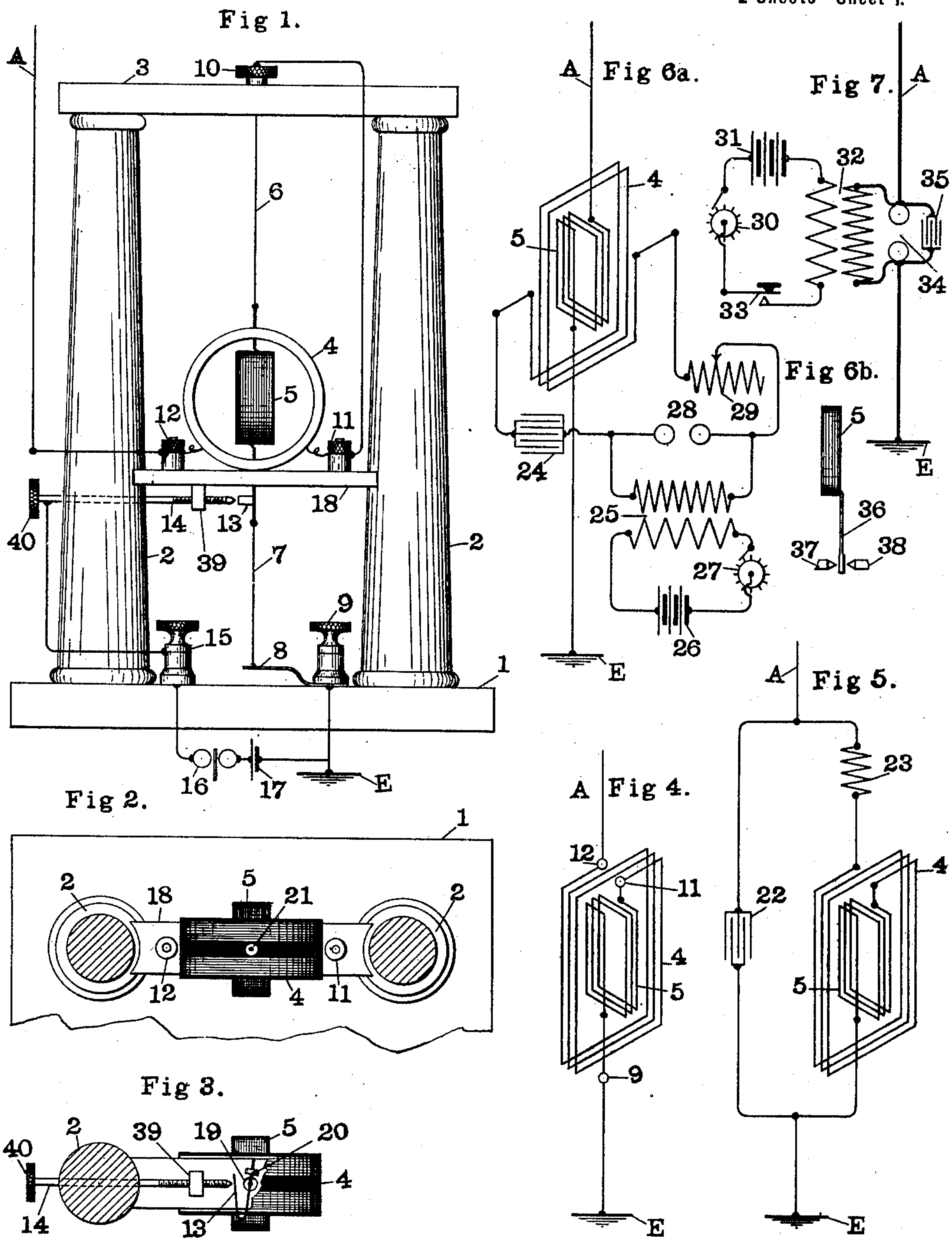
No. 711,184. Patented Oct. 14, 1902.

H. SHOEMAKER.

WIRELESS SIGNALING SYSTEM.

(Application filed Sept. 16, 1902.)

(No Model.) 2 Sheets—Sheet 1.



Witnesses
Geo. G. Ziegler
Alice I. Burnaugh

Inventor
Harry Shoemaker.
by Cornelius D. Ehret
his Attorney

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

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Fig 8.

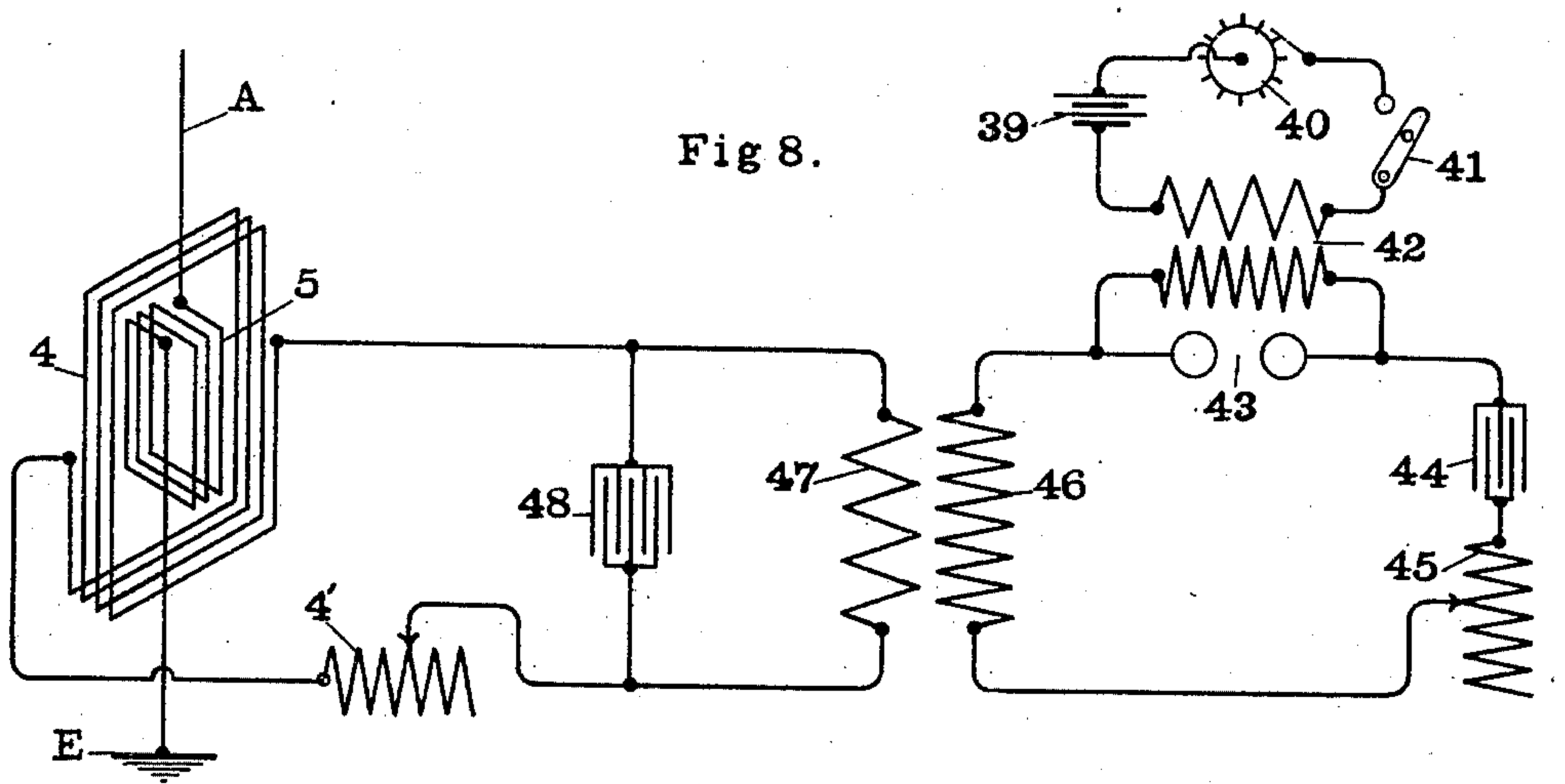


Fig 9.

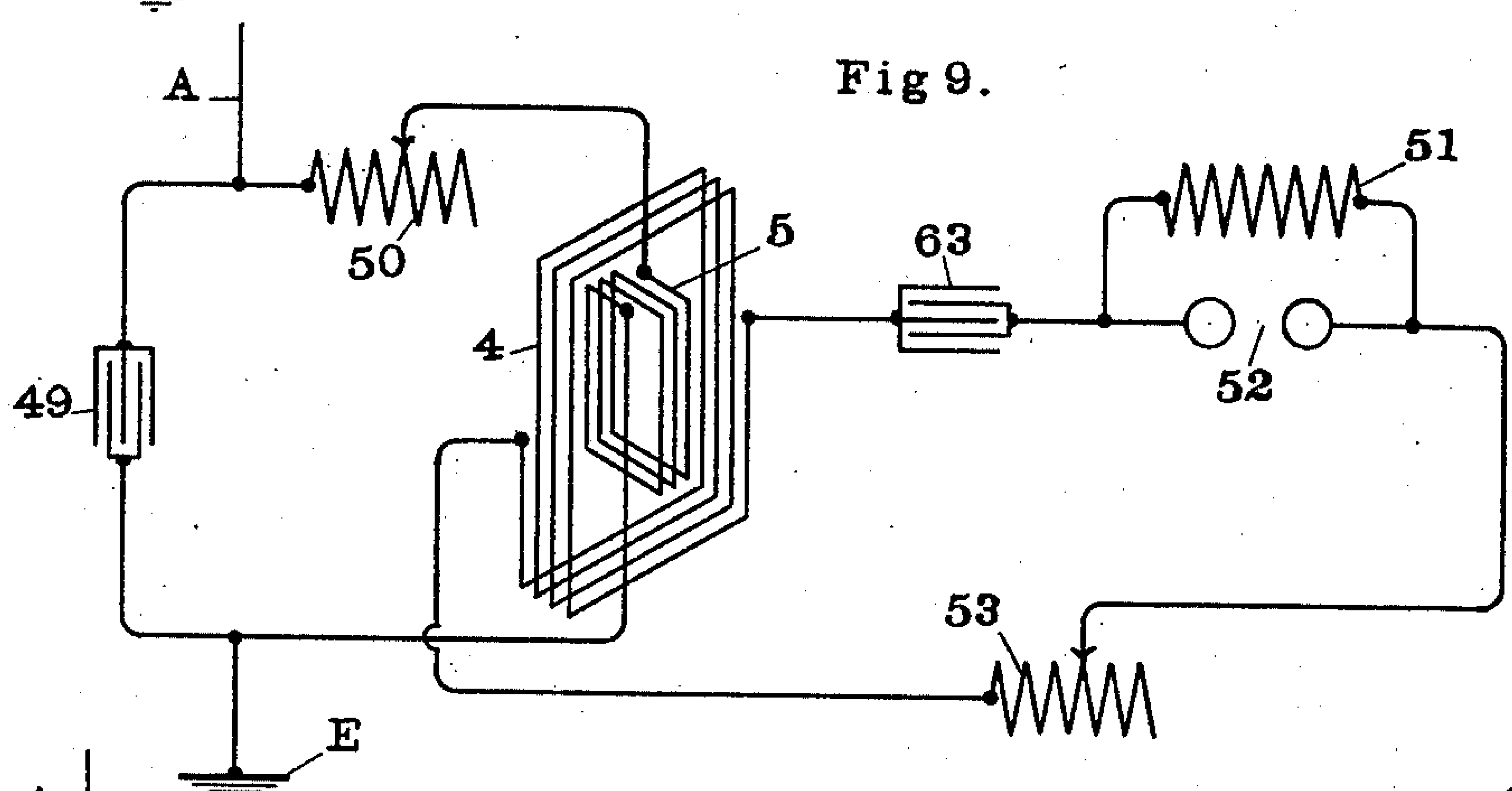
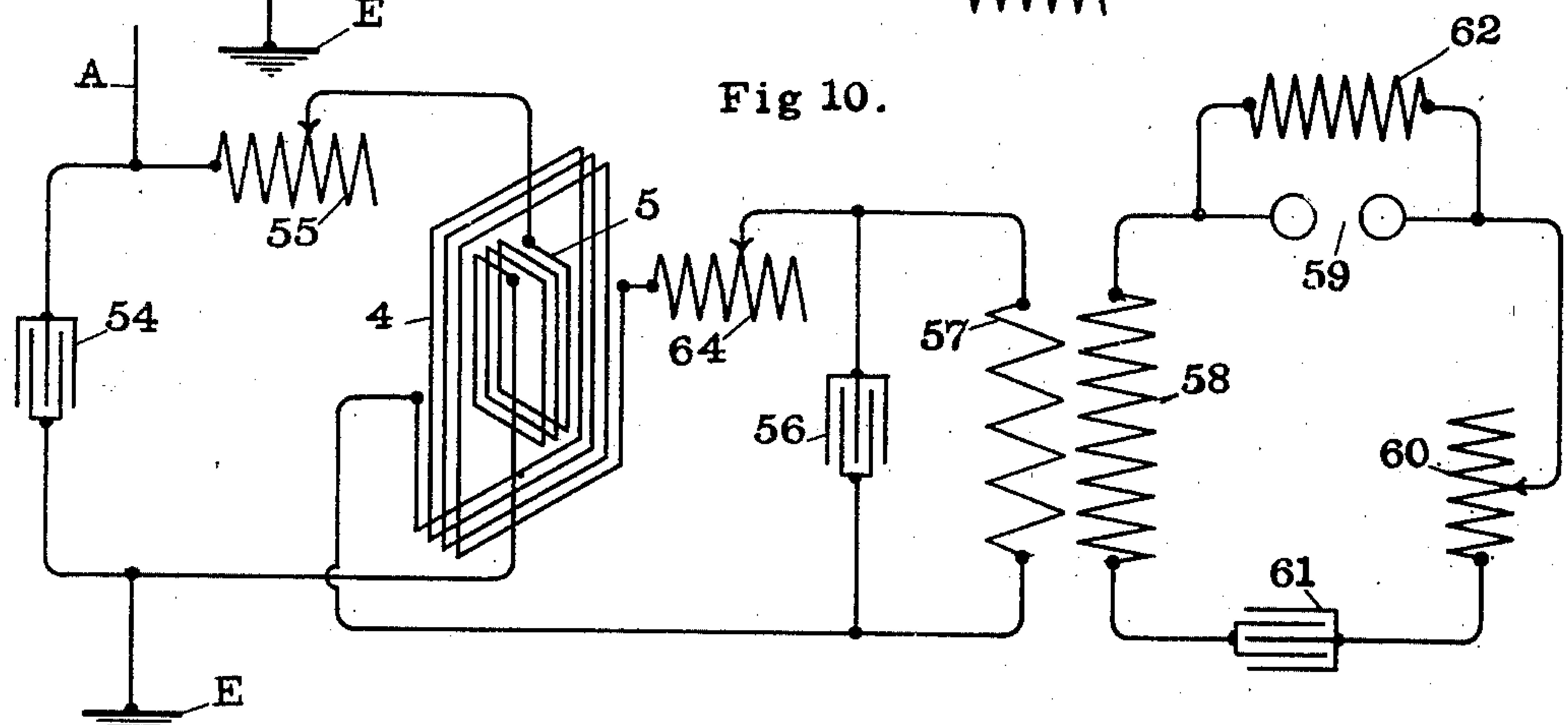


Fig 10.



Witnesses
Alice J. Burraigh
Mae Hofmann

Inventor.
Harry Shoemaker
by Cornelius D. Ehret
Attorney

UNITED STATES PATENT OFFICE.

HARRY SHOEMAKER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO CONSOLIDATED WIRELESS TELEGRAPH AND TELEPHONE COMPANY AND MARIE V. GEHRING, OF PHILADELPHIA, PENNSYLVANIA.

WIRELESS SIGNALING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 711,184, dated October 14, 1902.

Application filed September 16, 1902. Serial No. 123,653. (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 Wireless Signaling System, of which the following is a specification.

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

My invention consists of a system of wireless signaling, more particularly the receiving system, wherein an electrodynamometer is employed as a wave-responsive device.

My invention consists, further, of circuit arrangements whereby energy of received electroradiations is most efficiently used in producing a signal.

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

My invention consists, further, in connecting a winding of an electrodynamometer in a circuit traversed by oscillatory currents derived from the received electroradiant energy, while the other winding is included in a circuit traversed by 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 maintaining a magnetic field by means of a local source of oscillatory currents and supporting in such magnetic field means for producing a second 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 including one of the windings of an electrodynamometer in a closed, resonant, or tuned circuit traversed by currents due to the received electroradiant energy, while including the remaining winding of the electrodynamometer in a closed, resonant, or tuned circuit traversed by currents derived from a local source of energy.

The electrodynamometer is an instrument well known in the arts, and 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 entirely 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 field 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 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-spring 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 a 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 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 the system herein described. It is to be understood that the movable coil of the electrodynamometer is to be extremely light, delicately supported or pivoted, and to have 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 electric lighting, &c. In an electrodynamometer which I have employed for recording signals transmitted by electroradiant energy I have constructed the fixed coil of sixteen turns of No. 18 Brown & Sharpe gage-wire, while the movable coil was constructed of eight turns of the same size wire.

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 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. Secondary 47 operates simply as a source of alternating currents of a frequency equal to the frequency of the transmitted energy, (or greater than or less than such frequencies, depending upon 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 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, resonant, or tuned circuit, comprising condenser 49, adjustable inductance 50, and 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 adjusted 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 where 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 eletrodynamometer. 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 transformer 57. The primary 58 of this transformer is in series with the spark-gap 59, adjustable inductance 60, and adjustable condenser 61. 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 the 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 of the electrodynamometer 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, transmitters which send out 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 where a plurality of messages are 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.

What I claim is—

1. In a wireless signaling system, a wave-responsive device comprising an electrodynamometer.

2. In a wireless signaling system, a receiving-circuit, an electrodynamometer associated therewith, and a signal-producing circuit controlled by said electrodynamometer.

3. In a wireless signaling system, a receiving-conductor, a winding of an electrodynamometer associated therewith, and a signal-producing circuit controlled by said electrodynamometer.

4. In a wireless signaling system, means for producing a field of force by the received energy, means for maintaining a second field of force by locally-generated energy, and means for producing a signal by the reaction of said fields of force upon each other.

5. In a wireless signaling system, means for producing a magnetic field by the received energy, means for producing a second mag-

netic field at an angle of approximately ninety degrees with respect to the first magnetic field, and means for producing a signal by the reaction of said magnetic fields upon each other.

6. In a wireless signaling system, an electrodynamometer, means for energizing a winding of said electrodynamometer by the received energy, a source of locally-generated energy energizing another winding of said electrodynamometer, and a signal-producing circuit controlled by said electrodynamometer.

7. In a wireless signaling system, means for producing a field of force by the received energy, means for maintaining a second field of force by locally-generated energy of high frequency, and means for producing a signal by the reaction of said fields of force upon each other.

8. In a wireless signaling system, means for producing a magnetic field by the received energy, means for maintaining a second magnetic field by locally-generated currents of a frequency equal to the frequency of the transmitted electroradiant energy, and means for producing a signal by the reaction of said magnetic fields upon each other.

9. In a wireless signaling system, an electrodynamometer, means for energizing a winding of said electrodynamometer by the received energy, a second winding of said electrodynamometer included in a local circuit, and a source of locally-produced currents of a frequency equal to the frequency of the transmitted electroradiant energy included in said local circuit, and a signal-producing circuit controlled by said electrodynamometer.

10. In a wireless signaling system, means for producing a magnetic field by the received energy, means for maintaining a second magnetic field by the increased current component of locally-generated energy, and means for producing a signal by the reaction of said magnetic fields upon each other.

11. In a wireless signaling system, means for transforming the received electroradiant energy into the energy of electric currents, means for increasing the current component of said energy of electric currents, means for producing a field of force by the increased current component, means for producing a second field of force, and means for producing a signal by the reaction of said fields of force upon each other.

12. In a wireless signaling system, means for transforming the received electroradiant energy into the energy of electric currents, means for increasing the current component of said energy of electric currents, means for producing a field of force by the increased current component, means for producing a second field of force by locally-generated energy, and means for producing a signal by the reaction of said fields of force upon each other.

13. In a wireless signaling system, means for transforming the received electroradiant energy into the energy of electric currents, means for increasing the current component of said energy of electric currents, means for producing a field of force by the increased current component, a source of locally-generated energy, means for increasing the current component of said local energy, means for producing a second field of force by the increased current component of the local energy, and means for producing a signal by the reaction of said fields of force upon each other.

14. In a wireless signaling system, means for producing a field of force by the received energy, a local source of energy, means for increasing the current component of said local source of energy, means for producing a second field of force by the increased current component, and means for producing a signal by the reaction of said fields of force upon each other.

15. In a wireless signaling system, an electrodynamometer, a winding of said electrodynamometer energized by the received energy, a second winding of said electrodynamometer included in a local circuit, a local source of energy, means for increasing the current component of said local energy, means for energizing said second winding by the increased current component, and a signal-producing circuit controlled by said electrodynamometer.

16. In a wireless signaling system, an electrodynamometer, means for increasing the current component of the received energy, a winding of said electrodynamometer energized by said increased current component, a local source of energy energizing a second winding of said electrodynamometer, and a signal-producing circuit controlled by said electrodynamometer.

17. In a wireless signaling system, an electrodynamometer, means for increasing the current component of the received energy, a winding of said electrodynamometer energized by said increased current component, a local source of energy, means for increasing the current component of said local energy, a second winding of said electrodynamometer energized by the increased current component of the local energy, and a signal-producing circuit controlled by said electrodynamometer.

HARRY SHOEMAKER.

Witnesses:

CHARLES E. COLLINS,

JAMES M. SAWYER.