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Complete Specification Left, 5th Feb., 1898—Accepted, 10th Aug., 1898

PROVISIONAL SPECIFICATION.

Improvements in Syntonised Telegraphy without Line Wires.

I, Oliver Joseph Lodge, D.Sc., F.R.S., of 2, Grove Park, Liverpool, in the County of Lancaster, Professor of Physics, do hereby declare the nature of this invention to be as follows:—

The object of my invention is to enable an operator to transmit messages across space to any one or more of a number of different individuals in various localities, each of whom is provided with a suitably arranged receiver.

The method consists in utilising certain processes and apparatus for the purpose of producing and detecting rapid electric oscillations, and in so arranging them that the excitation of a particular frequency of oscillation at the sending station may cause a Morse or any other telegraphic instrument to respond at a distant station, by reason of being associated, through a relay or otherwise, with a subsidiary circuit actuated by electric oscillations of that same particular frequency, or by some multiple or sub-multiple of that frequency. Another distant station will similarly be made to receive messages by exciting at the sending station alternations of a different frequency, and so on; and thus individual messages can be transmitted to individual stations without disturbing the receiving appliances at other stations which are tuned or timed or syntonised to a different frequency. Each station will usually be provided with both sending and receiving apparatus, and messages can travel simultaneously in opposite or in cross directions without the least confusion or interference.

The sending apparatus consists of a suitable condenser or Leyden jar or other electric capacity (large or small) charged by an electrical machine or induction coil, or battery, or any other well known means, to some considerable potential, and then discharged suddenly with a spark of any required length or shortness, occurring between suitably arranged and prepared surfaces immersed in a gaseous or a liquid medium or *in vacuo* or in ordinary air, through a wire or other local circuit, or through the gas or water pipes of a town, or through any other local conductors which may be convenient, having coils of wire inserted or removed or shifted relatively to each other at will for the purpose of attaining any desired frequency of electric oscillation. The frequency can be adjusted either by varying the capacity of the condenser or jar or other conductor employed as the charged body, on the one hand, or by varying the number and position of coils or other portions of the discharge circuit, on the other. By means of suitable keys I propose to change easily from one rate of oscillation to another, and thus signal first to one station and then to another, using the appropriate key for each station, and manipulating it, or some other key or sending instrument in conjunction with it, so as to evoke dots and dashes or any other of the known forms of telegraphic signal at the desired station or set of stations.

The electric oscillations set up by a discharging jar have long been known to science, and the fact that such oscillations excite at a certain distance electric waves which travel through space and material bodies with the velocity of light

[*Price* 8*d*.]

was demonstrated by Hertz in 1888. I propose to employ a special combination of capacities with conductors or coils so arranged as to give electric oscillations of any desired frequency, so arranged also as to enable the frequency to be varied with ease and certainty, and so arranged that their effects may be transmitted to a distance either through the air or through the ground or through conductors present for other purposes or through any intervening medium whatever.

As a means of receiving or detecting those electric waves or oscillations, no matter whether the receiving station be within or beyond the distance at which true simply-progressive waves arise, I propose to use an instrument based on the "coherer" principle discovered by myself for metal in 1889, (Journal of the Institute of Electrical Engineers Part 87 Vol. XIX, pages 352—354, re-printed in "Lightning Conductors and Guards" pp. 382—384) and by Lord Rayleigh for liquids many years previously, and applied by Branly to the detection of electric waves in 1890, (see my book on "The Work of Hertz and some of his Successors" pp. 21—24.)

The "coherer," for the purpose of this invention, depends on the property which metals and liquids and other substances possess of uniting or cohering more readily under slight electric influence than when brought into mere gentle contact without such influence. Thus, at the delicately adjusted junction of two metallic or other substances, a feeble electric current, such as is sufficient to work a telegraphic relay, finds it easier to pass after the metals have been subjected to the influence of electric oscillations, *e.g.* of any distant electric spark or discharge, than before such influence. The original greater resistance of the light contact can be restored by a slight mechanical vibration or shock, which can be maintained automatically by any convenient means, such as the friction or percussion of clockwork, or electrical make and break, or any other shaking or trembling mechanism, as demonstrated by me before the British Association at Oxford in 1894 in a communication entitled "An electric eye and a hypothesis concerning vision" (see the work of Hertz &c., page 27); or, as I prefer in carrying out this invention, by means of a continuous sound, or sound board, or by means of a coherer contact on a rotating disc or drum or other moving surface; or in general any plan whereby metallic or other contacts are established or improved by electrical means and broken or impaired by mechanical means: and whether these contacts be in air or any other medium, including vacuum.

I have also shown a pair of syntonised electric circuits, whereby electrical oscillations set up in the one are able to cause another to respond only when it is exactly "tuned" to the same frequency of vibration; a very slight change in either the capacity or the self-induction of either circuit being sufficient to throw the correspondence out. This exactitude or approximate exactitude of response depends on the fact that the total number of oscillations in a suitably arranged circuit is very great, so that a very feeble impulse is gradually strengthened until it causes a perceptible effect, on the well known principle of sympathetic resonance. See Modern Views of Electricity pages 338—340, or Nature Vol. XL. p. 368, 1890, also my book on the work of Hertz &c., pages 5 and 7.

In carrying out this invention, I propose to associate with a coherer as above described such a definitely adjusted electric circuit, to the end that the electric oscillations purposely excited at a distant station in another syntonised circuit may excite in the first one a response sufficient to disturb and temporarily alter the resistance of the coherer associated with it, so as to enable the current of a local cell or battery to pass more easily, and thereby to give any required telegraphic signal, whether by means of a relay and auxiliary battery or otherwise. There will thus be a pair of syntonised circuits, one associated with a condenser and used as transmitter, the other associated with a coherer and used as receiver.

The ordinary Hertz vibrator, and still more the radiating spheres which I have myself heretofore employed with a receiving coherer, are powerful radiators, but the vibrations are for this very reason so rapidly damped that no precision of tuning is possible; and therefore such apparatus if employed in a system of telegraphy depending on Hertzian waves is liable to disturb all receivers within range, instead of an intended selection of them. But if, as in the arrangement I employ in carrying out this invention, the radiator be partially enclosed in a metallic box or cylinder of any shape, or if an arrangement of more electro-static capacity be employed, then although the radiation becomes less powerful, the total number of swings is so much increased that it may be made as ultimately effective at a distance as the single powerful swing; and it has the advantage of permitting precise tuning or syntonising, so that any desired one of a number of receivers may be affected and not any of the others. Part of this invention consists therefore in an arrangement whereby this desideratum becomes practically possible, as already explained, on the principles here laid down.

Dated this 8th day of May 1897.

WM. P. THOMPSON & Co.,
Of 6, Lord Street, Liverpool,
Patent Agents for the Applicant.

COMPLETE SPECIFICATION.

Improvements in Syntonised Telegraphy without Line Wires.

I, Oliver Joseph Lodge, D.Sc., F.R.S., of 2, Grove Park, Liverpool, in the County of Lancaster, Professor of Physics, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The object of my invention is to enable an operator by means of what is now known as Hertzian wave telegraphy, to transmit messages across space to any selected one or more of a number of different individuals in various localities each of whom is provided with a suitably arranged receiver, and to effect the ancillary improvements the nature of which are indicated in my Provisional Specification and are hereafter more particularly described.

The method of intercommunication consists, according to my invention, in utilising certain processes and apparatus for the purpose of producing and detecting a sufficiently prolonged series of rapid electric oscillations and in so arranging them that the excitation of a particular frequency of oscillation at the sending station may cause a telegraphic instrument to respond at a distant station, by reason of being associated, through a relay or otherwise, with a subsidiary circuit capable of electric oscillations of that same particular frequency, or of some multiple or sub-multiple of that frequency. Another distant station will similarly be made to receive messages by exciting at the sending stations alternations of a different frequency, and so on; and thus individual messages can be transmitted to individual stations without disturbing the receiving appliances at other stations which are tuned, or timed, or syntonised, to a different frequency. Each station will usually be provided with both sending and receiving apparatus.

In the accompanying drawings which are diagrammatic representations,

Figure 1 shows the simplest arrangement of emitter and receiver heretofore in use;

Figures 2, 4, 6, 7, 8, 9 and 10 show alternative arrangements to be adopted at signalling stations or appendages thereto in accordance with my invention;

Figure 3 in addition to showing an emitter serves to show a receiving circuit and means whereby parts of the emitting arrangement is utilised for receiving purposes;

Figure 5 depicts the more prominent features of a long distance arrangement, both sending and receiving;

Figure 12 illustrates a form of "coherer" made in accordance with my invention;

Figures 13 and 14 illustrate alternative forms of connection of apparatus in a syntonic receiving circuit with appendages; and

Figure 11 is a detail view hereinafter more particularly referred to.

Like letters of reference indicate similar parts throughout the drawings.

A complete installation of Hertzian wave telegraphy consists, in its simplest form, of the arrangement depicted in Figure 1 wherein A represents the emitting apparatus and B the receiving apparatus.

In the emitter illustrated in Figure 1, electricity from a suitable source, such as a Ruhmkorff coil *a*, is supplied to a pair of conductors which discharge into each other from knobs *b* and *c* and thus excite oscillations which emit one or two waves before they are damped out.

The receiving circuit consists essentially of a collector *d*, a coherer, *e*, a battery *f*, or other suitable source of electrical energy, and a telegraphic receiving instrument *g*, all in electrical connection as shown.

In carrying out my invention and referring now to the subsequent figures of the drawings, I use a definite radiator, consisting of a conductor, or pair of conductors h h^1 of large capacity arranged either as a Leyden jar or preferably spread out separately in space (one of them being the earth when desired). I join to h and h^1 respectively (which I denominate "capacity areas") a pair of polished knobs h^2 h^3 (protected by glass from ultra violet light) which form the adjustable spark gap called the "discharge gap." Between either capacity area and its knob I place a syntonising self inductance coil; that is a coil of wire or metallic ribbon h^4, preferably insulated with any solid or fluid insulator, as in Figure 2, or in air, of shape suitable to attain greatest inductance with a given amount of resistance; the object of this coil being to prolong the electric oscillations occurring in the radiator, so as to coustitute it a radiator of definite frequency or pitch, and obtain a succession of true waves emitted, and thereby to render syntony in a receiver possible, because exactitude of response depends on the fact that the total number of oscillations *in a suitably arranged circuit is very great, so that a* very feeble impulse is gradually strengthened till it causes a perceptible effect, on the well known principle of sympathetic resonance.

I supply the electricity to the radiator from a Ruhmkorff or a Tesla coil or a Wimshurst or other known or suitable high tension machine *a* in one of three ways according to circumstances.

The first way is by leading wires from the machine *a* to the two discharge knobs h^2 h^3 which is the customary plan, and gives a discharge which follows upon fairly steady electric strain.

The second way consists, as shown in Figure 3, in having a supplementary pair of spark gaps h^6 h^7 (which I call the supply gaps) one knob of each (called the receiving knob) being attached to the middle or other convenient point of each capacity area h h^1 and the other knob of each pair (called the supply knob) being connected by wires h^8 to the Ruhmkorff coil *a* and brought moderately near the first, so that when the coil is in action the capacity area shall receive their positive and negative charge by aerial disruption, that is, in a sudden manner, rather than by the slower process of metallic conduction, and shall then be left to discharge into each other through the connecting coil h^4 and across the short spark gap between the knobs h^2 h^3. The best width of this gap depends upon circumstances, and it may be closed altogether without stopping the action. The gap between the knobs h^2 h^3 may be optionally closed by a shunt h^9.

On the third plan as indicated in Figure 4, I interpose in each of the wires h^8 leading from the Ruhmkorff coil *a* to the supply knobs a Leyden jar or other suitable condenser *j* able to stand a high potential, so that the knobs are supplied from the outer that is the uninsulated coat of each jar, while between the inner coats or coil terminals I arrange a third spark gap called the starting gap, also consisting of suitable knobs h^{10} h^{11}. The outer coats of the jars must not be insulated from each other, and I usually join them by a self-inductance coil of fairly thin wire k so as to permit thorough charging. When the discharge occurs, this wire acts as an alternative path or bye-pass, but does not prevent the sparks at the supply gaps.

By both of the means described with reference to Figures 3 and 4, I charge the two capacity areas h h^1, which together with the inductance coil between them constitute the radiator by aerial disruption or impulsive rush. The advantage of this is that charges so communicated are left to oscillate free from any disturbance due to maintained connection with the source of electricity, and therefore oscillate longer and more simply than when supplied by wires in the usual way; moreover the capacity areas of a radiator are thus more conveniently employed as the capacity areas of a receiver without need of disconnection.

The arrangement described with reference to Figure 4 illustrates most completely the method of charging the capacity areas h h^1 with an impulsive rush. The action is as follows:—

The Ruhmkorff machine a charges the jars j, whose outer coats are connected, and discharges them at the starting gap h^{10}. This spark precipitates a discharge at the supply gaps h^7 h^8 and suddenly supplies the capacity areas h h^1 with electric charges, which then surge through the connecting coil h^4 (divided into two parts in this figure) and spark into each other at the discharge gap between the knobs h^2 h^3. This last discharge is the chief agent in starting the oscillations which are the cause of the emitted waves. But it is permissible in the arrangements of Figures 3 and 4 to close this last gap when desired and so leave the oscillations to be started by the sparks at the supply gaps only, whose knobs must in that case be polished and protected from ultra-violet light so as to supply the electric charge in as sudden a manner as possible.

As charged surfaces or capacity areas, spheres or square plates or any other metal surfaces may be employed, but I prefer, for the purpose of combining low resistance with great electrostatic capacity, cones or triangles or other such diverging surfaces, with the vertices adjoining and their larger areas spreading out into space. Or a single insulated surface may be used in conjunction with the earth, the earth or conductors embedded in the earth constituting the other oppositely charged surface. Radiation from an oscillator consisting of a pair of capacity areas is greater in the equatorial than in the axial direction, and accordingly, when sending in all directions is desired, it is well to arrange the axis of the emitter vertical. Moreover, radiation polarised in a horizontal plane, that is with its electric oscillations vertical, is less likely to be absorbed during its passage over partially conducting earth or water. A pair of insulated capacity areas arranged for long-distance-signalling is shown on the left hand side of Figure 5.

Figure 6 shows a single insulated capacity area h with the earth acting as the other surface and leading up to the spark knobs h^2 h^3 by a triangular sheet or cone h^1 so as to afford good conductance even to rapidly alternating currents. The wire h^8 in this case leads to one terminal of the Ruhmkorff coil a, the other terminal of which is taken to earth as shown. The capacity area h is insulated as indicated at h^{12}.

Figure 7 shows an arrangement which will catch the wind less, and with a syntonising coil h^4.

Figure 8 shows an insulated metal surface in the form of a roof h of a shed or building which may be used as a capacity area, with suitable connection and apparatus (not shown) for either emitting or receiving inside the little house l.

The self-inductance coil, represented at h^4 in all applicable figures, is a coil of highly conducting wire or ribbon well insulated by air or by some other medium as already described, or else covered to a sufficient thickness with insulating material; and it may be either a flat coil enclosing a plane area and shaped so as to have maximum self-inductance for a given resistance, or it may be a cylindrical coil wound upon a finely subdivided iron core, as shown at m in Figure 9, either ring-shaped or U-shaped or straight. The discharge knobs h^2 h^3 may be arranged at one end of such coil as shown in Figures 2, 3, 7 and 9, or the coil may be in two halves with the knobs inserted in the middle at pleasure (see Figures 4 and 5). Several such coils h^4 h^{4x} h^{4xx} with their knobs h^2 h^{2x} h^{2xx} may, as shown in Figure 10, be arranged for use with a single pair of capacity areas, and any one of them may be brought into action by a suitable switch, so that the desired frequency of vibration, or syntony with a particular distant station is attained by replacing one coil by another; for the frequency can be adjusted either by varying the capacity of the condenser or jar or other conductor employed or the charged body, on the one hand, or by varying the number and position of coils or other portion of the discharge circuit on the other. That discharger is in action whose spark gap is allowed to operate, and a switch A^1 B^1 C^1 can determine which of a set of different coils shall be utilised for a given distant station. Figure 11 illustrates the form of switch indicated in Figure 10.

A plan alternative to that described with reference to Figure 10 is to connect the capacity areas through one pair of knobs and a single large coil of a considerable number of turns, as shown in Figure 9, and to have keys or plugs, or switches S^1 and S^2 whereby some of the spires or turns of the coil can be shunted out of action, so that the whole or any smaller portion of the inductance available may be used, in accordance with the correspondingly attuned receiver at the particular station to which it is desired to signal. This arrangement may be used either in lieu of, or in combination with, interchangeable inductance coils such as shown in Figure 10; and in the latter case they are useful for correcting slight errors in tuning, for any one station. Another plan, and one well adapted to secure accurate tuning, is to arrange some or the whole of a syntonising coil so that its parts may be made to approach or recede from one another. This one I call an adjustable coil, the other I call replaceable or interchangeable coils.

A receiver or resonator consists of a similar pair of capacity areas connected by a similarly shaped conductor or self inductance coil, the whole constituting an absorber arranged so as to have precisely the same natural frequency of electrical vibration as the radiator in use at the corresponding emitting station, but it must not have a spark gap such as h^2 h^3, or if it have a spark gap the same must be carefully closed or shunted or bridged across by a good short conductor, for example, like Figure 11, before the arrangement can be properly used as a receiver. Identically the same capacity areas and self-inductance coil can be used at will either as emitter or as receiver, that is, either as radiator or as absorber (see Figure 5) if it be convenient to do so, on condition that the "discharge" spark gap h^2 h^3 of the radiator is perfectly closed whenever acting as receiver.

Thus referring to Figure 3 it will be seen that that diagram illustrates a combined emitting and receiving apparatus. When in use as a radiator the gap between the discharge knobs h^2 h^3 is left open. When utilised as a resonator the said gap is closed by the shunt h^9, (there supposed to be like Figure 11) and the coherer e battery f and telegraphic receiving instrument g are connected through a thin wire x from each end of the coil h^4 (that is from each of the capacity areas). If the Ruhmkorff machine a had been actually connected to the capacity areas h h^1, as in Figure 2, then it must be detached and substituted by the coherer circuit when a receiver is wanted, but if the charge was supplied through supply gaps as in Figures 3 and 4 (and this is the best plan) then the Ruhmkorff connections can be left unaltered, as it in no way then affects the action of the resonator, provided always that the coil is not put into activity while the receiving circuit is connected up.

A coherer consists of any arrangement which drops in resistance on receipt of an electric impulse, and rises to its old resistance on being subjected to a mechanical impulse such as a tremor or a tap.

A coherer circuit is any known arrangement for observing or recording effects due to fluctuations in the electrical resistance of a coherer.

As coherer I may use Branly's arrangement of a pair of conductors embedded in metallic grains or powder or filings, but I prefer selected iron filings of uniform size sealed up in a good vacuum and with the communicating surfaces or electrodes reduced to points or thin platinum wires fused into the glass and with their ends close together. In lieu of a known coherer I may employ that illustrated in Figure 12 wherein a point *n* rests lightly on a flat metallic surface *o*, for instance a needle point of steel or platinum making light contact with a steel or aluminium or other spring like a watch spring, straight or bent, usually fixed at one end *p* and delicately adjustable by a thumb screw *q* at some other part, so as to regulate the pressure which it exerts on the fixed needle point.

Whenever an electric wave or impulse from a distant radiator arrives and stimulates electric vibrations in the syntonised resonator or absorber arranged for the purpose, the delicately adjusted junction of the two metals or of the metallic or other particles which are connected up to the resonator so as to feel these vibrations suddenly and greatly changes its electrical resistance, and this diminished resistance enables a local battery to actuate a relay or a telephone or other telegraphic instrument in circuit therewith.

To break contact again, or to restore the original greater resistance, any form of mechanical vibration suffices, and so on the stand of the coherer I mount either a clock or a tuning fork or a cog-wheel or other device for causing a shake or tremor of sufficient intensity, maintaining it in motion by either a spring or weight or by electrical means. In Figure 12 *r* and *s* are two wheels of a clockwork train. Upon the arbor (or on a disc mounted thereon) is a series of serrations or the like *t* (shown exaggerated in the drawing) which as the wheel rotates effects the vibration of the lever or spring *o*. Such a tapper as is used in dentistry likewise serves very well. Or the mere motion of any clockwork attached to the stand will suffice. An exceedingly slight, almost imperceptible, tremor is all that is usually needed.

The diminution of resistance takes place instantaneously, and contact is broken again in a very small fraction of a second later. The instant it is broken the junction is ready to receive a fresh signal. The rapidity of signalling depends on the quickness of response of the signalling instrument, and it depends also on the rapidity with which the mechanical arrangement can break or interrupt the cohesion directly after the electrical stimulus has established it. When a telephone is used I find that the coherer restores itself sufficiently without specially arranged tremor and that a telephone is the quickest responder that can be used.

As coherer circuit, I usually arrange the coherer in simple series with a battery (voltaic or thermal) and a galvanometer or other indicator or recorder of fluctuations of current, and I then connect the terminals of this series of instruments to the capacity areas of the receiver close to its self inductance coil, so that this same coil of wire completes and forms an essential part of the coherer circuit. The coherer is thus affected by every electrical disturbance occurring in the connecting coil or in its capacity areas, and by aid of the battery at once enables the telegraphic or telephonic instrument to appreciate and indicate the signals. This plan is shown in Figure 13. It is an improvement on any mode of connection that had previously been possible without the connecting coil.

In some cases I may, as shown in Figure 14, surround the syntonising coil of the resonator with another or secondary coil *u* (constituting a species of transformer) and make this latter coil part of the coherer circuit, so that it shall be secondarily affected by the alternating currents excited in the conductor of the resonator, and thus the coherer be stimulated by the current in this secondary coil rather than primarily by the currents in the syntonising coil itself; the idea being thus to leave the resonator freer to vibrate electrically without disturbance from attached wires.

In all cases it is permissible and sometimes desirable to shunt the coils of the telegraphic instrument by means of a fine wire or other non-inductive resistance, as shown at *w* in Figure 13, in order to connect the coherer more effectively and closely to the capacity areas or receiving arrangement whereby it is to be stimulated.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (of which one may be the earth) of a self-inductance coil inserted between them electrically, for the purpose of prolonging any electrical oscillations excited in the system, and constituting such a system a radiator of definite frequency or pitch.

2. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (of which one may be the earth), of a self-inductance coil inserted between them electrically for the purpose of prolonging any electrical oscillations excited in the system and thereby enabling a distant radiator to act cumulatively if of corresponding period; thus constituting the system a resonator or absorber of definite frequency or pitch.

3. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (one of which may be the earth) of means inserted between them electrically serving to syntonise them and to render them adaptable for use at will either as a radiator or resonator.

4. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (one of which may be the earth), of a number of self-inductance coils, each of which is capable of being switched in or out of circuit so as to furnish different amounts of self-induction, thus serving to syntonise each radiator to a corresponding resonator or *vice versa*, whereby signalling may be effected between any two or more correspondingly attuned stations without disturbing other differently attuned stations.

5. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (one of which may be the earth) of an adjustable self-inductance coil adjustable either by definite steps or by continuous motion of its parts serving to syntonise such radiator and resonator to each other whereby signalling may be effected between any two or more correspondingly attuned stations without disturbing other differently attuned stations.

6. In combination, a pair of capacity areas connected by a coil of wire serving as a radiator in a system of Hertzian wave telegraphy, means for syntonising such radiator and means for charging it by aerial disruption or impulsive rush.

7. In a system of Hertzian wave telegraphy, the combination of a pair of capacity areas such as h h^1, means for syntonising such capacity areas, a receiving circuit completed through one or both of such capacity areas or their adjuncts, and means for bridging over the discharge gap between such capacity areas when they are to be used as a receiver whereby such capacity areas are rendered adaptable for use at will either as a radiator or resonator.

8. A coherer comprising a needle point resting upon a flat metallic surface, means for regulating the pressure of the one upon the other, and means for producing a mechanical impulse or tremor therein after it has received an electric impulse substantially as and for the purpose set forth and as illustrated in the accompanying drawing.

9. In a system of syntonic Hertzian wave telegraphy the combination with the self-inductance coil of the receiver of a secondary coil surrounding the same, which secondary coil forms part of the coherer circuit substantially as and for the purpose set forth.

10. The combination, in the receiving circuit of a system of Hertzian wave telegraphy, of an adjustable or replaceable self-inductance coil, connecting the capacity areas, a coherer, a battery, a telegraphic receiving instrument or a telephone with or without a shunt across the coils thereof substantially as and for the purpose set forth.

Lodge's Improvements in Syntonised Telegraphy without Line Wires.

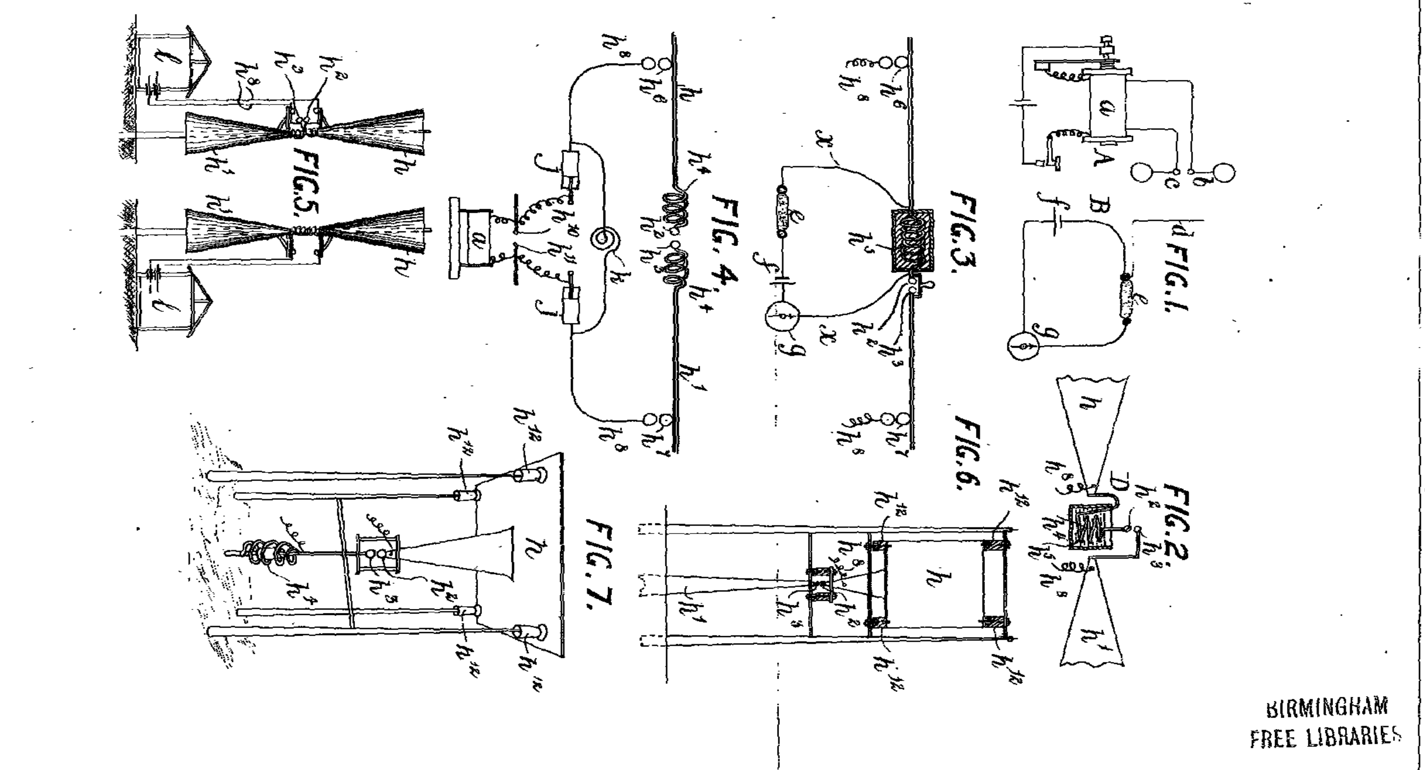
11. The construction arrangement and combination of parts constituting my improved system of syntonic Hertzian wave telegraphy substantially as set forth and as illustrated in the accompanying drawings.

Dated this 1st day of February 1898.

WM. P. THOMPSON & Co.,
Patent Agents, of Liverpool, Manchester, Birmingham & London.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1898

(2 SHEETS) SHEET 1.



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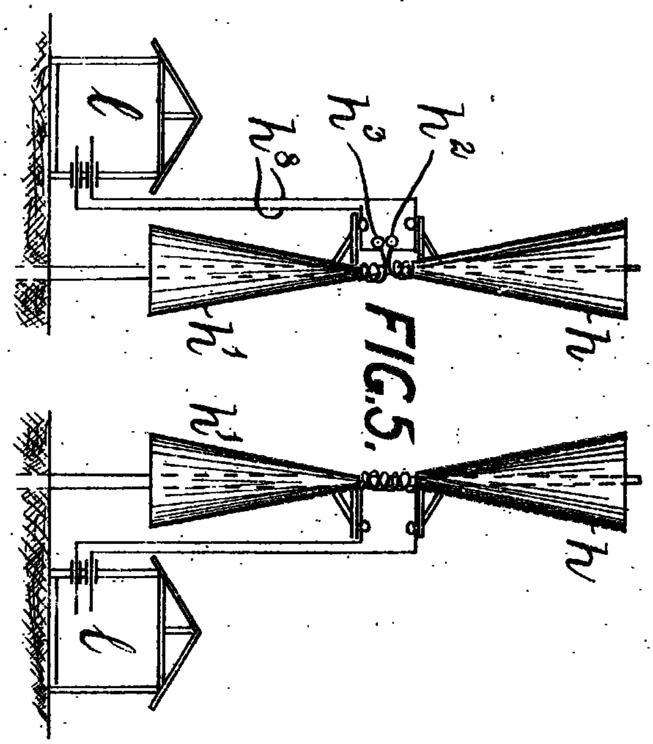
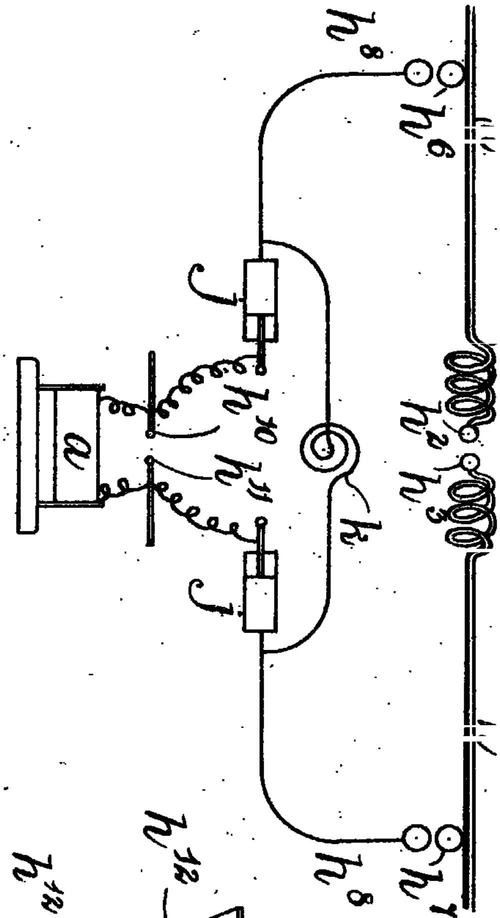


FIG. 5.



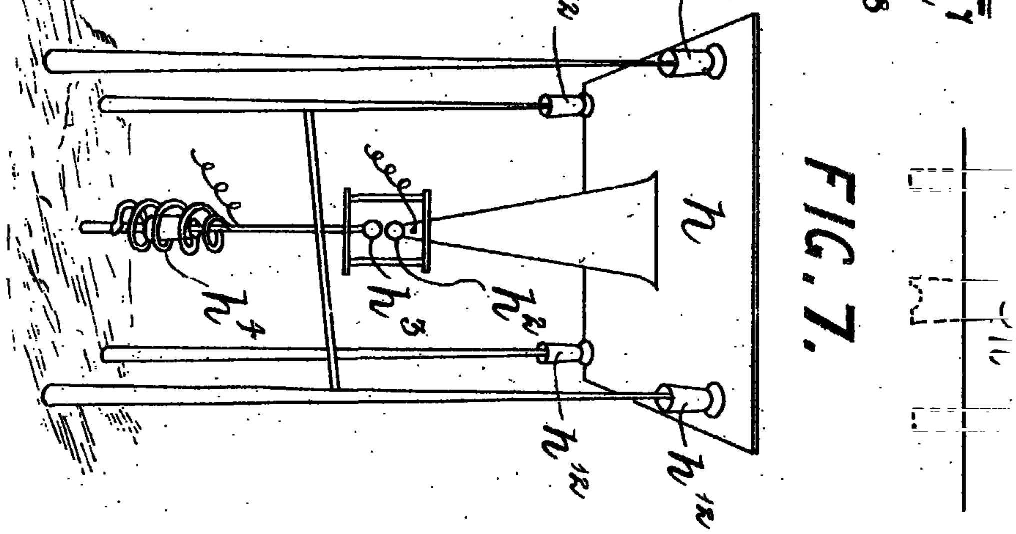


FIG. 7.

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FIG. 1.

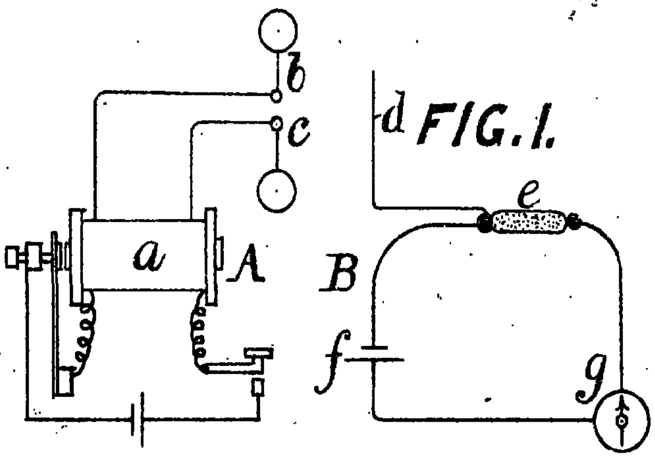

FIG. 2.

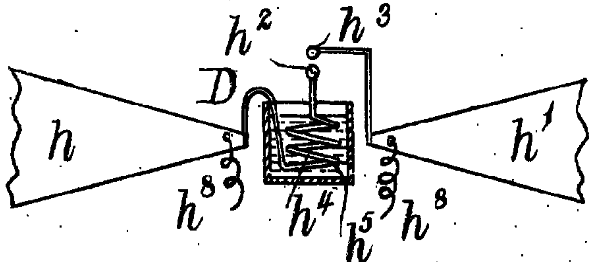

FIG. 3.

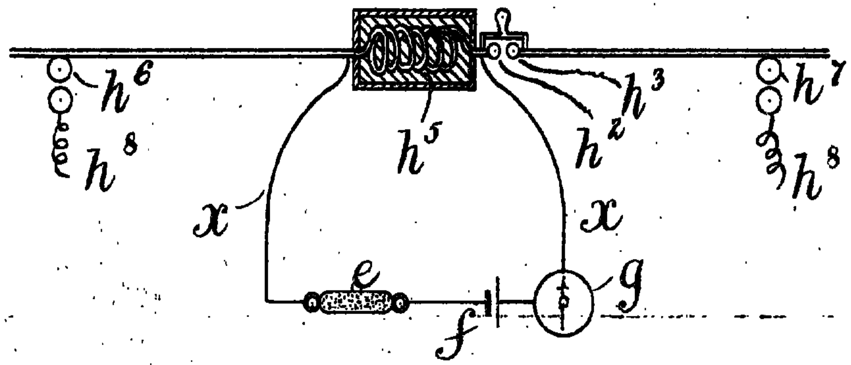

FIG. 6.

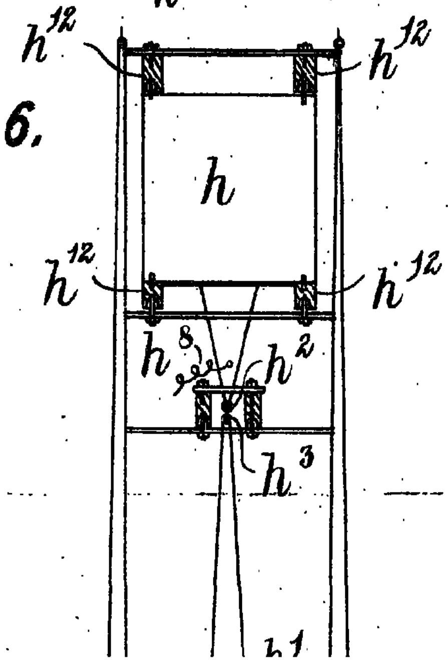

FIG. 4.

h^4 h^4

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(2 SHEETS)
SHEET 2

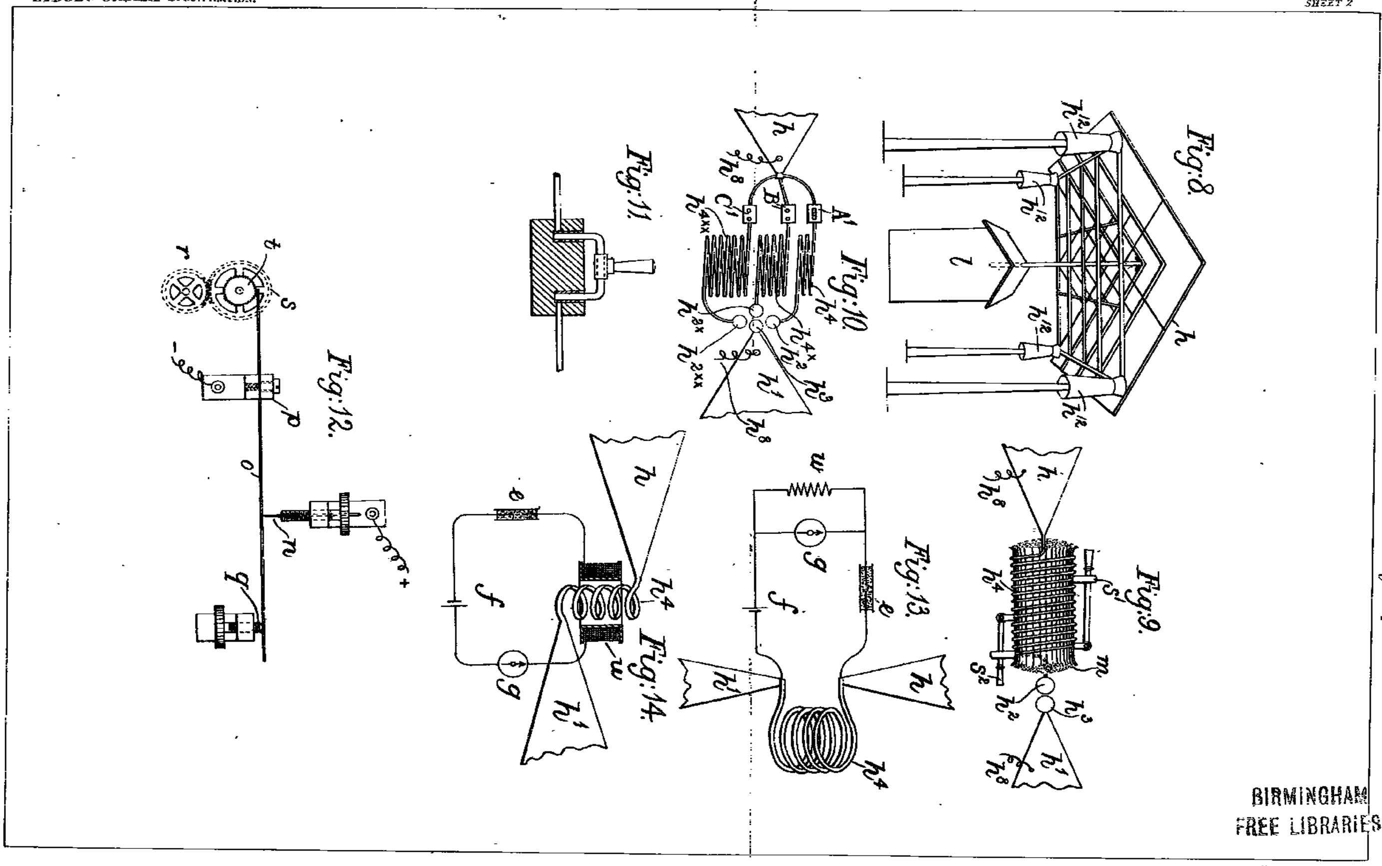


Fig. 11.

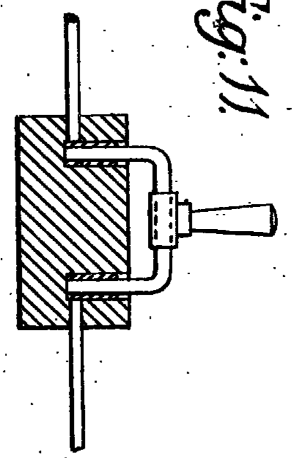


Fig. 12.

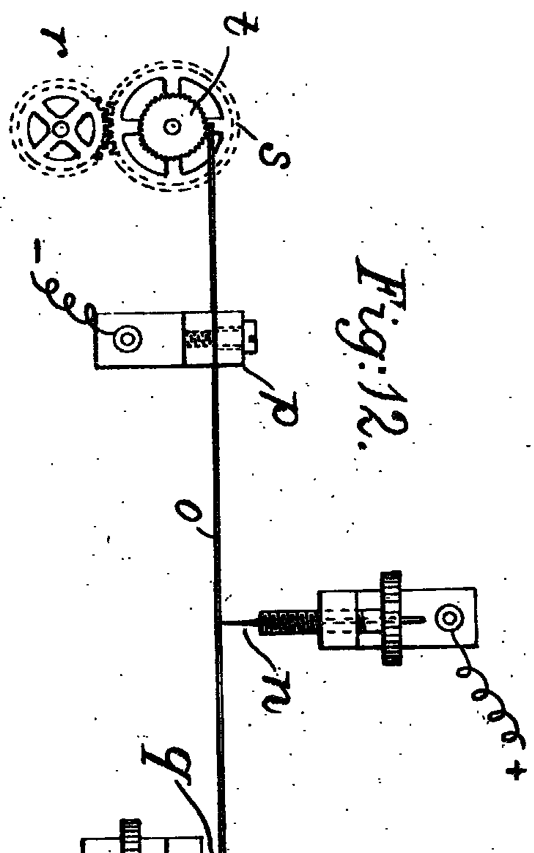
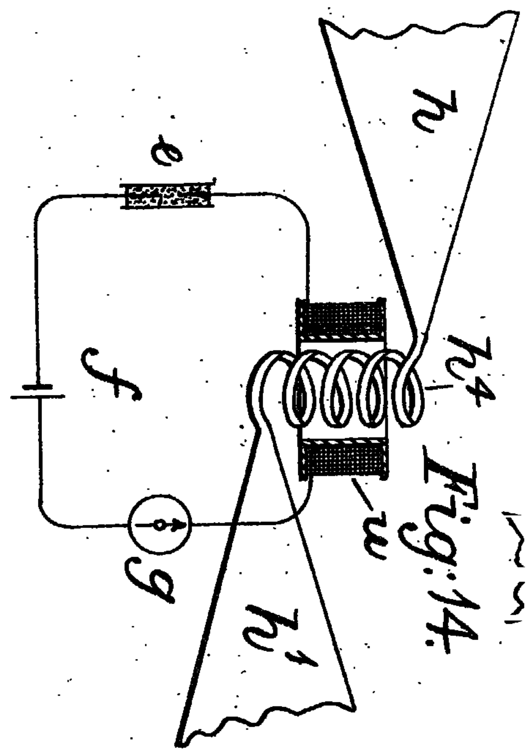


Fig. 14.



(2 SHEETS)
SHEET 2.

[This Drawing is a full-size reproduction of the Original.]

Fig:8.

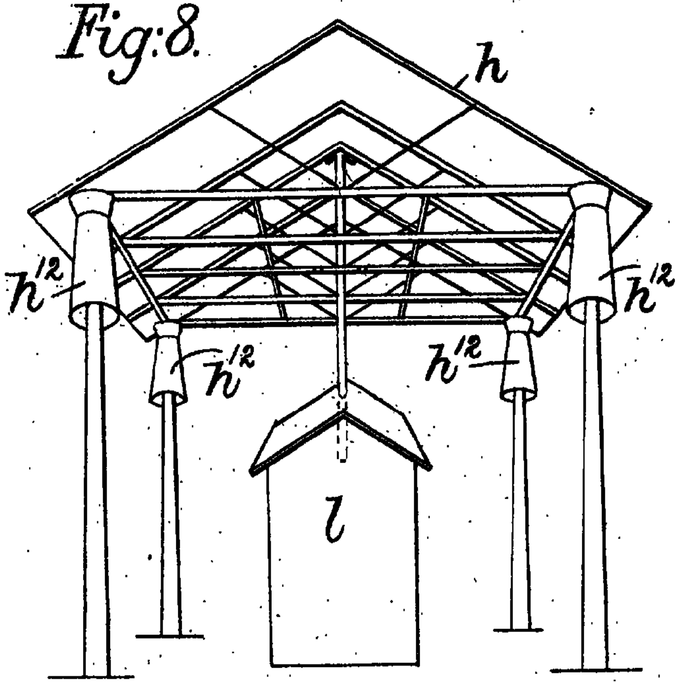


Fig:9.

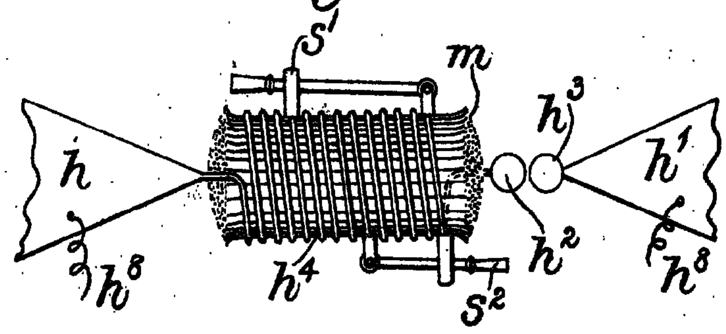


Fig:10.

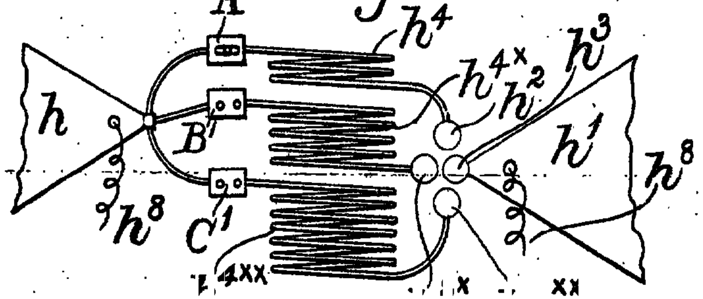
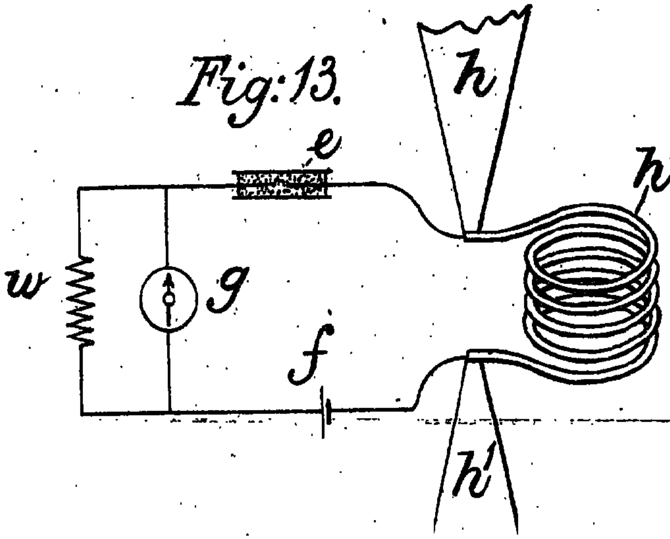


Fig:13.



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AMENDED SPECIFICATION.

Reprinted as amended in accordance with an Order made by Mr. Justice Parker on the 28th day of April, 1911.

(The Amendments are shown in erased and italic type.)

N° 11,575* A.D. 1897

Date of Application, 10th May, 1897

Complete Specification Left, 5th Feb., 1898—Accepted, 10th Aug., 1898

PROVISIONAL SPECIFICATION.

Improvements in Syntonised Telegraphy without Line Wires.

I, Oliver Joseph Lodge, D.Sc., F.R.S., of 2, Grove Park, Liverpool, in the County of Lancaster, Professor of Physics, do hereby declare the nature of this invention to be as follows:—

The object of my invention is to enable an operator to transmit messages across space to any one or more of a number of different individuals in various localities, each of whom is provided with a suitably arranged receiver.

The method consists in utilising certain processes and apparatus for the purpose of producing and detecting rapid electric oscillations, and in so arranging them that the excitation of a particular frequency of oscillation at the sending station may cause a Morse or any other telegraphic instrument to respond at a distant station, by reason of being associated, through a relay or otherwise, with a subsidiary circuit actuated by electric oscillations of that same particular frequency, or by some multiple or sub-multiple of that frequency. Another distant station will similarly be made to receive messages by exciting at the sending station alternations of a different frequency, and so on: and thus individual messages can be transmitted to individual stations without disturbing the receiving appliances at other stations which are tuned or timed or syntonised to a different frequency. Each station will usually be provided with both sending and receiving apparatus, and messages can travel simultaneously in opposite or in cross directions without the least confusion or interference.

The sending apparatus consists of a suitable condenser or Leyden jar or other electric capacity (large or small) charged by an electrical machine or induction coil, or battery, or any other well known means, to some considerable potential, and then discharged suddenly with a spark of any required length or shortness, occurring between suitably arranged and prepared surfaces immersed in a gaseous or a liquid medium or *in vacuo* or in ordinary air, through a wire or other local circuit, or through the gas or water pipes of a town, or through any other local conductors which may be convenient, having coils of wire inserted or removed or shifted relatively to each other at will for the purpose of attaining any desired frequency of electric oscillation. The frequency can be adjusted either by varying the capacity of the condenser or jar or other conductor employed as the charged body, on the one hand, or by varying the number and position of coils or other portions of the discharge circuit, on the other. By means of suitable keys I propose to change easily from one rate of oscillation to another, and thus signal first to one station and then to another, using the appropriate

[*Price 8d.*]

key for each station, and manipulating it, or some other key or sending instrument in conjunction with it, so as to evoke dots and dashes or any other of the known forms of telegraphic signal at the desired station or set of stations.

The electric oscillations set up by a discharging jar have long been known to science, and the fact that such oscillations excite at a certain distance electric waves which travel through space and material bodies with the velocity of light was demonstrated by Hertz in 1888. I propose to employ a special combination of capacities with conductors or coils so arranged as to give electric oscillations of any desired frequency, so arranged also as to enable the frequency to be varied with ease and certainty, and so arranged that their effects may be transmitted to a distance either through the air or through the ground or through conductors present for other purposes or through any intervening medium whatever.

As a means of receiving or detecting those electric waves or oscillations, no matter whether the receiving station be within or beyond the distance at which true simply-progressive waves arise, I propose to use an instrument based on the "coherer" principle discovered by myself for metal in 1889, (Journal of the Institute of Electrical Engineers Part 87 Vol. XIX, pages 352—354, re-printed in "Lightning Conductors and Guards" pp. 382—384) and by Lord Rayleigh for liquids many years previously, and applied by Branly to the detection of electric waves in 1890, (see my book on "The Work of Hertz and some of his successors" pp 21—24.)

The "coherer," for the purpose of this invention, depends on the property which metals and liquids and other substances possess of uniting or cohering more readily under slight electric influence than when brought into mere gentle contact without such influence. Thus, at the delicately adjusted junction of two metallic or other substances, a feeble electric current, such as is sufficient to work a telegraphic relay, finds it easier to pass after the metals have been subjected to the influence of electric oscillations, *e.g.* of any distant electric spark or discharge, than before such influence. The original greater resistance of the light contact can be restored by a slight mechanical vibration or shock, which can be maintained automatically by any convenient means, such as the friction or percussion of clockwork, or electrical make and break, or any other shaking or trembling mechanism, as demonstrated by me before the British Association at Oxford in 1894 in a communication entitled "an electric eye and a hypothesis concerning vision" (see the work of Hertz &c., page 27); or, as I prefer in carrying out this invention, by means of a continuous sound, or sound board, or by means of a coherer contact on a rotating disc or drum or other moving surface; or in general any plan whereby metallic or other contacts are established or improved by electrical means and broken or impaired by mechanical means: and whether these contacts be in air or any other medium, including vacuum.

I have also shown a pair of syntonised electric circuits, whereby electrical oscillations set up in the one are able to cause another to respond only when it is exactly "tuned" to the same frequency of vibration; a very slight change in either the capacity or the self-induction of either circuit being sufficient to throw the correspondence out. This exactitude or approximate exactitude of response depends on the fact that the total number of oscillations in a suitably arranged circuit is very great, so that a very feeble impulse is gradually strengthened until it causes a perceptible effect, on the well known principle of sympathetic resonance, See Modern Views of Electricity pages 338—340, or Nature Vol. XL. p. 368, 1890, also my book on the work of Hertz &c., pages 5 and 7.

In carrying out this invention, I propose to associate with a coherer as above described such a definitely adjusted electric circuit, to the end that the electric oscillations purposely excited at a distant station in another syntonised circuit may excite in the first one a response sufficient to disturb and temporarily alter the resistance of the coherer associated with it, so as to enable the current of a local cell or battery to pass more easily, and thereby to give any required telegraphic signal, whether by means of a relay and auxiliary battery or otherwise. There will thus be a pair of syntonised circuits, one associated with a condenser and used as transmitter; the other associated with a coherer and used as receiver.

The ordinary Hertz vibrator, and still more the radiating spheres which I have myself heretofore employed with a receiving coherer, are powerful radiators, but the vibrations are for this very reason so rapidly damped that no precision of tuning is possible; and therefore such apparatus if employed in a system of telegraphy depending on Hertzian waves is liable to disturb all receivers within range, instead of an intended selection of them. But if, as in the arrangement I employ in carrying out this invention, the radiator be partially enclosed in a metallic box or cylinder of any shape, or if an arrangement of more electrostatic capacity be employed, then although the radiation becomes less powerful, the total number of swings is so much increased that it may be made as ultimately effective at a distance as the single powerful swing; and it has the advantage of permitting precise tuning or syntonising, so that any desired one of a number of receivers may be affected and not any of the others. Part of this invention consists therefore in an arrangement whereby this desideratum becomes practically possible, as already explained, on the principles here laid down.

Dated this 8th day of May, 1897.

WM. P. THOMPSON & Co.,
Of 6, Lord Street, Liverpool,
Patent Agents for the Applicant.

COMPLETE SPECIFICATION (AMENDED).

Improvements in Syntonised Telegraphy without Line Wires.

I, Oliver Joseph Lodge, D.Sc., F.R.S., of 2, Grove Park, Liverpool, in the County of Lancaster, Professor of Physics, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The object of my invention is to enable an operator by means of what is now known as Hertzian wave telegraphy, to transmit messages across space to any selected one or more of a number of different individuals in various localities each of whom is provided with a suitably arranged receiver, and to effect the ancillary improvements the nature of which are indicated in my Provisional Specification and are hereafter more particularly described.

The method of intercommunication consists, according to my invention, in utilising certain processes and apparatus for the purpose of producing and detecting a sufficiently prolonged series of rapid electric oscillations and in so arranging them that the excitation of a particular frequency of oscillation at the sending station may cause a telegraphic instrument to respond at a distant station, by reason of being associated, through a relay or otherwise, with a subsidiary circuit capable of electric oscillations of that same particular frequency, or of some multiple or sub-multiple of that frequency. Another distant station will similarly be made to receive messages by exciting at the sending stations alternations of a different frequency, and so on; and thus individual messages can be transmitted to individual stations without disturbing the receiving appliances at other stations which are tuned, or timed, or syntonised, to a different frequency. Each station will usually be provided with both sending and receiving apparatus.

In the accompanying drawings which are diagrammatic representations,

Figure 1 shows the simplest arrangement of emitter and receiver heretofore in use;

Figures 2, 4, 6, 7, 8, 9 and 10 show alternative arrangements to be adopted at signalling stations or appendages thereto in accordance with my invention;

Figure 3 in addition to showing an emitter serves to show a receiving circuit and means whereby parts of the emitting arrangement is utilised for receiving purposes;

Figure 5 depicts the more prominent features of a long distance arrangement, both sending and receiving;

Figure 12 illustrates a form of "coherer" made in accordance with my invention;

Figures 13 and 14 illustrate alternative forms of connection of apparatus in a syntonic receiving circuit with appendages; and

Figure 11 is a detail view hereinafter more particularly referred to.

Like letters of reference indicate similar parts throughout the drawings.

A complete installation of Hertzian wave telegraphy consists, in its simplest form, of the arrangement depicted in Figure 1 wherein A represents the emitting apparatus and B the receiving apparatus.

In the emitter illustrated in Figure 1, electricity from a suitable source, such as a Ruhmkorff coil *a*, is supplied to a pair of conductors which discharge into each other from knobs *b* and *c* and thus excite oscillations which emit one or two waves before they are damped out.

The receiving circuit consists essentially of a collector *d*, a coherer, *e*, a battery *f*, or other suitable source of electrical energy, and a telegraphic receiving instrument *g*, all in electrical connection as shown.

In carrying out my invention and referring now to the subsequent figures of the drawings, I use a definite radiator, consisting of a conductor, or pair of conductors h h^1 of large capacity arranged either as a Leyden jar or preferably spread out separately in space (one of them being the earth when desired). I join to h and h^1 respectively (which I denominate "capacity areas") a pair of polished knobs h^2 h^3 (protected by glass from ultra violet light) which form the adjustable spark gap called the "discharge gap." Between either capacity area and its knob I place a syntonising self inductance coil; that is a coil of wire or metallic ribbon h^4, preferably insulated with any solid or fluid insulator, as in Figure 2, or in air, of shape suitable to attain greatest inductance with a given amount of resistance; the object of this coil being to prolong the electric oscillations occurring in the radiator, so as to constitute it a radiator of definite frequency or pitch, and obtain a succession of true waves emitted, and thereby to render syntony in a receiver possible, because exactitude of response depends on the fact that the total number of oscillations in a suitably arranged circuit is very great, so that a very feeble impulse is gradually strengthened till it causes a perceptible effect, on the well known principle of sympathetic resonance.

I supply the electricity to the radiator from a Ruhmkorff or a Tesla coil or a Wimshurst or other known or suitable high tension machine *a* in one of three ways according to circumstances.

The first way is by leading wires from the machine *a* to the two discharge knobs h^2 h^3 which is the customary plan, and gives a discharge which follows upon fairly steady electric strain.

The second way consists, as shown in Figure 3, in having a supplementary pair of spark gaps h^6 h^7 (which I call the supply gaps) one knob of each (called the receiving knob) being attached to the middle or other convenient point of each capacity area h h^1 and the other knob of each pair (called the supply knob) being connected by wires h^8 to the Ruhmkorff coil *a* and brought moderately near the first, so that when the coil is in action the capacity area shall receive their positive and negative charge by aërial disruption, that is, in a sudden manner, rather than by the slower process of metallic conduction, and shall then be left to discharge into each other through the connecting coil h^4 and across the short spark gap between the knobs h^2 h^3. The best width of this gap depends upon circumstances, and it may be closed altogether without stopping the action. The gap between the knobs h^2 h^3 may be optionally closed by a shunt h^9.

On the third plan as indicated in Figure 4, I interpose in each of the wires h^8 leading from the Ruhmkorff coil *a* to the supply knobs a Leyden jar or other suitable condenser *j* able to stand a high potential, so that the knobs are supplied from the outer that is the uninsulated coat of each jar, while between the inner coats or coil terminals I arrange a third spark gap called the starting gap, also consisting of suitable knobs h^{10} h^{11}. The outer coats of the jars must not be insulated from each other, and I usually join them by a self-inductance coil of fairly thin wire *k* so as to permit thorough charging. When the discharge occurs, this wire acts as an alternative path or bye-pass, but does not prevent the sparks at the supply gaps.

By both of the means described with reference to Figures 3 and 4, I charge the two capacity areas *h* h^1, which together with the inductance coil between them constitute the radiator by aërial disruption or impulsive rush. The advantage of this is that charges so communicated are left to oscillate free from any disturbance due to maintained connection with the source of electricity, and therefore oscillate longer and more simply than when supplied by wires in the usual way; moreover the capacity areas of a radiator are thus more conveniently employed as the capacity areas of a receiver without need of disconnection.

The arrangement described with reference to Figure 4 illustrates most completely the method of charging the capacity areas *h* h^1 with an impulsive rush.

The action is as follows:—

The Ruhmkorff machine *a* charges the jars *j*, whose outer coats are connected, and discharges them at the starting gap h^{10}. This spark precipitates a discharge at the supply gaps h^7 h^8 and suddenly supplies the capacity areas *h* h^1 with electric charges, which then surge through the connecting coil h^4 (divided into two parts in this figure) and spark into each other at the discharge gap between the knobs h^2 h^3. This last discharge is the chief agent in starting the oscillations which are the cause of the emitted waves. But it is permissible in the arrangements of Figures 3 and 4 to close this last gap when desired and so leave the oscillations to be started by the sparks at the supply gaps only, whose knobs must in that case be polished and protected from ultra-violet light so as to supply the electric charge in as sudden a manner as possible.

As charged surfaces or capacity areas, spheres or square plates or any other metal surfaces may be employed, but I prefer, for the purpose of combining low resistance with great electrostatic capacity, cones or triangles or other such diverging surfaces, with the vertices adjoining and their larger areas spreading out into space. Or a single insulated surface may be used in conjunction with the earth, the earth or conductors embedded in the earth constituting the other oppositely charged surface. Radiation from an oscillator consisting of a pair of capacity areas is greater in the equatorial than in the axial direction, and accordingly, when sending in all directions is desired, it is well to arrange the axis of the emitter vertical. Moreover, radiation polarised in a horizontal plane, that is with its electric oscillations vertical, is less likely to be absorbed during its passage over partially conducting earth or water. A pair of insulated capacity areas arranged for long-distance-signalling is shown on the left hand side of Figure 5.

Figure 6 shows a single insulated capacity area *h* with the earth acting as the other surface and leading up to the spark knobs h^2 h^3 by a triangular sheet or cone h^1 so as to afford good conductance even to rapidly alternating currents. The wire h^8 in this case leads to one terminal of the Ruhmkorff coil *a*, the other terminal of which is taken to earth as shown. The capacity area *h* is insulated as indicated at h^{12}.

Improvements in Syntonised Telegraphy without Line Wires.

Figure 7 shows an arrangement which will catch the wind less, and with a syntonising coil h^4.

Figure 8 shows an insulated metal surface in the form of a roof h of a shed or building which may be used as a capacity area, with suitable connection and apparatus (not shown) for either emitting or receiving inside the little house l.

The self-inductance coil, represented at h^4 in all applicable figures, is a coil of highly conducting wire or ribbon well insulated by air or by some other medium as already described or else covered to a sufficient thickness with insulating material; and it may be either a flat coil enclosing a plane area and shaped so as to have maximum self-inductance for a given resistance, or it may be a cylindrical coil wound upon a finely subdivided iron core, as shown at m in Figure 9, either ring-shaped or U-shaped or straight. The discharge knobs h^2 h^3 may be arranged at one end of such coil as shown in Figures 2, 3, 7 and 9, or the coil may be in two halves with the knobs inserted in the middle at pleasure (see Figures 4 and 5). Several such coils h^4 h^{4x} h^{4xx} with their knobs h^2 h^{2x} h^{2xx} may, as shown in Figure 10, be arranged for use with a single pair of capacity areas, and any one of them may be brought into action by a suitable switch, so that the desired frequency of vibration, or syntony with a particular distant station is attained by replacing one coil by another; for the frequency can be adjusted either by varying the capacity of the condenser or jar or other conductor employed or the charged body, on the one hand, or by varying the number and position of coils or other portion of the discharge circuit on the other. That discharger is in action whose spark gap is allowed to operate, and a switch A[1] B[1] C[1] can determine which of a set of different coils shall be utilised for a given distant station. Figure 11 illustrates the form of switch indicated in Figure 10.

A plan alternative to that described with reference to Figure 10 is to connect the capacity areas through one pair of knobs and a single large coil of a considerable number of turns, as shown in Figure 9, and to have keys or plugs, or switches S[1] and S[2] whereby some of the spires or turns of the coil can be shunted out of action, so that the whole or any smaller portion of the inductance available may be used, in accordance with the correspondingly attuned receiver at the particular station to which it is desired to signal. This arrangement may be used either in lieu of, or in combination with, interchangeable inductance coils such as shown in Figure 10; and in the latter case they are useful for correcting slight errors in tuning, for any one station. Another plan, and one well adapted to secure accurate tuning, is to arrange some or the whole of a syntonising coil so that its parts may be made to approach or recede from one another. This one I call an adjustable coil, the other I call replaceable or interchangeable coils.

A receiver or resonator consists of a similar pair of capacity areas connected by a similarly shaped conductor or self inductance coil, the whole constituting an absorber arranged so as to have precisely the same natural frequency of electrical vibration as the radiator in use at the corresponding emitting station, but it must not have a spark gap such as h^2 h^3, or if it have a spark gap the same must be carefully closed or shunted or bridged across by a good short conductor, for example, like Figure 11, before the arrangement can be properly used as a receiver. Identically the same capacity areas and self-inductance coil can be used at will either as emitter or as receiver, that is, either as radiator or as absorber (see Figure 5) if it be convenient to do so, on condition that the "discharge" spark gap h^2 h^3 of the radiator is perfectly closed whenever acting as receiver.

Thus referring to Figure 3 it will be seen that that diagram illustrates a combined emitting and receiving apparatus. When in use as a radiator the gap between the discharge knobs h^2 h^3 is left open. When utilised as a resonator the said gap is closed by the shunt h^9, (there supposed to be like Figure 11) and the coherer e battery f and telegraphic receiving instrument g are connected through a thin wire *x* from each end of the coil h^4 (that is from each of the capacity areas). If the Ruhmkorff machine *a* had been actually connected to the capacity areas *h* h^1, as in Figure 2, then it must be detached and substituted by the coherer circuit when a receiver is wanted, but if the charge was supplied through supply gaps as in Figures 3 and 4 (and this is the best plan) then the Ruhmkorff connections can be left unaltered, as it is no way then affects the action of the resonator, provided always that the coil is not put into activity while the receiving circuit is connected up.

A coherer consists of any arrangement which drops in resistance on receipt of an electric impulse, and rises to its old resistance on being subjected to a mechanical impulse such as a tremor or a tap.

A coherer circuit is any known arrangement for observing or recording effects due to fluctuations in the electrical resistance of a coherer.

As coherer I may use Branly's arrangement of a pair of conductors embedded in metallic grains or powder or filings, but I prefer selected iron filings of uniform size sealed up in a good vacuum and with the communicating surfaces or electrodes reduced to points or thin platinum wires fused into the glass and with their ends close together. In lieu of a known coherer I may employ that illustrated in Figure 12 wherein a point *n* rests lightly on a flat metallic surface *o*, for instance a needle point of steel or platinum making light contact with a steel or aluminium or other spring like a watch spring, straight or bent, usually fixed at one end *p* and delicately adjustable by a thumb screw *q* at some other part, so as to regulate the pressure which it exerts on the fixed needle point.

Whenever an electric wave or impulse from a distant radiator arrives and stimulates electric vibrations in the syntonised resonator or absorber arranged for the purpose, the delicately adjusted junction of the two metals or of the metallic or other particles which are connected up to the resonator so as to feel these vibrations suddenly and greatly changes its electrical resistance, and this diminished resistance enables a local battery to actuate a relay or a telephone or other telegraphic instrument in circuit therewith.

To break contact again, or to restore the original greater resistance, any form of mechanical vibration suffices, and so on the stand of the coherer I mount either a clock or a tuning fork or a cog-wheel or other device for causing a shake or tremor of sufficient intensity, maintaining it in motion by either a spring or weight or by electrical means. In Figure 12 *r* and *s* are two wheels of a clock-work train. Upon the arbor (or on a disc mounted thereon) is a series of serrations or the like *t* (shown exaggerated in the drawing) which as the wheel rotates effects the vibration of the lever or spring *o*. Such a tapper as is used in dentistry likewise serves very well. Or the mere motion of any clockwork attached to the stand will suffice. An exceedingly slight, almost imperceptible, tremor is all that is usually needed.

The diminution of resistance takes place instantaneously, and contact is broken again in a very small fraction of a second later. The instant it is broken the junction is ready to receive a fresh signal. The rapidity of signalling depends on the quickness of response of the signalling instrument, and it depends also on the rapidity with which the mechanical arrangement can break or interrupt the cohesion directly after the electrical stimulus has established it. When a telephone is used I find that the coherer restores itself sufficiently without specially arranged tremor and that a telephone is the quickest responder that can be used.

As coherer circuit, I usually arrange the coherer in simple series with a battery (voltaic or thermal) and a galvanometer or other indicator or recorder of fluctuations of current, and I then connect the terminals of this series of instruments to the capacity areas of the receiver close to its self inductance coil, so that this same coil of wire completes and forms an essential part of the coherer circuit. The coherer is thus affected by every electrical disturbance occurring in the connecting coil or in its capacity areas, and by aid of the battery at once enables the telegraphic or telephonic instrument to appreciate and indicate the signals;

This plan is shown in Figure 13. It is an improvement on any mode of connection that had previously been possible without the connecting coil.

In some cases I may, as shown in Figure 14, surround the syntonising coil of the resonator with another or secondary coil *u* (constituting a species of transformer) and make this latter coil part of the coherer circuit, so that it shall be secondarily affected by the alternating currents excited in the conductor of the resonator, and thus the coherer be stimulated by the current in this secondary coil rather than primarily by the currents in the syntonising coil itself; the idea being thus to leave the resonator freer to vibrate electrically without disturbance from attached wires.

In all cases it is permissible and sometimes desirable to shunt the coils of the telegraphic instrument by means of a fine wire or other non-inductive resistance, as shown at *w* in Figure 13, in order to connect the coherer more effectively and closely to the capacity areas or receiving arrangement whereby it is to be stimulated.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (of which one may be the earth) of a self-inductance coil inserted between them electrically, for the purpose of prolonging any electrical oscillations excited in the system, and constituting such a system a radiator of definite frequency or pitch.

2. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (of which one may be the earth), of a self-inductance coil inserted between them electrically for the purpose of prolonging any electrical oscillations excited in the system and thereby enabling a distant radiator to act cumulatively if of corresponding period; thus constituting the system a resonator or absorber of definite frequency or pitch.

~~3. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (one of which may be the earth) of means inserted between them electrically serving to syntonise them and to render them adaptable for use at will either as a radiator or resonator.~~

~~4. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (one of which may be the earth), of a number of self inductance coils, each of which is capable of being switched in or out of circuit so as to furnish different amounts of self induction, thus serving to syntonise each radiator to a corresponding resonator or *vice versa*, whereby signalling may be effected between any two or more correspondingly attuned stations without disturbing other differently attuned stations.~~

~~5. In a system of Hertzian wave telegraphy, the combination with a pair of capacity areas (one of which may be the earth) of an adjustable self inductance coil adjustable either by definite steps or by continuous motion of its parts serving to syntonise such radiator and resonator to each other whereby signalling may be effected between any two or more correspondingly attuned stations without disturbing other differently attuned stations.~~

3. ~~6.~~ In combination, a pair of capacity areas connected by a coil of wire serving as the radiator in a system of Hertzian wave telegraphy, means for syntonising such radiator and means for charging it by aërial disruption or impulsive rush.

4. ~~7.~~ In a system of Hertzian wave telegraphy, the combination of a pair of capacity areas such as h h^1, means for syntonising such capacity areas, a receiving circuit completed through one or both of such capacity areas or their adjuncts, and means for bridging over the discharge gap between such capacity areas when they are to be used as a receiver whereby such capacity areas are rendered adaptable for use at will either as a radiator or resonator.

~~8. A coherer comprising a needle point resting upon a flat metallic surface, means for regulating the pressure of the one upon the other, and means for producing a mechanical impulse or tremor therein after it has received an electric impulse substantially as and for the purpose set forth and as illustrated in the accompanying drawing.~~

5. ~~9.~~ In a system of syntonic Hertzian wave telegraphy the combination with the self-inductance coil of the receiver of a secondary coil surrounding the same, which secondary coil forms part of the coherer circuit substantially as and for the purpose set forth.

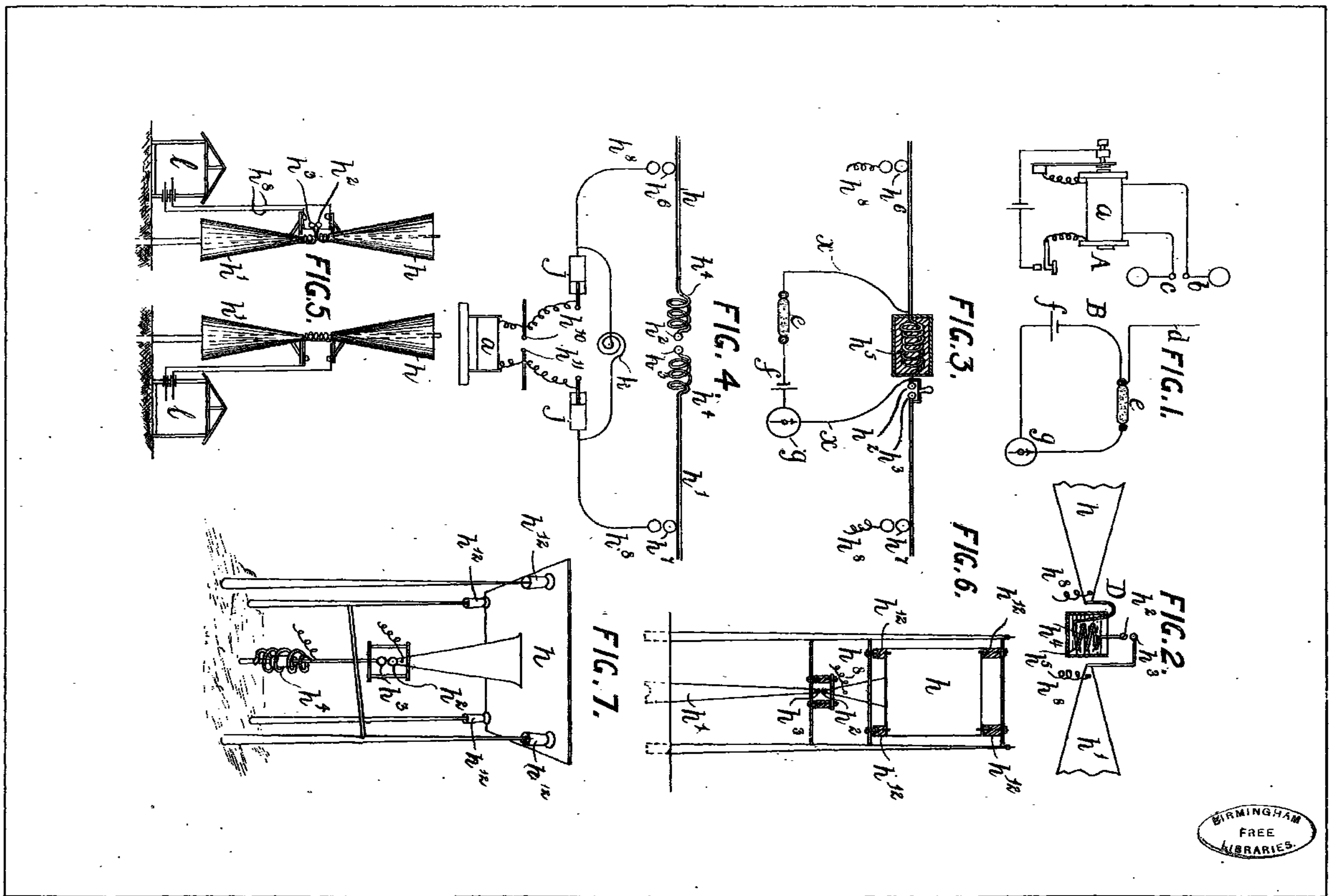
6. ~~10.~~ The combination, in the receiving circuit of a system of Hertzian wave telegraphy, of an adjustable or replaceable self-inductance coil, connecting the capacity areas, a coherer, a battery, a telegraphic receiving instrument or a telephone with or without a shunt across the coils thereof substantially as and for the purpose set forth.

7. ~~11.~~ The construction arrangement and combination of parts constituting my improved system of syntonic Hertzian wave telegraphy substantially as set forth and as illustrated in the accompanying drawings.

Dated this 1st day of February, 1898.

WM. P. THOMPSON & Co.,
Patent Agents,
Of Liverpool, Manchester, Birmingham & London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1911.



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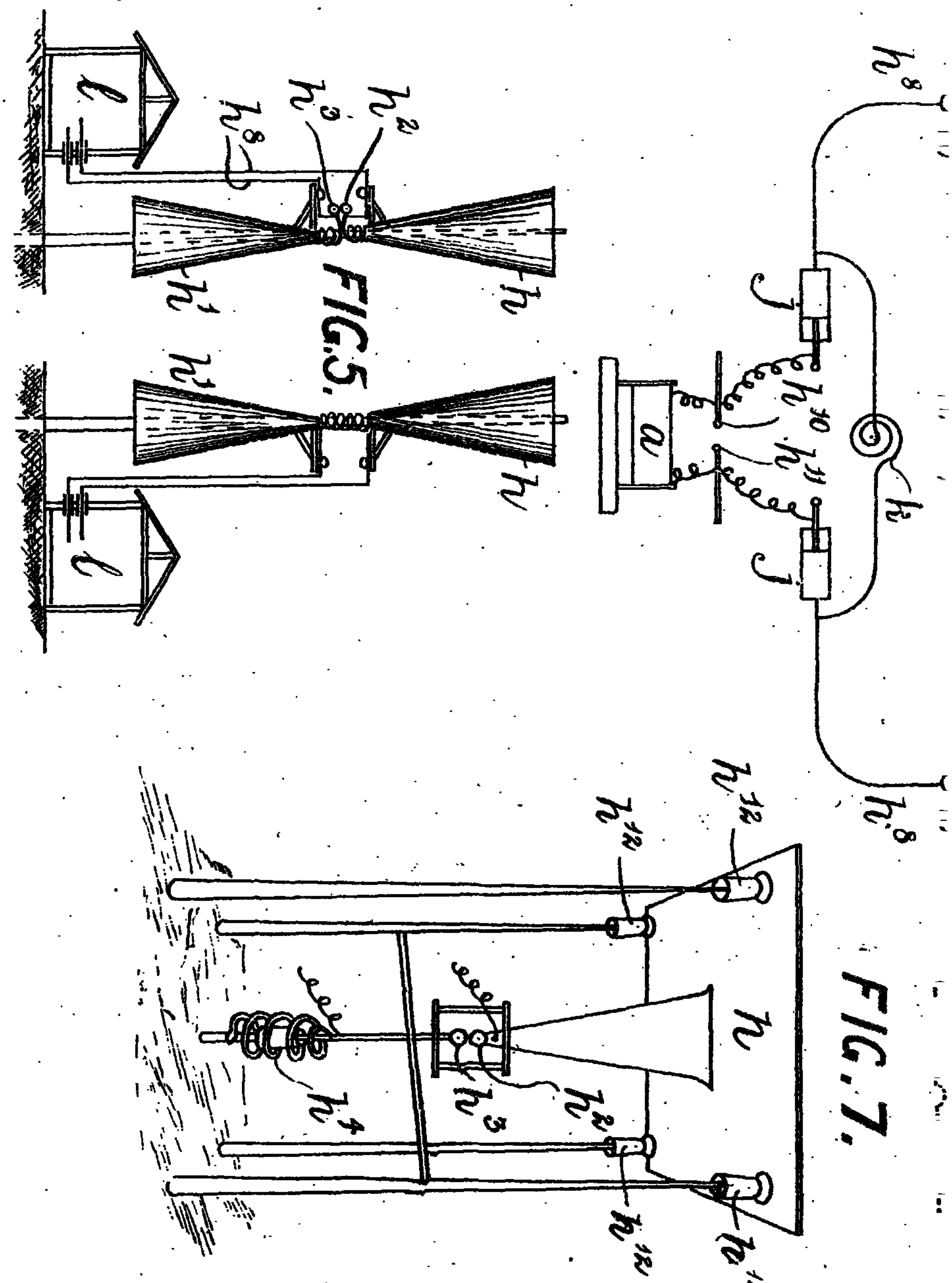
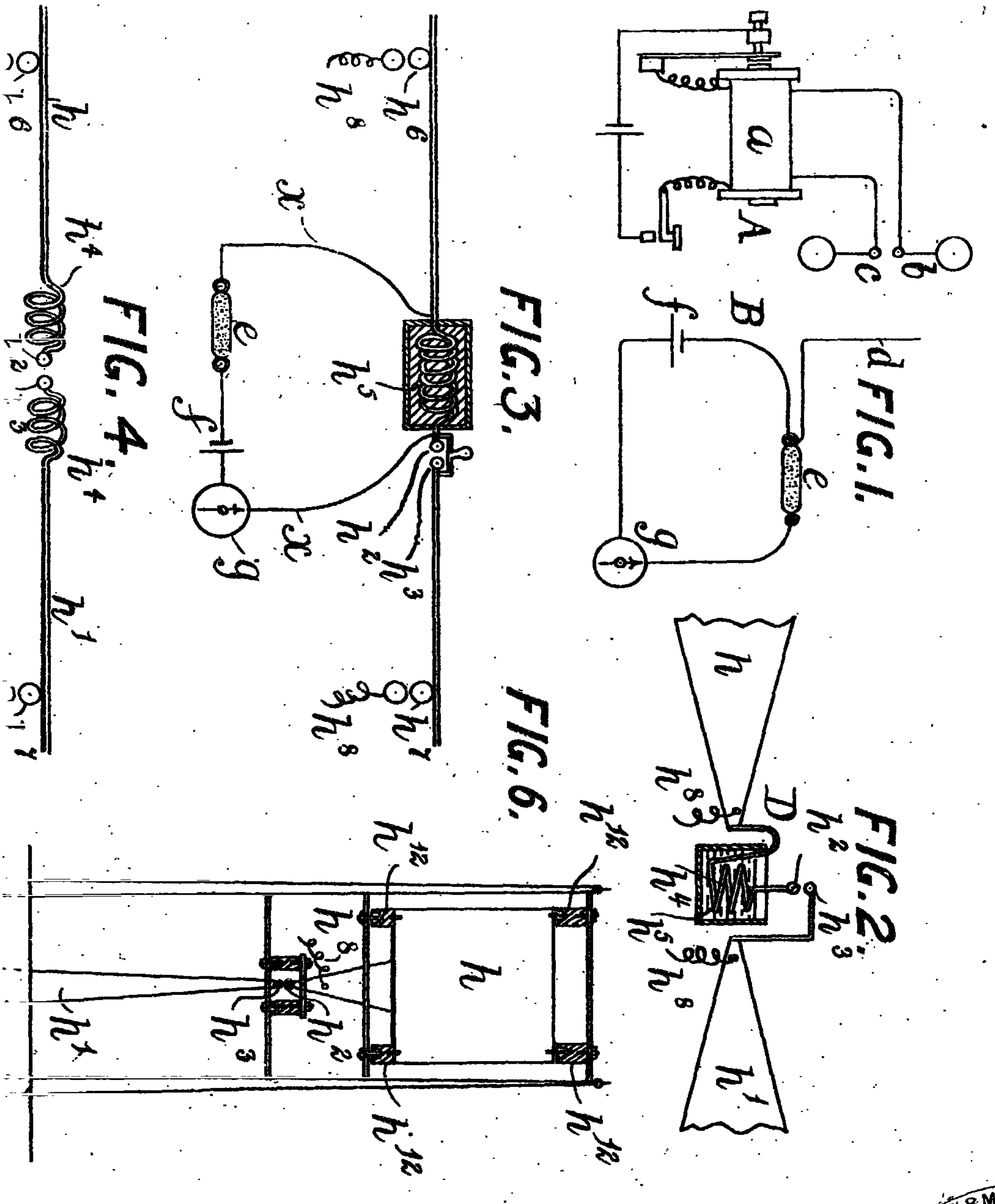


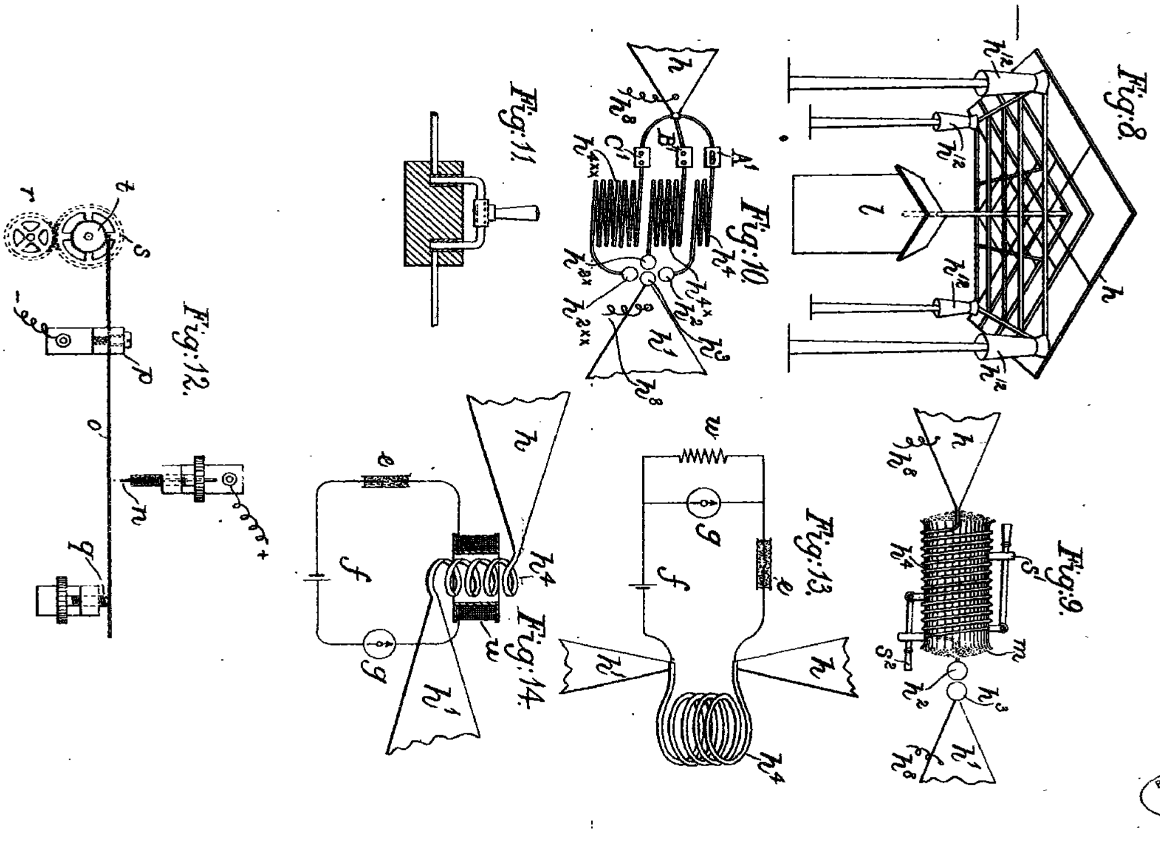
FIG. 5.

FIG. 7.

[This Drawing is a full-size reproduction of the Original.]



Malby & Sons, Photo-Litho.



[This Drawing is a full-size reproduction of the Original.]

Fig: 11.

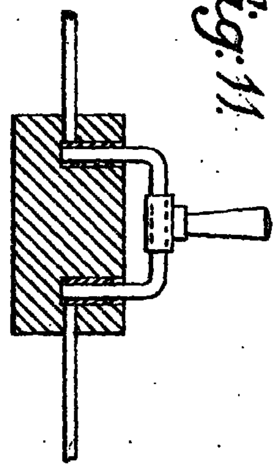


Fig: 12.

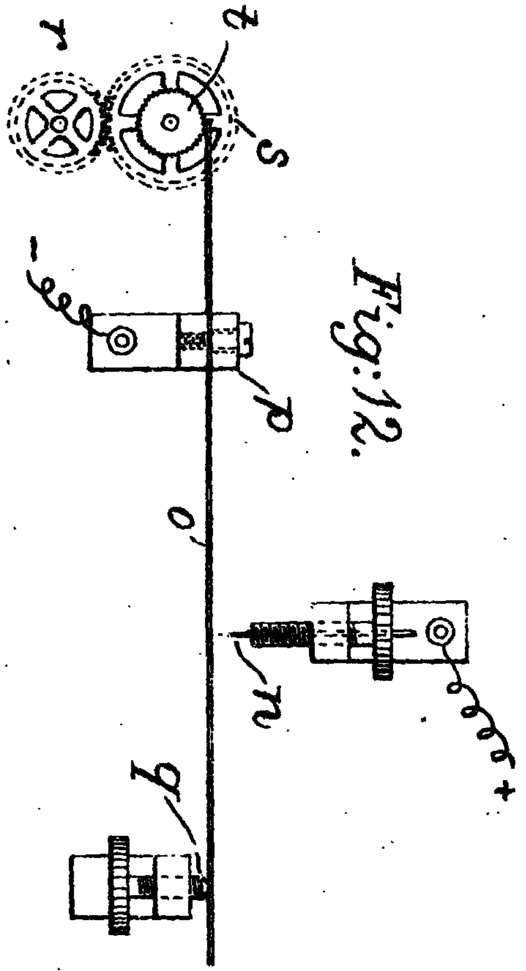
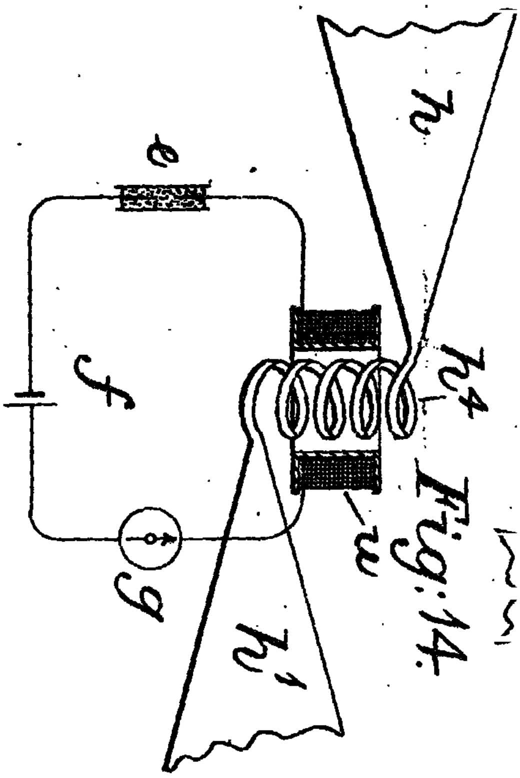


Fig: 14.



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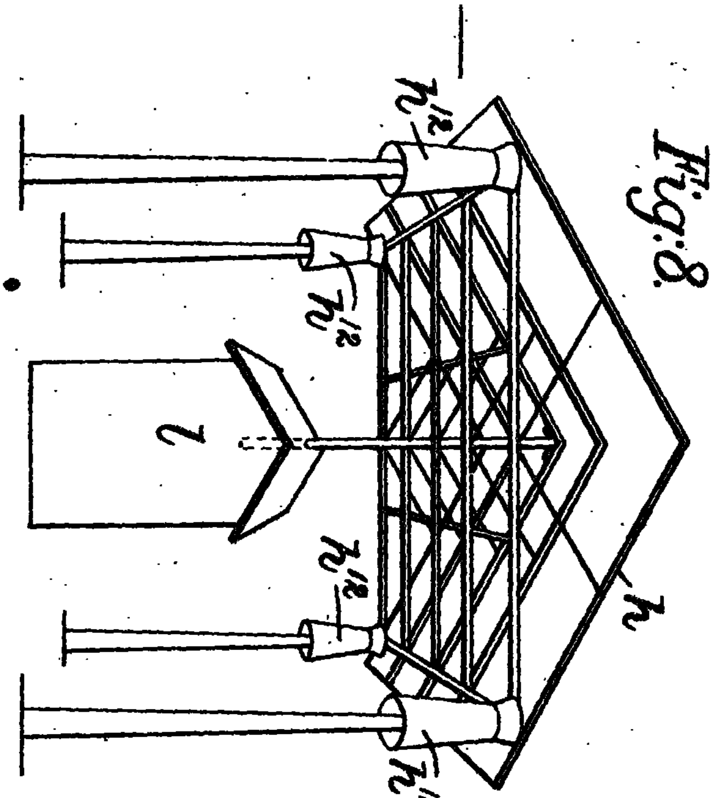

Fig: 8.

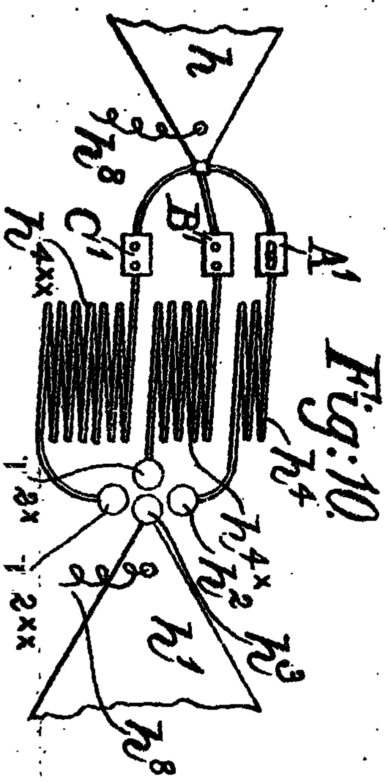

Fig: 10.

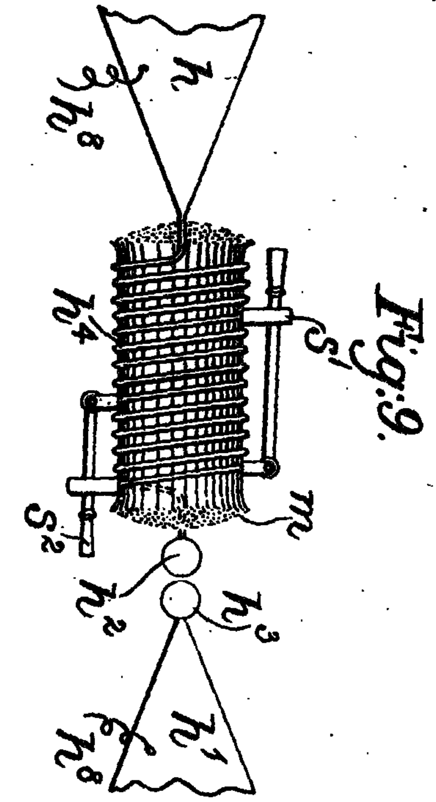

Fig: 9.

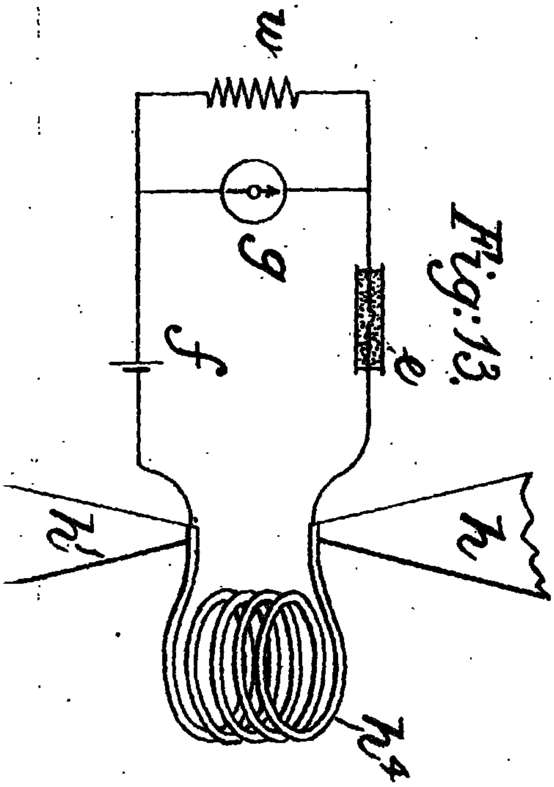

Fig: 13.