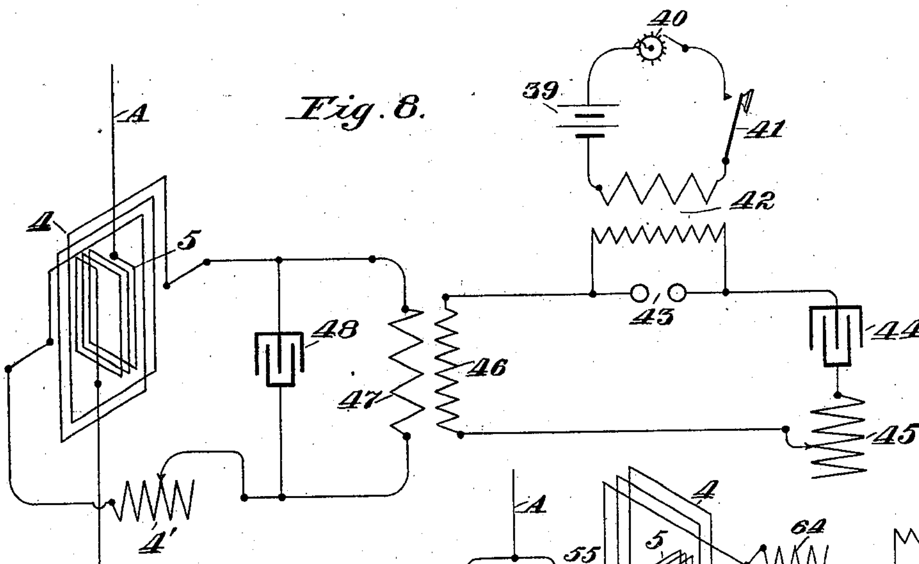
Fig. 8.



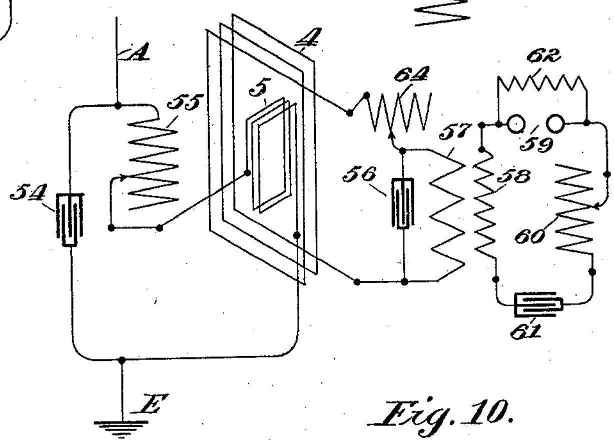
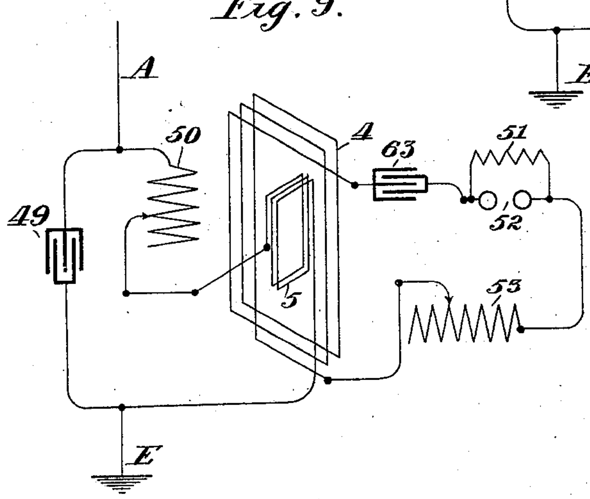


Fig. 10.

Fig. 9.



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UNITED STATES PATENT OFFICE.

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ART OF TRANSMITTING INTELLIGENCE.

SPECIFICATION forming part of Letters Patent No. 711,445, dated October 14, 1902.

Original application filed September 16, 1902, Serial No. 123,653. Divided and this application filed September 23, 1902. Serial No. 124,518. (No model.)

To all whom it may concern:

Be it known that I, HARRY SHOEMAKER, a citizen of the United States, residing at Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented a new and useful Improvement in the Art of Transmitting Intelligence, of which the following is a specification.

My invention relates to a method of transmitting intelligence by means of electroradiant energy transmitted through the natural media.

My invention is a method of transmitting signals, more particularly the method of receiving the electroradiant energy and causing it to produce signals by causing the energy received to produce manifestation by means of an electrodynamometer, which is, in fact, the wave-responsive device of my system.

My invention consists also in a method whereby feeble energy received is most efficiently used in producing a signal.

My invention consists also of a method of employing an electrodynamometer in a closed, resonant, or tuned circuit, the electrodynamometer winding or windings forming a part of or the entire inductance of such circuit.

My invention consists, further, in a method of producing a signal which consists in connecting a winding of an electrodynamometer in a circuit traversed by oscillatory currents derived from the received electroradiant energy while subjecting the other winding to oscillatory currents derived from a local source of energy, such local currents being of a frequency less than, equal to, or greater than the frequency of the transmitted energy.

My invention consists also in a method of maintaining a magnetic field by means of a local source of oscillatory currrents and subjecting to the action of such magnetic field means for producing another magnetic field due to the oscillatory currents derived from the received electroradiant energy.

My invention consists, further, in producing a magnetic field by the received electroradiant energy and maintaining a second magnetic field by means of the increased current component of energy in a closed, tuned, or resonant circuit.

My invention consists, further, in including one of the windings of an electrodynamometer in a closed, tuned, or resonant circuit traversed by currents due to the received electroradiant energy while including the remaining winding of the electrodynamometer in a circuit supplied by oscillatory currents from a local source of energy.

My invention consists, further, in subjecting one of the windings of an electrodynamometer to currents due to the received electroradiant energy and traversing a closed, resonant, or tuned circuit and subjecting the remaining winding of the electrodynamometer to currents traversing a closed, resonant, or tuned circuit, which currents are derived from a local source of energy.

The electrodynamometer is an instrument well known in the electrical arts and in its earliest form was known as the "Weber" dynamometer. It is well known that such an instrument responds to either direct currents or alternating currents and is independent of the frequency of such currents, because the reversal of currents in one winding is simultaneous with the reversal of current in the remaining winding, and therefore the reaction of the magnetic fields due to these windings is always in the same direction. I employ the force exerted by the windings of an electrodynamometer upon each other due to the currents produced by electroradiant energy to control a local circuit including the signal recording or producing apparatus. I have found that with the currents produced at a receiving-station by electroradiant energy I can by means of an electrodynamometer suitably constructed and arranged produce force sufficient to control local circuits for the purpose of operating signal recording or producing means.

Reference is to be had to the accompanying drawings, in which—

Figure 1 is an elevational view, partly in diagram, of an electrodynamometer instrument. Fig. 2 is a partial plan view from the top of the electrodynamometer shown in Fig. 1 with the support shown in section. Fig. 3 is a partial plan view looking upwardly toward the member 18. Fig. 4 is a diagrammatic view showing the electrodynamometer-coils connected in series with each other and in series with the usual aerial conductor of a wireless signaling system. Fig. 5 is a diagrammatic view of a closed, resonant, or tuned circuit included in the aerial conductor, the windings of the electrodynamometer forming a portion of the inductance of the said closed, resonant, or tuned circuit. Fig. 6[a] is a diagrammatic view of a modified arrangement of the receiver-circuits. Fig. 6[b] is a fragmentary view showing the circuit-controlling contacts in duplicate in connection with the movable coil of the electrodynamometer when employed as shown in Fig. 6[a] and others. Fig. 7 is a diagrammatic view of transmitting-circuits. Fig. 8 is a diagrammatic view showing one of the windings of an electrodynamometer in a closed, resonant, or tuned circuit traversed by currents derived from a local source. Fig. 9 is a diagrammatic view similar to Fig. 5, except that one of the windings of the electrodynamometer is supplied by oscillatory currents from a local source. Fig. 10 is a diagrammatic view similar to Fig. 5, except that one of the coils of the electrodynamometer is included in a closed, resonant, or tuned circuit and traversed by currents derived from a local source.

In Fig. 1, 1 represents a base from which rise two supports 2, supporting at their upper extremities member 3. Members 1 2 3 are preferably of insulating material. 4 represents the stationary coil of the electrodynamometer, within which is supported the movable coil 5, which carries relatively heavy supporting means, as clearly shown, and to these means are secured the torsional metallic ribbons 6 and 7. The upper ribbon 6 is joined at its upper end to the torsion-head 10, while the lower ribbon 7 is connected at its lower extremity to the leaf 8, which is in electrical communication with the binding-post 9. 11 and 12 are binding-posts for stationary coil 4. 13 is the movable contact in the local circuit to be controlled and is of a form clearly shown in Fig. 3 and constitutes a U-shaped metallic spring secured at its inner end to the extension from coil 5 and contacting with its outer end with the screw 14, which passes through 2 and is screw-threaded in the lug 39, extended from the lower side of the member 18. Stationary coil 4 is, in fact, two coils slightly separated from each other by insulating material, as shown in Figs. 2 and 3, and through said insulating material are openings at opposite ends of the diameter, through which pass the extension from coil 5.

In Fig. 2 the upper opening is shown at 21.

In Fig. 3, 19 represents a corresponding opening in member 18 to permit the passage of said extension from coil 5.

In Fig. 3, 20 represents a counterpoise which is, in fact, a nut engaging a screw-threaded extension of the contact 13. By means of this counterpoise the center of gravity of the moving system may be kept in the vertical geometric axis. 15 is a binding-post in electrical communication with the screw 14, and from said binding-post 15 extends a conductor from the relay 16 or other recording device in a local circuit, including battery 17, binding-post 9, ribbon 7, and contact 13. A represents the usual aerial conductor of a wireless signaling system and connects at its lower extremity with binding-post 12, which then communicates with one terminal of coil 4, whose remaining terminal connects by binding-post 11 and conductor with ribbon 6, the coil 5, ribbon 7, spring 8, and earth-plate E. This is precisely the arrangement of connection of the electrodynamometer. Upon the reception of electroradiant energy upon an aerial conductor alternating currents of very high frequency pass through the coils of the electrodynamometer, and by the well-known reaction the moving coil 5 is slightly displaced and in virtue of such displacement closes the local circuit at contacts 13 and 14. The circuit shown in Fig. 4 is the simplest mode of connection for an electrodynamometer, and in this connection it is to be remembered that the inductance of the windings of the electrodynamometer may operate as a frequency-determining element for rendering the receiving-circuit selective of or resonant with the transmitted energy.

In Fig. 5, A represents the usual aerial conductor, between which and the earth-plate E is connected the closed, tuned, or resonant circuit embracing the condenser 22, inductance 23, and the coils 4 and 5 of an electrodynamometer. As is well understood, by the reception of electroradiations of a definite frequency and with the condenser 22 and the combined inductance of the coils 4 and 5 and inductance 23, having certain critical proportions, there will flow in the local circuit, including the condenser 22, the windings of an electrodynamometer, and the inductance 23, a relatively large current. In other words, of the energy received at the receiving-station the current component of the resulting electric-current energy is increased by this arrangement of circuits, though of course the actual energy is in no way increased. However, since the magnetic fields depend for their strength simply upon the ampere-turns of their respective coils a gain is made by increasing the current component for the purpose of increasing said ampere-turns. With this increased current through the windings of the electrodynamometer-coils 4 and 5 there is then an increased reaction between such coils for the same amount of energy arriving, and the effect is greater than with the arrangement shown in Fig. 4. Coil 5, as explained heretofore, is the moving coil and controls the local circuit.

In Fig. 6[a], A represents the usual aerial conductor, between which and the earth-plate E is connected a coil of an electrodynamometer, and in this case it is the moving coil 5. The stationary coil 4 is not in electrical communication with the aerial conductor, nor is it traversed by any such current resulting from the received electroradiant energy. It is, however, traversed by oscillatory currents derived from a local source of energy 26, which is a battery in series with interrupter 27 and the primary of transformer 25, whose secondary is shunted to the spark-gap 28. The spark-gap 28 is in series with the condenser 24, stationary coil 4, and the adjustable inductance 29. This circuit, including condenser 24, stationary coil 4, and adjustable inductance 29, is traversed by an alternating current of a frequency dependent upon the capacity 24 and the combined inductance of the coil 4 and inductance 29. The condenser 24 is adjustable also, and by adjusting either the condenser 24 or inductance 29, or both, the frequency of the alternating currents flowing through the coil 4 may be adjusted so as to be equal to the frequency of the received energy. The purpose of this arrangement is to obtain a maximum effect in the receiver for the slight amount of energy received. The reactive force between the coils of an electrodynamometer is a function of the product of the ampere-turns of the coils. The current flowing through coil 5 being necessarily small, the ampere-turns of such coil are relatively few. To compensate for this weak field, the above arrangement is resorted to, for then a considerable current can be made to traverse the coil 4, and such coil 4 will in consequence develop a relatively powerful magnetic field. The result is, then, that the product of the ampere-turns of the two coils is increased, and therefore with a relatively small amount of received energy a relatively powerful deflection of the movable coil may be obtained. The principle is the same as that employed in d'Arsonval galvanometers of Thomson's siphon-recorders, where a light movable coil is traversed by a very weak current, and such coil is supported in a very powerful magnetic field in order that the resulting deflection may be a strong one. In this arrangement coil 5 may be of comparatively large number of turns of relatively small conductor, while coil 4 may be of comparatively large conductor and few turns. Inasmuch as coils 4 5 in this arrangement are independent, the coil 5 may rotate either in a clockwise direction or a counter-clockwise direction, depending upon the relative phase relation of the arriving energy and the energy in the coil. To insure closure of the local circuit in whichever direction the coil 5 may start, I supply, as shown in Fig. 6^b, two contacts 37 and 38. Contacts 37 and 38 are connected together, and the contact 36 corresponds with the contact 13 in Fig. 1. Contacts 37 and 38 correspond with contact 14 in Fig. 1. The aerial conductor A and the coil 5 may be made selective of or resonant with the transmitted energy. Similarly by adjusting the condenser 24 or the inductance 29, or both, oscillations through the coil 4 may be made equal in rate to that of the transmitted energy. However, if the period of the current through the coil 4 is either greater than or less than the period of the received oscillations the instrument will still be operative. The circuit 24 28 29 4 may be said to be adjusted to resonance with received energy, in which case the period of the current through coil 4 is equal to the period of the received energy.

In Fig. 7, A represents the usual aerial conductor of a transmitting-station, in series with which and the earth-plate E is the spark-gap 34. In shunt to the spark-gap 34 is a condenser 35 of relatively great capacity, whose connections to the spark-gap 34 are through conductors which are short and thick, and therefore of negligible inductance. In shunt to the spark-gap 34 is the secondary of the transformer 32, in whose primary is the interrupter 30, source of energy 31, and key 33. This transmitter will radiate very forcibly and will emit a large amount of energy in a very few oscillations. This will cause at the receiver the reception of a large amount of energy in an extremely short time, which is beneficial in a system as herein described. It is to be understood that the movable coil of the electrodynamometer is to be extremely light, delicately supported or pivoted, and having a very small inertia, so it will respond quickly and accurately to the received energy. It is preferable to construct the moving coil of a conductor of aluminium, as is common practice in electrodynamometer instruments employed in making measurements in electric lighting, &c. In an electrodynamometer which I have employed for recording signals transmitted by electroradiance energy I have constructed the fixed coil of sixteen turns of No. 18 Brown & Sharpe gage-wire, while the movable coil is constructed of eight turns of the same-sized wire. The diameter of the fixed coil was approximately one and one-fourth inches in diameter and the movable coil made as large as possible, and yet capable of free movement within the fixed coil. The movable coil was mounted upon jewel pivot-bearings and was opposed in its motion by a very weak flat spiral spring, one end of which was connected to a pivot-pin, while the other end was secured to the frame of the apparatus.

In Fig. 8, A represents the aerial conductor, between which and the earth-plate E is connected a coil 5 of the electrodynamometer. In this instance it is the movable coil, though of course the stationary coil might be so connected. The aerial circuit, including coil 5, may, if desired, be selective of or resonant with the transmitted waves. The remaining coil 4 is in an independent circuit supplied by alternating currents from the secondary winding 47 of a transformer whose primary is shown at 46. 39 is a source of energy, 40 an interrupter, and 41 a switch controlling the primary circuit of the transformer 42. In shunt to the secondary of the transformer 42 is the spark-gap 43, which is in series relation in circuit with adjustable condenser 44, adjustable inductance 45, and the primary 46. By adjusting condenser 44 or inductance 45, or both, the period of the high-frequency oscillatory currents in the circuit of the primary 46 may be determined. The secondary 47 operates simply as a source of alternating currents of a frequency equal to or approximately equal to the frequency of the transmitted energy (greater than or less than such frequencies, depending upon the adjustment of condenser 44 and inductance 45.) The coil 4 operates as the inductance element of a closed, resonant, or tuned circuit, of which 48 forms the condenser. By this means the current component of the energy supplied by the secondary 47 is increased for the purpose described in connection with Fig. 5. In series with coil 4 is the adjustable inductance 4′. It is to be understood also that condenser 48 is adjustable, so that by adjusting said condenser 48 or inductance 4′, or both of them, the constants of the circuit 4 4′ 48 may be properly determined for the purposes above described.

In Fig. 9, A represents the usual aerial conductor, between which and the earth-plate E is connected the local closed resonance or tuned circuit comprising condenser 49, adjustable inductance 50, and a coil 5 of the electrodynamometer. Condenser 49 is adjustable, so that by adjusting said condenser, inductance 50, or both, the relations of the constants of the local circuit may be so proportioned as to cause such circuit to be a closed, resonant, or tuned circuit with respect to the frequency of the transmitted energy. 4 represents the remaining winding of an electrodynamometer and is located in series with the circuit comprising adjustable condenser 63, spark-gap 52, and adjustable inductance 53. In shunt to the spark-gap 52 is the secondary 51 of a transformer, such as 42 in Fig. 8. The constants of the circuit including condenser 63, spark-gap 52, inductance 53, and coil 4 are adjusted so that the high-frequency alternating currents traversing such circuit shall be of a period equal to that or approximately equal to the period of the received electroradiations. By this arrangement a double effect is obtained. In the first place the ampere-turns in coil 5, due to the received electroradiant energy, are made as great as possible, and, secondly, the ampere-turns of the stationary coil are made very great by resorting to a local source of energy. This then greatly increases the product of the ampere-turns of the two coils, resulting in a very forcible deflection.

In Fig. 10 an arrangement is shown by which a still more forcible deflection may be obtained. Between the aerial conductor A and the earth-plate E is the closed, tuned, or resonant circuit, including adjustable condenser 54, inductance 55, and one coil 5 of an electrodynamometer. As previously described, this arrangement produces a relatively great magnetic field by the winding 5 with a certain amount of received energy. The ampere-turns of the remaining coil 4 are increased by making it either the entire or a portion of the inductance of a second closed, tuned, or resonant circuit, comprising the coil 4, adjustable inductance 64, and the adjustable condenser 56, which circuit is supplied with energy derived from the secondary of a transformer 57. The primary 58 of this transformer is in series with the spark-gap 59, adjustable inductance 61, and adjustable condenser 60. In shunt to the spark-gap 59 is the secondary 62 of a transformer, such as transformer 42. (Shown in Fig. 8.) The period of the alternating currents in the circuit of the primary 58 is determined by inductance 60 and condenser 61. By the arrangement shown in Fig. 10, then, we have a maximum number of ampere-turns in one coil of the electrodynamometer and a maximum number of ampere-turns in the remaining coil, due to the increased current component of alternating currents derived from a local source of energy.

It is to be understood that in connection with the invention herein described it is within the ability of one skilled in the art to interchange the movable and fixed coils of an electrodynamometer in any of the circuits shown or their equivalents, and, furthermore, to use a pivoted coil in place of the coil supported by torsion ribbons or wires.

It is to be understood also that a transmitter other than the one shown in Fig. 7 may be used—for example, a transmitter which emits trains of waves consisting of a great number of waves, and therefore persistent.

It is to be understood that this system may be employed in connection with circuits for a plurality of messages or simultaneously or independently received.

It is to be understood also that a Thomson balance may be used instead of an electrodynamometer, as herein shown, in which case one coil or set of coils will displace the movable coil of my electrodynamometer and the other coil or set of coils will displace the fixed coil of my electrodynamometer.

It is to be understood also that the current component of the energy of electric currents may be increased by a step-down transformer as well as by the closed, tuned, or resonant circuit herein described.

This application is a division of my application filed September 16, 1902, and bearing Serial No. 123,653.

What I claim is—

1. The method of rendering intelligible transmitted electroradiant energy representing a signal or message, which consists in

producing magnetic fields by the received electroradiant energy, and producing a signal by the action of said magnetic fields upon each other.

2. The method of rendering intelligible transmitted electroradiant energy representing a signal or message, which consists in producing magnetic fields at an angle of approximately ninety degrees with respect to each other by the received energy, and producing a signal by the action of said magnetic fields upon each other.

3. The method of rendering intelligible transmitted electroradiant energy representing a signal or message, which consists in transforming the electroradiant energy into the energy of electric currents, producing magnetic fields by said electric current, and producing a signal by the reaction of said fields upon each other.

4. The method of rendering intelligible transmitted electroradiant energy, which consists in transforming the received energy into the energy of electric currents, generating magnetic fields at an angle of approximately ninety degrees with respect to each other by said currents, and producing a signal by the reaction of said magnetic fields upon each other.

5. The method of rendering intelligible transmitted electroradiant energy, which consists in transforming the received electroradiant energy into the energy of electric currents, energizing an electrodynamometer by said currents, and producing a signal by the deflection of a member of said electrodynamometer.

6. The method of rendering intelligible transmitted electroradiant energy, which consists in producing a magnetic field by the received electroradiant energy, maintaining a second magnetic field by locally-produced currents of a frequency approximately equal to the frequency of the transmitted energy, and producing a signal by the action of said magnetic fields upon each other.

7. The method of rendering intelligible transmitted electroradiant energy, which consists in producing a magnetic field due to the received electroradiant energy, maintaining a second magnetic field by locally-generated energy, and producing a signal by the action of said magnetic fields upon each other.

8. The method of rendering intelligible transmitted electroradiant energy, which consists in producing a field of force by the received electroradiant energy, maintaining a second field of force by locally-produced currents of a frequency approximately equal to the frequency of the transmitted energy, and producing a signal by the action of said fields of force upon each other.

9. The method of rendering intelligible transmitted electroradiant energy, which consists in producing a field of force by the received electroradiant energy, maintaining a second field of force by locally-generated energy, and producing a signal by the action of said fields of force upon each other.

10. The method of rendering intelligible transmitted electroradiant energy, which consists in producing a field of force due to the received electroradiant energy, maintaining a second field of force by locally-generated energy of high frequency, and producing a signal by the action of said fields of force upon each other.

11. The method of rendering intelligible transmitted electroradiant energy, which consists in transforming the received energy into the energy of electric currents, increasing the current component of the energy of electric currents, producing magnetic fields by the increased current component, and producing a signal by the interaction of said magnetic fields.

12. The method of rendering intelligible transmitted electroradiant energy, which consists in transforming the received radiant energy into the energy of electric currents, energizing an electrodynamometer by the increased current component of the energy of electric currents, and producing a signal by the deflection of a member of the electrodynamometer.

13. The method of rendering intelligible transmitted electroradiant energy, which consists in transforming the received radiant energy into the energy of electric currents, increasing the current component of the energy of electric currents, producing a field of force by the increased current component, maintaining a field of force by energy locally produced, and producing a signal by the reaction of said fields of force upon each other.

14. The method of rendering intelligible transmitted electroradiant energy, which consists in transforming the received radiant energy into the energy of electric currents, increasing the current component of the energy of electric currents, producing a field of force by the increased current component, maintaining a field of force by energy locally generated and having high frequency, and producing a signal by the reaction of said fields of force upon each other.

15. The method of rendering intelligible transmitted electroradiant energy, which consists in transforming the received radiant energy into the energy of electric currents, producing a field of force by the increased current component, maintaining a field of force by the increased current component of energy locally generated, and producing a signal by the reaction of said fields of force upon each other.

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