N° 4710 A.D. 1907

Date of Application, 26th Feb., 1907—Accepted, 26th Feb., 1908

COMPLETE SPECIFICATION.

"Improvements in the Transmission of Energy by Electromagnetic Waves."

I, REGINALD AUBREY FESSENDEN, of No. 1737 Riggs Place, Washington D.C., U.S.A., Electrical Engineer, 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:—

This invention relates to certain improvements in the transmission and receipt of the energy of electromagnetic waves, and more particularly to improvements in the antennae used for receiving or transmitting the energy of electromagnetic waves and the method of tuning them.

Heretofore in the practice of the art of wireless telegraphy vertical antennae have usually been suspended and insulated from a mast or tower or similar support. This method is disadvantageous on account of difficulties of insulation and necessitates a costly construction. When the vertical antenna has been partly or wholly constituted by and integral with a metallic mast or tower, it has been supported on an insulating base and by means of guys having insulators interposed at one or more points of their length.

One object of the present invention is to obviate the electrical and constructional difficulties associated with such structures, and this may be effected in two different ways, and that without the necessity of surrounding the antenna with a coating medium.

One of these methods is applicable to vertical antennae which are constituted partly or wholly by and are integral with the metallic supporting mast or tower, and consists in insulating the antennae and also the supporting guys, when such are used, inductively from the earth.

The other method consists essentially in utilising the magnetic component of the electromagnetic waves for sending and receiving and thereby obviating the necessity of long vertical antennae, instead of as heretofore utilising the electrostatic component of the waves by means of an upper and lower capacity (the latter generally formed by the earth) connected usually by a vertical wire, although horizontal wires have also been used but in such cases act as electrical conductors and capacity antennae and not as in the method hereinafter described to increase the magnetic permeability of the sending or receiving element or antenna.

In the accompanying drawings Figs. 1 and 2 shew one form of construction embodying the latter method. Fig. 3 shews a form embodying the first method. Figs. 4, 5 and 6 shew means for tuning the antennae whether used for sending or receiving.

In Fig. 1, 1, 1^1 is a horizontal wire or bundle of wires preferably of iron, preferably insulated, and preferably of small diameter, for example No. 40 B. & S. gauge. This wire or bundle of wires is extended horizontally as shewn in Fig. 2 and may either rest upon the ground or is preferably supported therefrom at a small height, for example two feet, by the insulators 10, 10^1. For receiving messages, a coil or coils, 2, 2^1 is wound around the bundle of wires, preferably near its centre, and the terminals of the coil or coils are connected with a

[*Price* 8*d*.]

detector 4 which may be a barretter or other suitable wave responsive device. The local circuit includes an indicating device 5 which may be a telephone, and its potential is regulated in the usual manner by means of a potentio-meter or other suitable device 6. The receiving circuit 4, 2, 3, 2^1, is preferably tuned to the periodicity of the wave which it is desired to receive, and for this purpose a condenser 3 may be used.

For transmitting signals the bundle of wire is encircled as shewn in Fig. 1, preferably near its centre by a coil 8 which with the condensers 9, 9^1 and the spark gap 11 forms a circuit for producing oscillations of the desired frequency. 12 is an induction coil and 13 a local battery for operating the induction coil. 10 is a key which on being depressed cuts out a portion of the capacity 9^1 and changes the period of the oscillations and which may also be used as a signalling key which operates by throwing the sending station in and out of tune with the receiving station.

The object of the bundle of iron wires is to increase the permeability of the sending or receiving coils, and when it is used, the bundle may either be compact as shewn in 1, 1^1 or may be spread out into a fan shape as shewn in 7, 7^1. Fig. 2 shews a side view where 1, 1^1 is the antennae, 8 a coil of wire wrapped around it and 9 either the receiving or sending apparatus. 11^1 shews the ground level and 10, 10^1 are insulators which may be used for supporting the antennae.

It is to be noted that in the apparatus shewn in Figs. 1 and 2, the magnetic component of the electromagnetic waves is utilised instead of the vertical or electrostatic component. It is also to be noted that the length of the bundle of iron wires 1, 1^1, is preferably adjusted so that it is in tune with the wave length of the waves which it is desired to generate or receive. It is found that a receiving antenna of this form responds only to waves impinging upon it laterally and therefore proceeding from a source more or less in line with the plane of the coil of the receiving circuit and is not responsive to waves reaching it in the direction of its axis, hence this form of antenna may be arranged so as to be rotatable about a vertical axis and be made unresponsive to impulses emanating from a given direction. This method is therefore of use for selective working, and for determining the direction from which the impulses are sent. By the use of a horizontal reflector, arranged parallel with the bundle of iron wires as shewn 12^1, 12^2, Fig. 2, impulses may be received from one direction only, and this is specifically useful where it is desired to locate accurately the direction from which received impulses are sent.

It may also be used for sending strengthened impulses in one direction.

Fig. 3 shews another form of antenna where 15 is a galvanised steel tower preferably constructed of lattice work, and supported by the steel post 16. The steel post 16 has wound around it a coil 17 preferably formed of fine iron wires, for example No. 40 B. & S. gauge, so as to give the steel tower a high impedance. A conductor 18 preferably of strip copper is connected to shunt the post 16, so that, having a smaller inductance than the post 16, practically all the oscillations will follow the conductor 18 to ground instead of the post 16. The conductor 18, together with condensers 19, 19^1 and spark gap 20, form a local oscillating circuit for prolonging the oscillations produced in the sparking circuit by a generator 22 preferably of constant voltage, an impedance 21, preferably of appreciable ohmic resistance being included in the circuit. By this construction which is similar to that shewn in the Specification to British Patent No. 17705 of 1902, Fig. 10, oscillations are set up in the antennae 15 and radiated therefrom, the local circuit 18, 19, 20, 19^1 being tuned to the vertical conductor 15, 18, 23. Any other suitable means, however, of generating the oscillations, for example an induction coil, may be used. If the strip 18 is omitted the local circuit 19, 20, 19^1, 17 is tuned to the vertical conductor 15, 17, 23.

Where it is necessary to support this antenna by metal guys at 14, 14^1 a coil of iron wire 24 similar to the coil 17 is used to prevent these guys from carrying

off the energy sent out, or the energy received when the antenna is used for receiving.

In Fig. 4 a method is shewn of tuning the antennae by changing the capacity of the antennae. 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, are antennae. 35 is a device whereby more or less of the antennae can be connected at will, and 36 is a coil which may form either the primary of the transformer in which a receiver is placed, when it is desired to receive, or the secondary of a transformer whose primary is in a circuit for producing oscillations when it is desired to send.

Fig. 5 shews an alternative method or means for accomplishing the same results, where 37, 38 and 39 are antennae, one or more of which may be switched in as desired by the switch 40 passing over the contacts 41, 42 or 43, and being connected by the switch 14 so as to send or receive at will while 44, 45 and 46 are wires which may be connected to the ground at will by the switch 40^1 making contact with one or more of the contacts 47, 48, 49.

50, 51 and 52 are capacities and it will be seen that on connecting the wire 44 to ground, the capacity of the vertical 37 will be largely increased and similarly with the other antennae.

Fig. 6 shews an alternative method in which the antennae 25, 26, 27, 28 are in series with the capacities 53, 54, 55, 56 and 57 and by moving the switch 58 the capacity of the vertical to ground may be increased or decreased at will, and hence the tune of the vertical conductor changed as desired.

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 an electromagnetic wave wireless telegraph system the method of signalling in which instead of the electrostatic component the magnetic component of the electromagnetic waves is primarily utilised.

2. In the method of signalling according to Claim 1, as an element of the transmitting or receiving circuit a coil or coils of wire having the plane thereof perpendicular to the direction of the magnetic component and containing the line joining the sending and receiving stations, substantially as described.

3. In combination with the coil or coils of the preceding claim, a core of highly permeable material.

4. In the apparatus of the preceding claim a core consisting of a bundle of iron wires or rods threading the coil or coils axially and extending horizontally on each side thereof and adjusted in length to be in tune with the waves which it is desired to transmit or receive, said core being insulatingly supported or not, substantially as described.

5. In combination with the apparatus of Claims 2, 3, and 4, a conducting screen in rear of the said coil or coils, substantially as described.

6. Arranging the apparatus of Claims 2, 3, 4 and 5, to be rotatable about a vertical axis.

7. An apparatus for the transmission and reception of electromagnetic waves arranged and operating substantially as herein described and illustrated in Figs. 1 and 2.

8. In an electromagnetic wave wireless telegraphy system, in which the antennae at the sending or receiving station or at both are combined with their supports in a continuous metallic structure, localising the radiating and receiving portions by increasing the impedance of the other portions, substantially as described.

9. In an electromagnetic wave wireless telegraphy system, antennae constructed substantially as herein described and illustrated in Fig. 3.

10. The herein described method of radiating or receiving electromagnetic waves which consists in using multiple radiating or receiving antennae and altering an electrical characteristic of the radiating or receiving conductors of the antennae by one or more of the other conductors of the antennae.

11. In the transmission or reception of the energy of electromagnetic waves the method of tuning the circuits by means of multiple antennae of variable capacity, substantially as herein described.

12. In the transmission or reception of the energy of electromagnetic waves the method of tuning the circuits which consists in using one or more of the conductors or wires of a multiple antennae as sending or receiving conductors, connecting one or more of the conductors or wires to earth and arranging the earthed conductor or conductors in electrostatic inductive relation to the other wires of the multiple antennae.

13. Multiple antennae consisting of two or more conductors or wires, one or more of the conductors being utilised to alter an electrical characteristic of the other conductor or conductors.

Dated this 26th day of February 1907.

ABEL & IMRAY,
Agents for the Applicant,
Birkbeck Bank Chambers, Southampton Buildings, London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1908.

A.D. 1907. Feb. 26. Nº 4710.

FESSENDEN'S Complete Specification.

(1 SHEET)

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

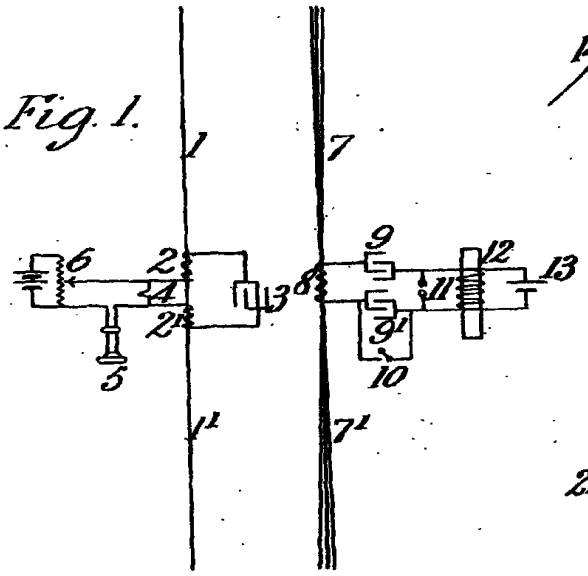


Fig. 3.

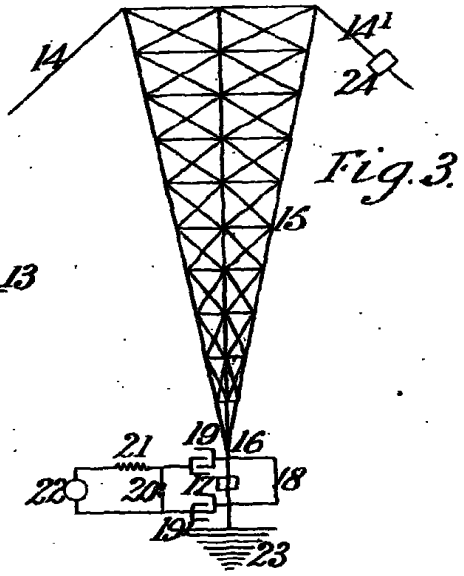


Fig. 2.

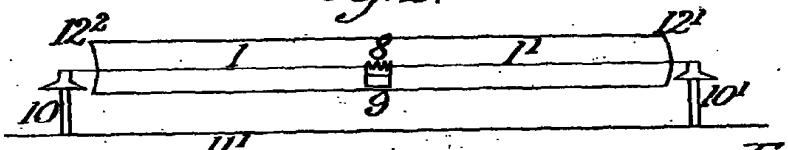


Fig. 4.

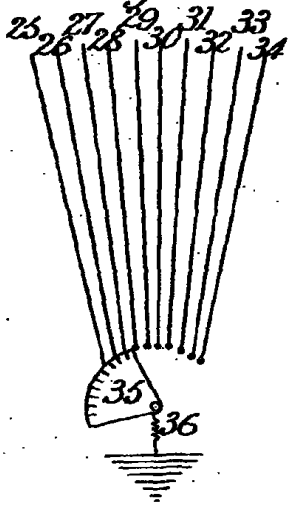


Fig. 6.

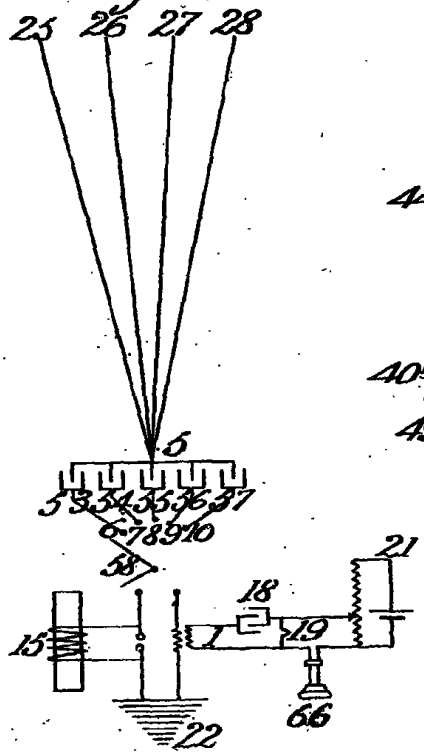
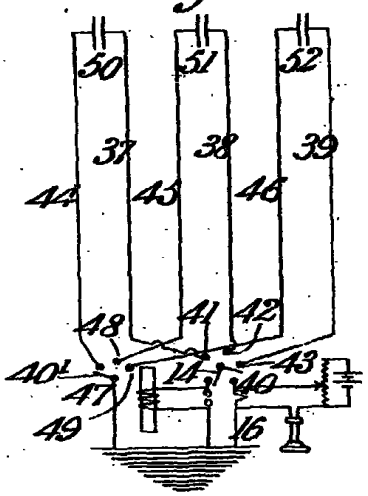


Fig. 5.



Malby & Sons, Photo-Litho.