L. ESPENSCHIED.

WIRELESS RECEIVING SYSTEM.

APPLICATION FILED SEPT. 23, 1915.

1,223,376.

Patented Apr. 24, 1917.

2 SHEETS—SHEET 1.

Fig. 1

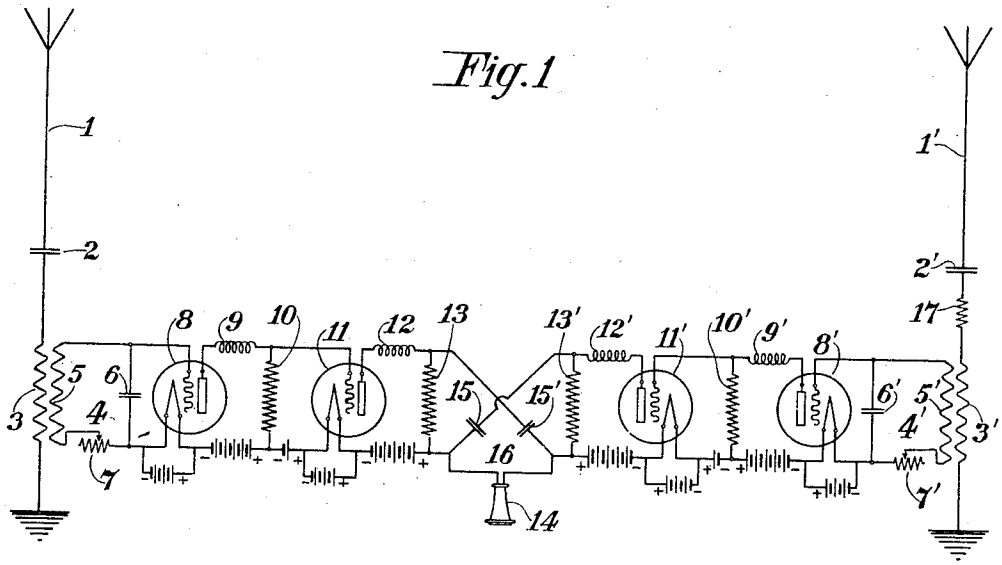
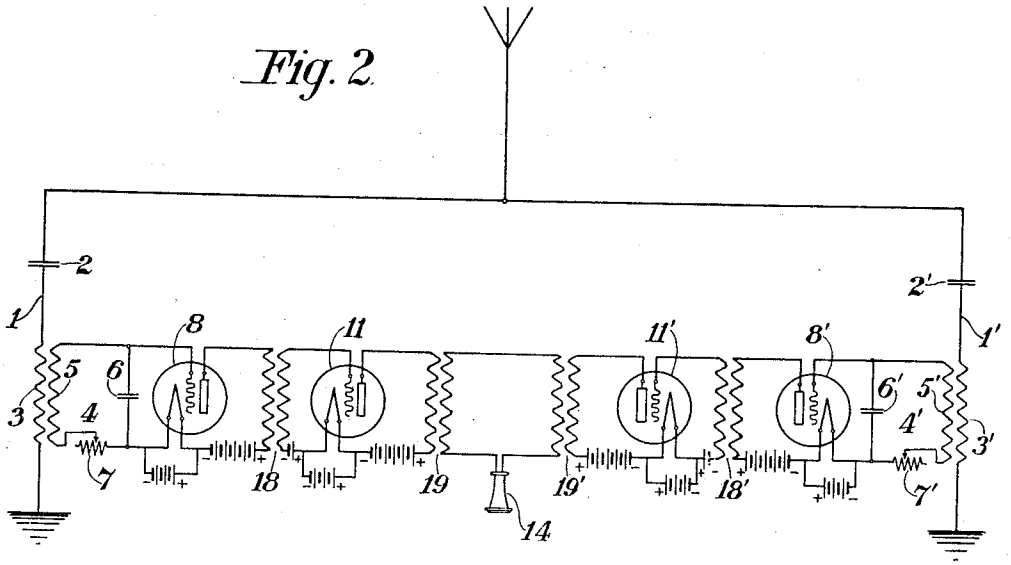


Fig. 2



Inventor:
L. Espenschied
per Mauro, Cameron, Lee & Massie
Associate *Attorneys*

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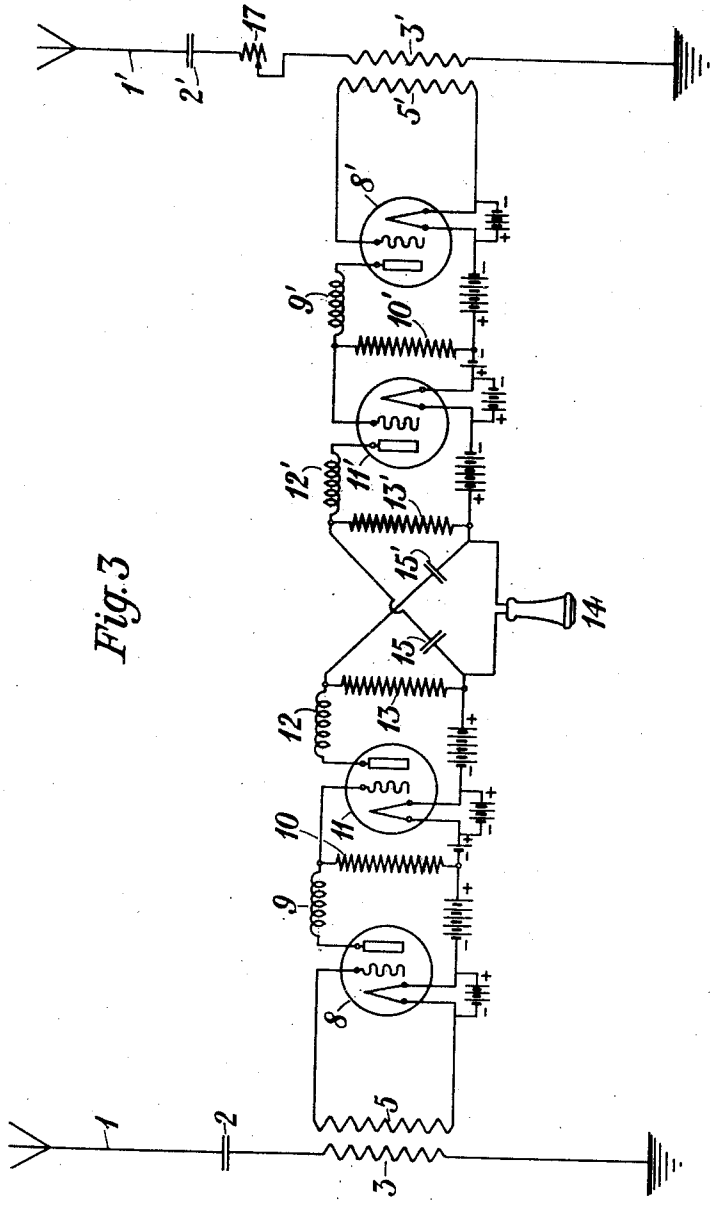


Fig. 3

INVENTOR

L. Espenschied

BY

Thomas D. Lockwood

ATTORNEY

UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

WIRELESS RECEIVING SYSTEM.

1,223,376. Specification of Letters Patent. Patented Apr. 24, 1917.

Application filed September 23, 1915. Serial No. 52,260.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at 1369 Dean street, Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Wireless Receiving Systems, of which the following is a specification.

This invention relates to a wireless signaling system, and more particularly to a system for the reception of wireless signals. Its object is to provide a receiving system in which the receiving instrument shall be protected from disturbing oscillations, such as those due to atmospheric or static disturbances, which might interfere with the efficient reception of signals. The invention finds its use in connection with a wireless telegraph or telephone system.

It is well known to those acquainted with the art that atmospheric or static interference constitutes a very serious menace to the satisfactory reception of wireless messages and that the elimination of said interference is a problem of great difficulty. This difficulty inheres in the fact that the frequency to which the receiving system is tuned, and is therefore most responsive, is very closely the same as the frequency of the natural oscillations set up by the incidence of an atmospheric disturbance on the receiving antenna. The natural oscillations are therefore of substantially the frequency to most strongly affect the receiving device, and cannot be eliminated by tuning as can persistent disturbances from a foreign station.

This invention contemplates an arrangement by which the receiving device, in addition to being operatively connected to the antenna circuit proper, is also connected to an auxiliary antenna circuit, such connections being made through suitable translating means, such as detectors, for rendering the receiving device unresponsive to disturbing oscillations simultaneously occurring in the two antenna circuits.

The invention will be best understood by reference to the accompanying drawings in which, Figures 1, 2 and 3 are diagrams showing three different embodiments of my invention.

Referring to Fig. 1, it will be observed that the particular organization shown consists of a receiving system proper and a similar auxiliary system having a common receiving device, the latter being conventionally represented by a telephone receiver 14. The component parts of the auxiliary system, whose function will hereinafter be fully set forth, are similar to the corresponding elements of the receiving system proper. It will therefore be understood that, so far as the physical structures are concerned, the same description applies to the auxiliary system as to the receiving system proper.

In the receiving system proper, a receiving antenna 1, contains a tuning condenser 2 and a coupling coil 3. An oscillation circuit 4 contains a tuning condenser 6 and a coupling coil 5, whereby it is loosely coupled to the antenna. Circuit 4 is tuned to the same frequency, or wave length, as the antenna 1, that is to the wave length of the signals it is desired to receive from the sending station (not shown). In the auxiliary system, a circuit 4′ is similarly loosely coupled to an auxiliary antenna 1′ and tuned to the same wave length as said antenna 1′. This wave length is, however, different from the wave length to which the elements 1 and 4 are tuned. Bridged across the condenser 6 is the input side of a detector, preferably of the vacuum tube type, conventionally represented by 8. 8′ is the corresponding detector of the auxiliary receiving system. The output side of the detector 8 is closed through an impedance coil 9 and a non-inductive resistance element 10. Bridged across the resistance element 10 is the input side of an amplifier 11, preferably of the vacuum tube type. The output side of said amplifier is closed through an impedance coil 12 and a non-inductive resistance element 13. The telephone receiver 14 is connected across both non-inductive resistance elements 13 and 13′, in such a manner that no current flows through 14 if the potential drop across resistances 13 and 13′ are equal. Condensers 15, 15′ prevent the flow of steady direct current through the receiver 14. The auxiliary antenna may contain a resistance element 17, whereby its natural damping may be adjusted.

The operation of the organization shown in Fig. 1 may now be described. As hereinbefore stated, the antenna structure 1 and the circuit 4 are tuned to the wave length of the sending station, while the corresponding parts 1′ and 4′ of the auxiliary system are tuned to a different wave length. Cir-

cuit 4, therefore, oscillates strongly in response to the electromagnetic waves from the sending station to which it is tuned, while circuit 4′ responds very weakly thereto. It is evident, therefore, that the oscillating potential impressed across the terminals of resistance 13 is very large compared to that across resistance 13′, and therefore an oscillating current, corresponding to the received signals, flows in the receiver 14. Said oscillatory current flowing in the receiver 14 will not be of high or radio-frequency as are the oscillations in the antenna and oscillation circuits, but owing to the translating action of detector 8 and the choking action of impedance coil 9, it will be of low or audio-frequency corresponding in telegraphy to the group frequency of said high frequency oscillations, or in telephony to the modulation frequency of said high frequency oscillations. In fact said oscillatory current in the receiver 14 will be substantially independent of the frequency of the radio-frequency oscillations operating on the input side of the detector and will depend only on the amplitude and damping factor or modulation of said radio-frequency oscillations; that is, on the envelop of said radio-frequency oscillations. It is further evident that if the auxiliary system were tuned to the same wave length and were identical in all respects with the receiving system proper, that the oscillating potential drop across resistances 13 and 13′ would be equal and that the resultant current in the receiver would be zero. It is essential therefore, for efficient reception of signals, that the auxiliary system be tuned to respond very feebly to the waves originating at the sending station. When this condition obtains the response of the receiver 14 to the received signals is practically independent of the auxiliary system. The auxiliary system, it will be seen, plays no part in reception of signals from the sending station, its function being solely to reduce and substantially eliminate interference from atmospheric or static disturbances in a manner now to be explained.

When a static, atmospheric or natural disturbance is incident on a wireless system, the action thereon may be likened to the effect of a blow on a tuning fork; that is, natural or characteristic damped oscillations are set up. The periodicity and damping of said natural oscillations are dependent on the constants of the vibrating system. In the organization shown in Fig. 1, the receiving system and the auxiliary system are separate and distinct as regards natural oscillations, and therefore each oscillates in its own natural or characteristic damped period or periods in response to the static disturbance. It is well known that the natural oscillation of a loosely coupled circuit, such as the circuit 4, has a characteristic damping factor

$$\frac{R}{2L},$$

when R is the resistance of the circuit and L the inductance. By means, therefore, of the adjustable resistance elements 7 and 7′, the circuits 4 and 4′ may be adjusted to have the same characteristic damping factor, and therefore voltage drops across resistances 10 and 10′ will be of similar form though not necessarily of equal amplitudes. By adjustment of the relative amplifying powers of the amplifiers 11 and 11′, the voltage drops across 13 and 13′ may be made substantially equal. When this condition is attained the resultant current in the receiver 14 is zero and the receiver is unaffected by natural oscillations set up by static disturbances. It will be observed that the detectors 8 and 8′ interposed between the common receiver 14 and the antennæ 1 and 1′ make the voltage drops in resistances 10 and 10′ substantially independent of the frequencies of the natural oscillations occurring in circuits 4 and 4′ respectively.

Fig. 2 is a diagram of a second embodiment of my invention which differs from the organization shown in Fig. 1 in that the receiving antenna and the auxiliary antenna are embodied in a simple antenna structure having two branches, and repeating coils 18, 18′, 19, 19′ are substituted for the reactance coils 9, 9′, 12, 12′ and non-inductive resistances 10, 10′, 13, 13′ shown in Fig. 1.

It will be observed that, in order to substantially eliminate static interference in the receiving device, it is of the utmost importance that the high frequency natural oscillations occurring in the oscillation circuits 4 and 4′ shall be characterized by the same damping factors. This condition is attained by loosely coupling said circuits to the antennæ structures and adjusting said circuits to have the same time constants, that is each of the oscillation circuits 4 and 4′ is so loosely coupled to the antennæ as to render its natural oscillations practically dependent on its own electrical constants alone and also adjusted to make

$$\frac{R}{L}=\frac{R'}{L'}$$

when R and L are the resistance and inductance of circuit 4 respectively and R′ and L′ the resistance and inductance of circuit 4′ respectively. The same result may be obtained without the use of the oscillation circuits 4—4′ as shown in Fig. 3. This figure differs from Fig. 1 in the omission of condensers 6—6′ and resistances 7—7′, the equality of the damping factors in this case being attained by adjustment of resistance 17 in the antenna circuit. Other changes

will readily suggest themselves to those skilled in the art, and it will therefore be understood that the invention is not limited to the specific structures shown.

What is claimed is:

1. A wireless receiving system comprising a receiving antenna and an auxiliary antenna, a vacuum tube detector associated with said receiving antenna, a second vacuum tube detector associated with said auxiliary antenna, a receiving device connected through said detectors with said antennæ, and means, including adjustable resistance elements for controlling the damping factors of waves set up in the two antennæ, whereby the natural characteristic oscillations in said antennæ, consequent upon a static disturbance, oppose and substantially neutralize each other as regards the said receiving device.

2. A wireless signaling system comprising a receiving antenna circuit proper, an auxiliary antenna circuit, a detecting device connected to said receiving antenna circuit, a second detecting device connected to said auxiliary antenna circuit, a receiving device differentially connected to both of said detecting devices and means for amplifying disturbing oscillations in said circuits to approximately equal amplitude.

3. A wireless telegraph or telephone system comprising an antenna, a second auxiliary antenna, an oscillation circuit including inductance, capacity and resistance elements connected to first named antenna, a second oscillation circuit containing inductance, capacity and resistance elements connected to said auxiliary antenna, said oscillation circuits being adjusted to have the same damping factors, a detecting device connected to said first named oscillation circuit, a second detecting device connected to said second named oscillation circuit, an amplifying device whose input side is connected to said first named detecting device, a second amplifying device whose input side is connected to said second named detecting device and a receiving device differentially connected to the output side of both of said amplifying devices.

4. A wireless telegraph or telephone system comprising an antenna, a second auxiliary antenna, an oscillation circuit, including inductance, capacity and resistance elements, connected to said first named antenna; a second oscillation circuit containing inductance, capacity and resistance elements connected with said auxiliary antenna, a vacuum tube detector whose input side is connected to said first named oscillation circuit, a second vacuum tube detector whose input side is connected to said second named oscillation circuit, and a receiving device connected to the output side of both of said vacuum tube detectors in such a manner that the effects upon said receiving device of oscillations occurring in said oscillation circuits are opposed and substantially neutralized.

5. A wireless telegraph or telephone system comprising an antenna, a second auxiliary antenna, an oscillation circuit, including inductance, capacity and resistance elements, connected to said first named antenna, a second oscillation circuit containing inductance, capacity and resistance elements connected with said auxiliary antenna, a vacuum tube detector whose input side is operatively connected to said first named oscillation circuit, a second vacuum tube detector whose input side is connected to said second named oscillation circuit, a vacuum tube amplifier whose input side is connected to said first named detector, a second vacuum tube amplifier whose input side is connected to said second named detector; and a receiving device connected to the output sides of both said amplifiers, the constants of said oscillation circuits and the amplifying powers of said amplifiers being so adjusted that the receiving device is unresponsive to simultaneous natural oscillations occurring in said oscillation circuits.

6. A wireless system comprising a receiving antenna circuit proper, an auxiliary antenna circuit, two oscillation circuits responsive, respectively to natural oscillations of said antennæ circuits, a detecting device connected to one of said oscillation circuits, a second detecting device connected to the other of said oscillation circuits, a receiving device differentially connected to both of said detectors, and resistance elements included in said oscillation circuits and so adjusted that said receiving device is practically unaffected by the natural oscillations of said antenna circuits while responsive to signals which it is desired to receive.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses, this first day of September, A. D. 1915.

LLOYD ESPENSCHIED.

Witnesses:
P. H. BURNETTE,
E. H. DUISENBERG.