N° 4713 A.D. 1907

Date of Application, 26th Feb., 1907—Accepted, 26th May, 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 the transmission of energy by electromagnetic waves and consists more particularly in improvements for the prevention of interference at the receiving station by disturbing impulses, whether such interference is caused by atmospheric disturbance or by the generation of waves at other stations. The invention relates more particularly to the method whereby such disturbances are caused to neutralise each other described in the Specification to British Patent No. 17704 of 1902.

In the accompanying drawings forming a part of this specification Figs. 1 and 7 are diagrammatic views illustrating receiving stations constructed in accordance with this invention. Fig. 2 is a detail view illustrating the preferred form of transformer. Figs. 3 and 4 are plan and side elevations respectively, illustrating the preferred form of adjustable capacity. Fig. 5 is a perspective view of a modified form of variable condenser, and Fig. 6 shews in plan and elevation a modified construction of transformer.

In Fig. 1, 1 is a receiving antenna, grounded at 4, 2 and 5 represent inductances adjustable by means of the sliding contacts 3 and 6; 7 and 8 represent primaries and 9 and 10 secondaries of transformers; 11 and 12 and 13 represent condensers, preferably adjustable. The secondaries 9 and 10 are arranged in series with each other and in operative relation to the receiver 17. The circuit including the secondaries 9 and 10 and the receiver preferably contain the variable inductances 14 and 14^1 and the adjustable condensers 15, 16 and 18. An indicating mechanism 19 is connected with the receiver 17 in a local circuit the E.M.F. of which is adjustable by means of the potentio-meter 20.

The capacity to ground of a point on the receiving circuit, preferably one of the terminals of the receiver, though both may be so connected, is made adjustable by the inclusion of a condenser or condensers, such as 21, 22 which are preferably adjustable and are connected to ground at 23.

In Fig. 2, 7 is a primary and 9 a secondary. The primary may consist for example of 100 turns of No. 18 copper wire wound on a glass jar 24, five inches in diameter and the secondary may consist of 35 turns of No. 32 wire wound on a glass jar 25, six inches in diameter.

The inside of the glass jar 25 is preferably covered with a conducting material 26 so arranged as to shield the secondary from electrostatic effects caused by the primary but at the same time not to prevent electromagnetic inductive effects between the two. One suitable method of arranging this is by painting the inside of the jar with metallic paint such as bronze or gold paint or by coating it with gold-leaf or by placing a cylinder of copper slotted vertically, between the two jars.

This conducting shield may be connected to ground with good results and the conducting shields of both transformers may be connected together as shewn in

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Fig. 7. The shield for the construction of transformer shewn in Figs. 6 and 7 is indicated at 50 in Fig. 7. A high resistance or inductance 27 may be placed in the circuit to ground when the shield is grounded.

Another form of transformer is shewn in Fig. 6 where 28, 29 are hard rubber rings having grooves cut in them and the primary wound in the groove of one ring and the secondary wound in the groove of the other ring. These rings may also be covered with metallic paint or gold-foil or a metallic disc 50 (Fig. 7) radially slotted may be placed between the two coils. This construction is especially adapted for the use where it is desired to obtain large inductance with small capacity.

Figs. 3 and 4 shew one form of variable condenser consisting of intercallating metal plates 30 and 31 preferably semicircular or approximately so in contour. Alternate plates are movable in and out between the other plates so that the one set of plates may be made to over-lap the other plates more or less as required. It is preferred to secure the movable plates 31 to a shaft 32 provided with an operating handle. The shaft has its axis coinciding with the centre of the arcs forming the perimeters of the plates so that by the rotation of the shaft one set of plates may be moved to a position in which they are entirely overlapped by the other plates and to a position in which there is not any material overlapping of one set of plates by the other. One set of plates is insulated from the other. A dial 33 and indicating finger 34 are so arranged that one or the other will be shifted with the movable plates.

The variable condenser shewn in Fig. 5 consists of a tube 36 of conducting material, an insulating tube 35 inside the tube 36, and a tube 37 inside the insulating tube 35. The metallic tubes are arranged so that one may be moved longitudinally of the other. A scale is arranged in proper relation to these tubes so as to indicate capacity in different relative positions of the tubes.

Both the primaries 7 and 8 should have the same number of turns and both the secondaries 9 and 10 should have the same number of turns, means for altering the number of turns being provided, as for example by the movable contacts 46 and 47, shewn in Fig. 7. By sliding these contacts the circuits may be tuned by varying the inductance instead of by varying the capacity. The primary 7^a and the secondary 9^a may also be made movable relative to each other by sliding along the graduated arm 48 so as to vary the mutual inductance between primaries and secondaries, as shewn in Fig. 7.

The circuits 1, 2, 8, 12, 5, 13, 4, and 1, 2, 7, 11, 5, 13, 4 are tuned in such a way that when an impulse of the desired periodicity is received on the receiving conductor, it generates strong currents through one of these circuits, for example 1, 2, 8, 12, 5, 13, 4 but very weak currents through the other and consequently, the secondaries 9 and 10 being wound in opposite directions the receiver 17 is strongly affected; but said circuits are so tuned that impulses which have not the desired periodicity will divide evenly through both circuits and consequently produce equal and opposite effects which, being thus neutralised, produce no effect on the receiver.

This is generally accomplished empirically, a suitable method being to turn the variable capacity 11 to the position of zero capacity and then to turn the variable capacity 12 until the maximum effect is produced by the waves it is desired to receive. The variable capacity 11 is then turned until the interfering signals or disturbances are cut out.

It may happen that the neutralisation cannot be rendered quite complete, on account of there being a phase difference in the currents flowing through the two primaries, and this is more especially apt to happen with interference preventers in which two transformers are used instead of the three or four-transformers.

In order to insure complete neutralisation a device which may be called a phase-correcter may be used, consisting of a circuit adapted to generate a voltage equal and in opposite phase to the non-compensated voltage impressed upon the secondaries 9 and 10 and opposite in direction. A suitable method is shewn in Fig. 1 where 38 and 39 are coils in inductive relation to each other and preferably capable of being adjusted to different distances apart by sliding on the graduated arm 40. Coil 38 is in series with the secondaries 9 and 10 and coil 39 is operatively connected to an adjustable inductance 41, and adjustable resistance 42.

A current will therefore flow through the circuit 39, 41, 42 and the phase of this current can be altered by varying the adjustable inductance 41, which consists of two coils capable of relative angular movement or by changing the resistance 42 which is preferably of very small capacity.

The intensity of the voltage which would be impressed on the circuit containing the secondaries 9, 10 and the coil 38 may be varied by varying the position of the coil 39. In this way a voltage may be impressed on the circuit of the secondaries 9 and 10 which will have the proper phase and the proper value to neutralise the unbalanced component of the interfering signals or disturbances.

Many other ways will suggest themselves of accomplishing this result. For example, the phase compensater may be inductively connected to the vertical, instead of directly connected, as shewn in Fig. 7. Also a variable capacity 49 may be substituted for the variable inductance 41, in which case a leading current will be obtained instead of a lagging one, and the winding of the coil 39 must be reversed.

The connections of the coil 39 may be so arranged that they may be changed by means of a switch shewn at 43 according as the unbalanced component is a leading or lagging one.

I am aware that it has been proposed to employ two or more wave collecting and conducting systems, which may have a common collecting antenna, and to connect these differentially with a common wave-responsive device so that wave trains of a frequency differing from those which it is desired to receive will affect both sides of the wave-responsive device alike and will thus be ineffective upon the indicating device and to such an arrangement broadly I make no claim; but my invention is distinguished from this arrangement by the differentially acting parts of the divided circuit being arranged to operate appositely in series with respect to the receiving circuit, and subject to this statement, and

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 transmitting power electrically, the herein described method which consists in dividing the received impulses between two or more parallel resonant circuits having constants so related that the currents produced by the impulses which it is desired to receive are unequally divided, while the currents due to other impulses are equally or approximately equally divided, whereby a receiver subject to the differential action of the divided currents will respond only to the desired impulses, substantially as described.

2. In the method herein described in which currents produced by received impulses are divided between two parallel circuits each including the primary of a transformer, the method of compensating an unbalanced voltage in the secondary circuit which consists in impressing on the said circuit a voltage of the required phase and value, substantially as described.

3. In a system of transmitting power electrically the combination of means for dividing currents produced by received impulses, a receiver arranged to be affected by the divided currents, and means for causing the divided currents of undesired periodicity to affect the receiver oppositely and equally substantially as described and illustrated.

4. In a system of transmitting power electrically, the combination of a receiving conductor having its ground connection divided into two or more portions or

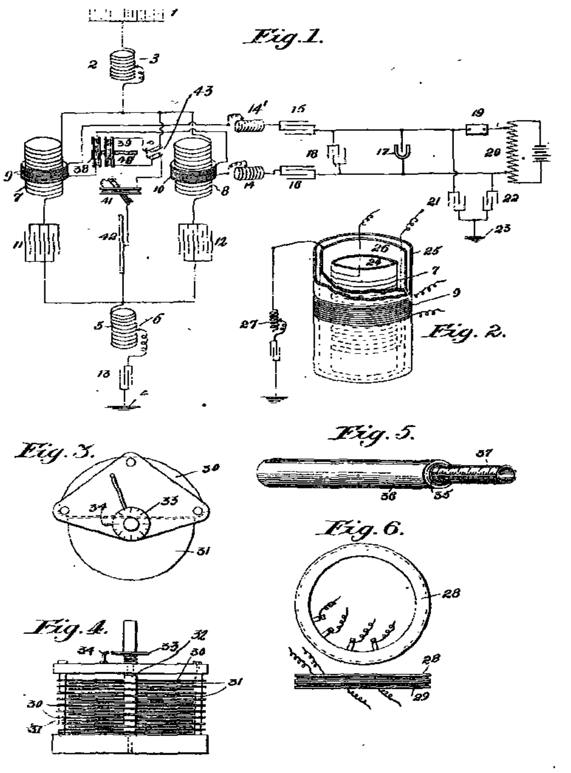
legs, transformers or transformers and capacities in each of said portions or legs and a receiver in operative relation to the secondaries of the transformer, substantially as described.

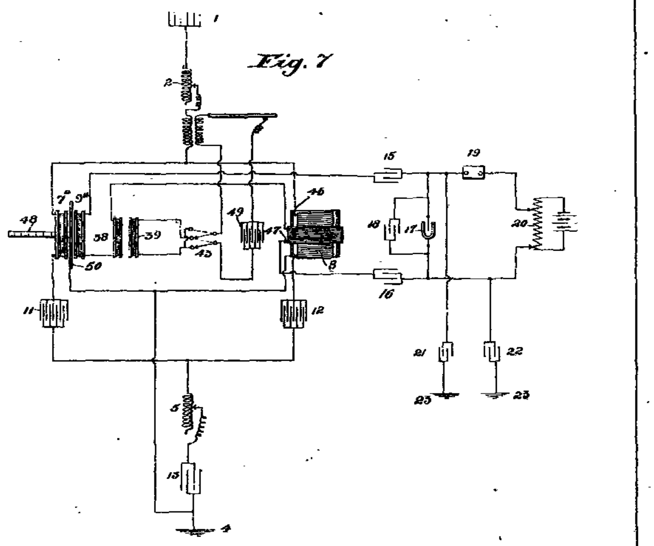
Dated this 26th day of February 1907.

ABEL & IMRAY,
Agents for the Applicant.

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

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





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FESSENDEN'S Complete Specification.

SHEET 1.

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Fig. 1.

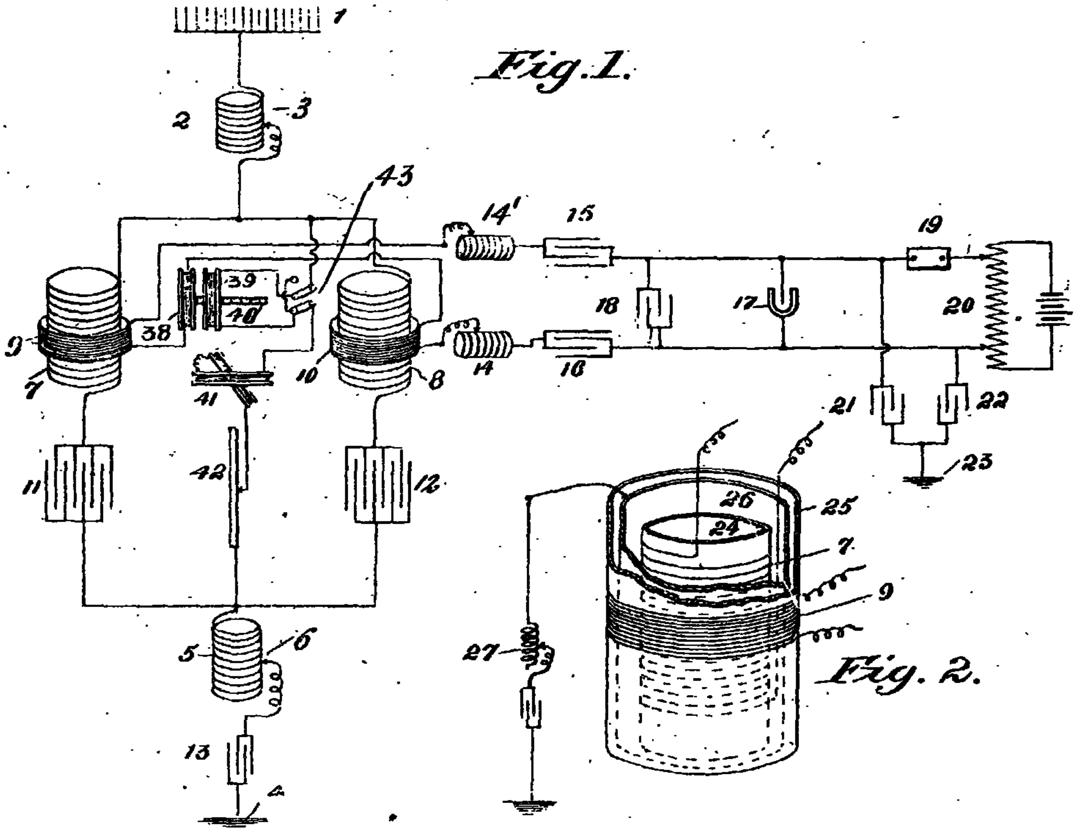


Fig. 2.

Fig. 3.

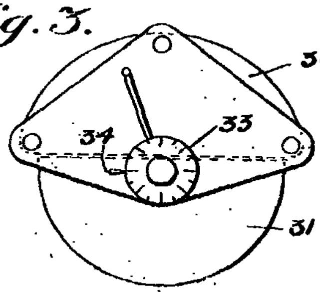


Fig. 5.

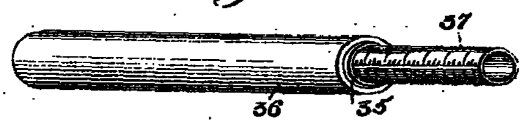


Fig. 6.

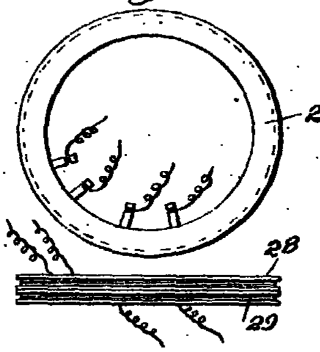


Fig. 4.

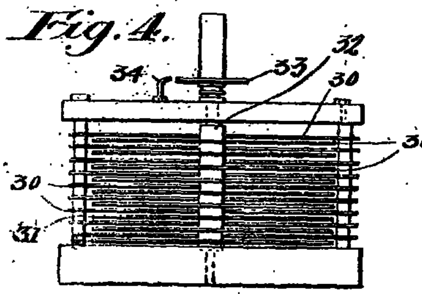
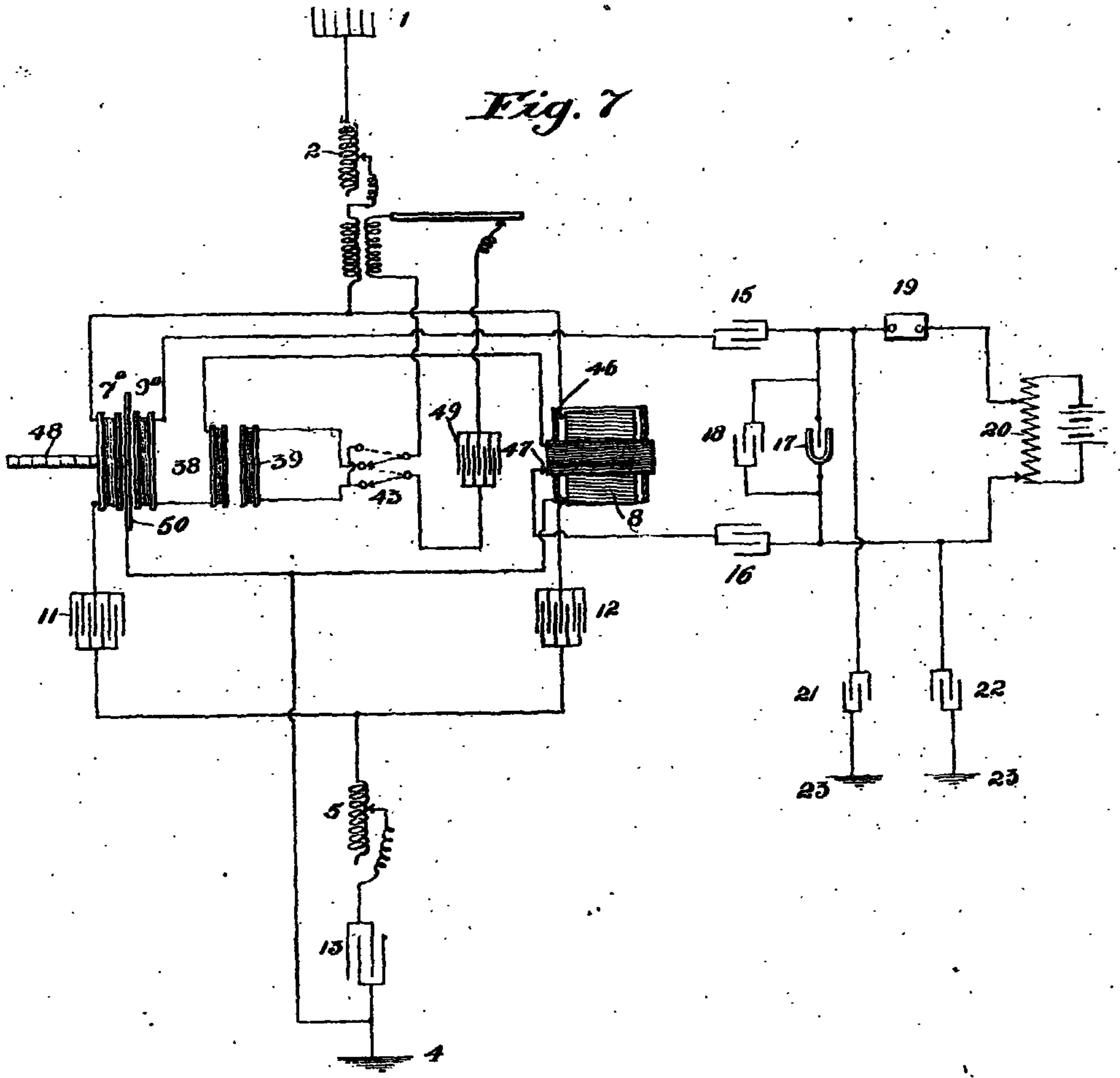


Fig. 7



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