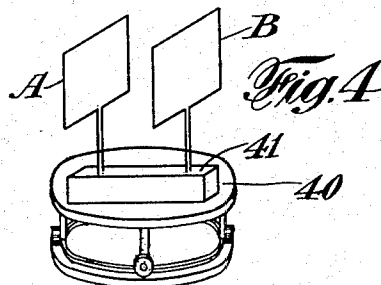
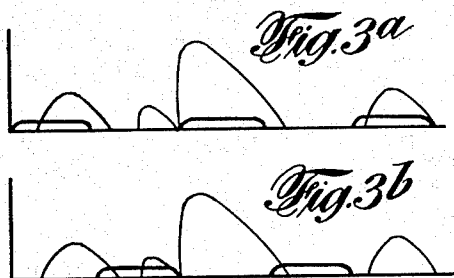
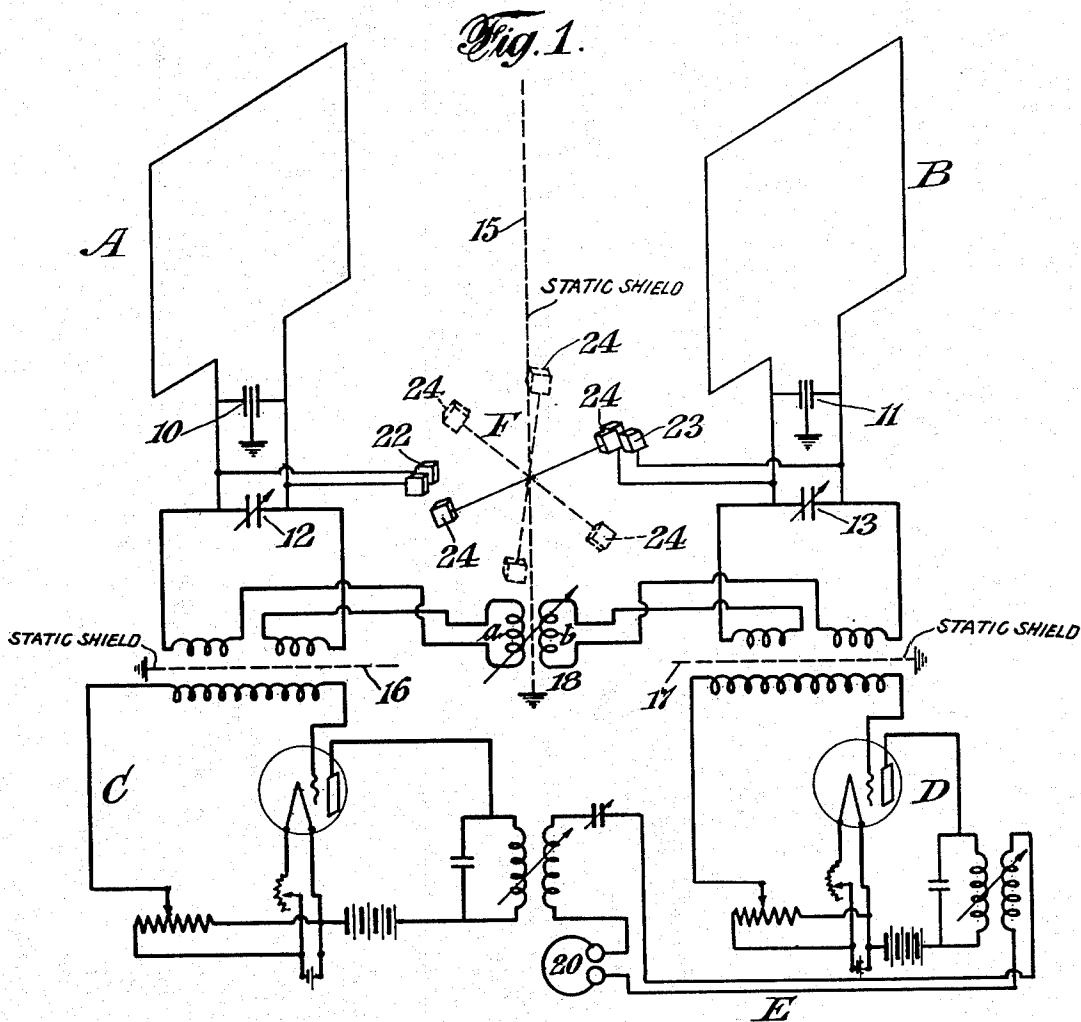


Oct. 16, 1923.

1,471,165

L. L. ISRAEL NOW BY JUDICIAL
CHANGE OF NAME L. L. JONES
RADIORECEPTION
Filed July 19, 1920

2 Sheets-Sheet 1



Inventor
Lester L. Israel, now by
judicial change of name,
Lester L. Jones.

BY *Arthur L. Kears*
his ATTORNEY

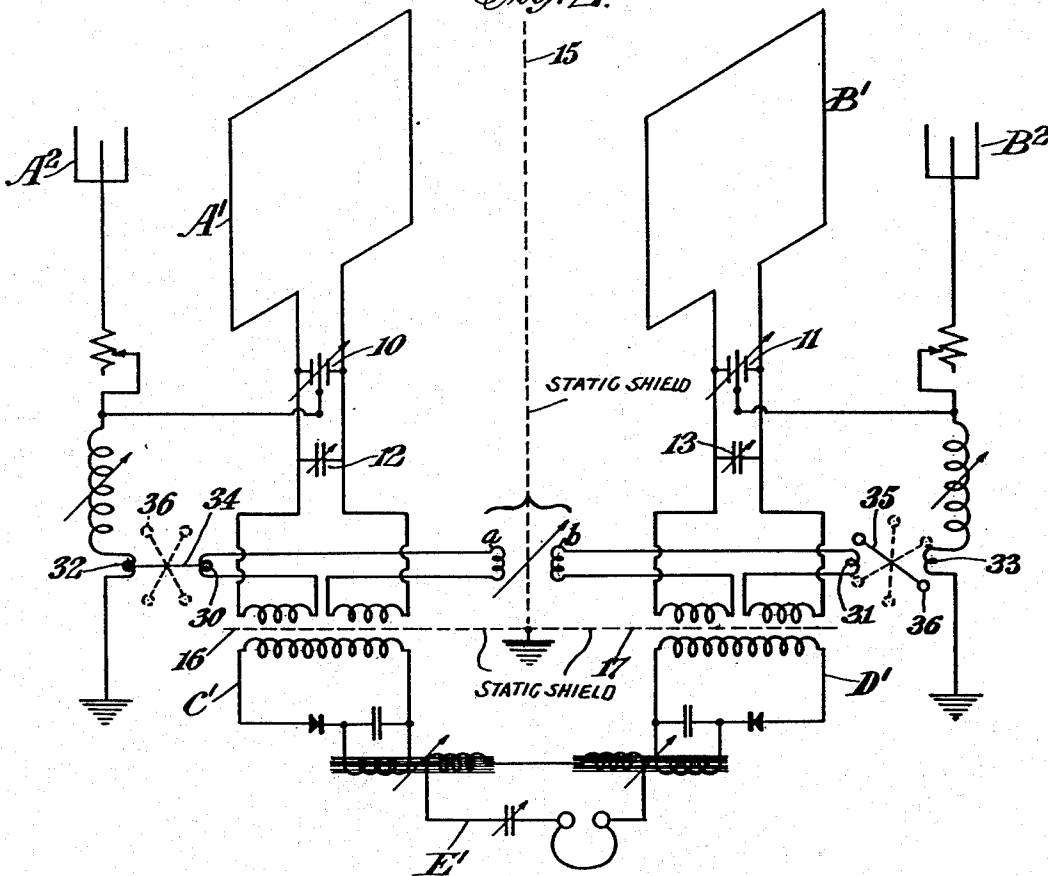
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2 Sheets-Sheet 2

Fig. 2.



Inventor

*Lester L. Israel, now by
judicial change of name,
Lester L. Jones.*

BY *Arthur H. Kent*
his ATTORNEY

UNITED STATES PATENT OFFICE.

LESTER L. ISRAEL (NOW BY JUDICIAL CHANGE OF NAME LESTER L. JONES), OF NEW YORK, N. Y.

RADIORECEPTION.

Application filed July 19, 1920. Serial No. 397,167.

To all whom it may concern:

Be it known that I, LESTER L. ISRAEL, now by judicial change of name LESTER L. JONES, a citizen of the United States, residing at New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Radioreception, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to a method and apparatus or system for the reception of radio signals. The invention aims to provide a receiving system whereby radio signals of low damping, and especially continuous waves, may be efficiently received with the exclusion of disturbances of all kinds resulting from waves or pulses of relatively high damping, or from waves differing in frequency from the signal waves. A further object of the invention is to provide a receiving system in which sustained wave signals are received in an indicator operable by audible frequency current produced by the periodic interruption method and which has the advantage that the whole available signal energy is absorbed from the wave field for operating the indicator. A further object of the invention is to provide a unilateral loop receiver which in addition to the usual advantage of directional elimination of such a receiver, shall have the property of substantially eliminating disturbances resulting from waves coming from directions from which the desired signal waves reach the receiver.

With these objects in view, the invention comprises a method wherein two receiving antennas, or absorbing means, are utilized which are designed to receive substantially equal amounts of wave energy of high damping or of frequency substantially different from the signal frequency, and greatly unequal amounts of signal energy of low damping, and wherein the currents produced by the energy absorbed in the two antennas are separately rectified and thereafter combined in opposition for operating the indicating means. The currents resulting from energy absorbed from waves of high damping, and from waves of a frequency substantially different from the signal fre-

quency, are thus caused to neutralize each other in the indicating circuit, while a signal current is produced in the indicating circuit by the absorbed signal wave energy of low damping and operates the indicating device free from disturbance. The two receiving antennas should be electrically alike, should have low and equal dampings, and should be in close proximity and electrically and magnetically decoupled one from the other. Loop antennas are best used because of the greater difficulty of decoupling open antennas. The loop antennas should both point in the same direction, and should most desirably be symmetrically placed with respect to surrounding objects. For convenience in adjusting the setting of the loops, it is desirable to use loops of fairly small dimensions.

In operation, the antenna through which the signal waves are to be received is tuned closely to the signal wave, and the other antenna is slightly detuned from the signal wave length. Such detuning should be sufficient to cause only a relatively small amount of signal energy to be absorbed by the detuned antenna, preferably to a wave length 1% or 2% shorter or longer than the signal wave length. The receiving antennas will then absorb greatly unequal amounts of signal energy of low damping, but will absorb substantially equal amounts of wave energy of high damping or of a frequency substantially different from the signal frequency. In receiving spark signals, one antenna may be permanently so detuned while the other serves alone for receiving the signal waves. For continuous wave reception by the periodic interruption method, I cause, according to my present invention, the two receiving antennas to be periodically in tune and slightly out of tune with the signal wave, one being detuned while the other is tuned to the signal wave, and the periodic tuning and detuning being at an audible frequency. In this way the signal currents are caused to alternate first in one loop and then in the other, and the whole available signal E. M. F. in the region of the antennas is absorbed, while the static, being more of a pulse or damped excitation, will excite both loops the same, and the loops being adjusted to have equal decre-

ments in the wave length range of variation under the action of the detuning means, the envelope of the static oscillations will be nearly identical.

5 The invention may be carried out with the use of unilateral loops by using an open antenna exciter for each loop, either aperiodic open antennas, or tuned open antennas which are detuned synchronously with the
10 respective loops with which they are associated.

A full understanding of the invention and the various features thereof can best be given by a detailed description in connection with diagrammatic representations of illustrative systems embodying and for practicing the invention, and such a description will now be given in connection with the accompanying drawings, in which:

20 Fig. 1 is a diagrammatic representation of a simple loop receiving system embodying and for practicing certain features of the invention;

Fig. 2 is a similar diagram of a unilateral
25 loop receiving system according to the invention;

Figs. 3^a and 3^b are diagrams illustrating the envelopes of the rectified currents from the two loop receiving circuits; and

30 Fig. 4 is a view illustrating a way of mounting the loops and co-acting circuits and apparatus.

Referring first to Fig. 1, the apparatus shown comprises two loop antennas A and B of the same electrical characteristics, the loop circuits being provided with the usual balancing condensers 10 and 11, and variable tuning condensers 12 and 13. The loops should have minimum coupling with
40 each other, which condition may be obtained by having them mounted not too close together and by providing static shields 15, 16 and 17 and an adjustable decoupler 18 having small coils *a* and *b* connected to the
45 respective loop circuits.

The antenna circuits each feed into a rectifying circuit, C and D respectively. The rectifying circuits may be of any suitable character. Fig. 1 shows simple electron
50 tube or audion circuits each having in addition to the secondary of the radio frequency transformer by which it is coupled to one of the antenna circuits, a coil forming the primary of an audio frequency transformer by which the rectifying circuit is coupled to
55 an indicating circuit E common to both rectifying circuits and provided with an audio frequency indicating device 20, usually a telephone receiver as shown.

60 The loop circuits should be constructed to have low and equal dampings, and for sustained wave reception and for the most efficient elimination of static and avoidance of disturbance resulting from other highly
65 damped waves and interference by waves

of low damping but of widely different wave length from the signal wave, the two loop circuits are tuned to the signal wave, as by means of the variable condensers 12 and 13 in the arrangement shown, and are periodically and alternately slightly detuned by means of periodic detuning means such as means for periodically varying the capacity or inductance of the circuits. In the arrangement shown in Fig. 1 there is provided a tone condenser device F comprising
70 condenser elements 22 and 23 connected in the circuits of the loops A and B respectively, and a rotor carrying a plurality of condenser elements 24. This device is adjusted and operated to detune the loops by 1% or 2% alternately at a suitable audio frequency, most desirably of the order of 300 to 1000 cycles, and in such manner that each loop is detuned for approximately one-half
75 the time or slightly more, and that when one loop is in tune the other is out of tune. Signal currents resulting from signal waves absorbed by the loops will thus alternate first in one loop and then in the other, and since the two loops are always out of tune with each other, their reaction on each other and on the signal wave field is negligible and the whole available signal energy in the region of the loops is absorbed.
80 The static, however, being more of a pulse or damped excitation, will not be affected by the periodic detuning of the loop circuits, but will excite both loops equally even though they are relatively detuned, and the loops being adjusted to have equal decrements in the wave length range of variation under the action of the detuning means, the envelopes of the static oscillations will be nearly identical; and the same is true in the case of waves of low damping but of widely different wave length from the signal wave, since the forced oscillations of such interfering wave frequency will have practically the same amplitude in the two antennas.
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The loop circuit currents being impressed on the rectifying circuits C and D, the signal currents give rise to rectified audio frequency currents as indicated by heavy lines in Figs. 3^a and 3^b, the currents in the two circuits being opposite in phase, and the static or other disturbing currents give rise to rectified currents as indicated by light lines in Figs. 3^a and 3^b which are in phase. These rectified currents produced in the rectifying circuits being applied to the indicating circuit are combined in opposition in the indicating circuit and produce opposing E. M. F.'s in the telephone or other detecting device. The static and other disturbing E. M. F.'s will approximately counterbalance each other and have no effect on the telephone, and the signal E. M. F.'s will produce an alternating current which may be made to be of approximately sinusoidal
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form. The indicator circuit is best when of fairly low damping and resonant to the tone condenser frequency. This circuit may then be loosely coupled with the rectifying circuits so as to minimize reaction between these circuits.

Any suitable amplifying means adapted for amplifying without distortion of amplitudes may be provided in the system for amplifying the currents either before or after rectification, and if desired, amplification may take place after the separately rectified currents have been combined.

Fig. 2 shows diagrammatically a unilateral loop receiving system which is similar to that shown in Fig. 1 in having two loop antennas A' and B' of the same electrical characteristics, the circuits of which are decoupled by means of static shields 15, 16 and 17 and decoupling coils a and b, and in having the loop circuits coupled to rectifying circuits C' and D' respectively, which rectifying circuits are in turn both coupled to a common indicating circuit E'. As in Fig. 1, the rectifying circuits are inductively coupled to the respective loop circuits and to the common indicating circuit; but the audio frequency transformers coupling the rectifying circuits to the indicating circuit are, however, in this figure shown as iron core transformers, and the rectifying circuits are provided with crystal rectifiers.

Coupled to each loop antenna is an open antenna, A² and B² respectively, for limiting the directional receptivity of the loops. Aperiodic open antenna exciters may be used with fairly good results, but most desirably tuned open antennas are employed, each such antenna being as nearly as possible in tune with its corresponding loop antenna, and when the loop antennas are detuned alternately the associated open antennas are detuned correspondingly and synchronously with the loops with which they are associated. Such periodic detuning may be effected by any suitable means. In Fig. 2 there is shown means for effecting such detuning by varying the inductance of the antenna circuits, such means comprising small inductance elements or coils 30 and 31 connected in the circuits of the loops A' and B' respectively, and similar coils 32 and 33 connected in the open antenna circuits A² and B² respectively, and rotors 34 and 35 each carrying a plurality of inductance elements 36. The rotor 34 is operated to detune the loop circuit A' and its associated open antenna circuit A² simultaneously and periodically at a suitable audio frequency, and the rotor 35 is operated to detune the loop circuit B' and its associated open antenna circuit B² simultaneously and periodically at the same audio frequency, and the two rotors operate in synchronism to detune the respective pairs of circuits, A', A² and B', B², alternately

and in such manner that each pair of circuits is detuned for approximately one-half the time or slightly more, and that when one pair is in tune the other is out of tune. The detuning means is desirably adjusted to detune the antenna circuits by 1% or 2%.

The tone inductance devices may be connected in any suitable manner in series or in parallel with the respective loops so as to detune the loops by the inductance variation, but are best connected in series with the transformer coils and at their mid-points as shown. The open antennas might be coupled inductively with the loop antennas, but I find it most desirable to employ capacitive coupling through connection through the balancing condensers 10 and 11 of the loop circuits as shown in Fig. 2, and in this case the energy receptivity of the open antenna should be from one to five times that of the loop. This way of coupling has the advantage of being more constant on different wave lengths and of giving only one degree of freedom to the loop and open antenna system.

A receiving system or apparatus such as shown in Fig. 2 will operate to receive signal waves and to exclude disturbances in the same way as the apparatus of Fig. 1, the open antenna exciters serving the usual purpose of limiting the directional receptivity of the loop, and currents resulting from energy absorbed by these open antennas from waves of high damping and from waves of a frequency substantially different from the signal frequency being caused to neutralize each other in the indicating circuit in the manner already explained. The open antennas should, as in the case of the loop antennas, be electrically alike, and should have equal dampings. The damping of the system will be nearly as low as the damping of the loop even though the open antennas have a very high damping.

As stated, the invention is effective not only in avoiding disturbance due to static and other waves of high damping, but also in eliminating interference due to waves of low damping but of widely different wave length from the signal wave, and this is so even when such interfering waves are from nearby high power transmitters. This elimination is due, I believe, to the fact that the forced oscillations of interfering wave frequency have practically the same amplitude in the two antennas, so that their rectified currents when combined in opposition in the indicating circuit balance. As the interfering wave approaches the frequency of the signal wave the elimination becomes less and less, but such waves which would not otherwise be eliminated may be eliminated by adjusting the antennas so that they detune on opposite sides of the resonant point

for the signal wave, and by loosening the coupling between the indicating circuit and that antenna whose natural frequency is nearer the interfering wave. In this manner the interfering wave current is always a definite amount stronger in one antenna than the other, but the rectified currents are again balanced through the unbalanced coupling to the indicating circuit. This way of operating, however, results in an increase of static disturbance and a slight decrease of received signal intensity, and is, therefore, useful only under certain circumstances.

As stated, the receiving antennas should for best results be symmetrically placed with respect to the surrounding objects. Otherwise the two antennas will not be equally excited by the static impulses and other forms of electromagnetic disturbance. This is principally a matter of proper adjustment of the angle between the axes of the loops and the signal wave direction to symmetry with the surrounding objects. In order that the desired adjustment may be readily made, the loops are most desirably mounted on a rotatable support. Such an arrangement is shown by Fig. 4 in which the loops are mounted on a platform 40 which is rotatable about an upright axis and on which the other elements of the receiving system, represented in this figure by the casing 41, are also most desirably mounted.

In the preceding description and explanation of the invention I have sought to point out the features and conditions necessary for best results in the use of my invention, and more particularly in the illustrative systems shown in the drawings and to which the description more especially applies. I may further state that in order to make the invention most effective under all conditions, the two antennas should be effectively shielded from excitation by so-called contact static, as by the use of static shields, because this form of excitation is not equally applied to both antennas; that the rectifying means used should be such as do not change the damping of the antennas when oscillation currents of different amplitudes are being rectified; that the oscillatory circuits should be constructed so as to have no change of damping over the range of wave length variation used; and that the two antennas should have equal radiation receptivity, especially to waves or pulses of high damping.

What is claimed is:

1. In the art of radio reception, the method of receiving signals which comprises absorbing electro-magnetic energy from the atmosphere in two antennas having low damping and approximately the same electrical characteristics, setting the antennas in close proximity and to receive

from the same direction, preventing transfer of energy between the antennas, tuning one antenna to the signal wave and slightly detuning the other therefrom, rectifying the currents generated in each of said antennas, combining in opposition forces due to the rectified currents, and operating an indicating means by the resultant force.

2. In the art of radio communication, the method of receiving signals which comprises absorbing electromagnetic energy from the atmosphere in two receiving antennas, periodically and alternately tuning said receiving antennas to and slightly detuning them from the signal wave, rectifying the currents originating in each of the antenna systems, and combining the rectified currents in opposition in an indicating circuit.

3. In the art of radio communication, the method of receiving signals which comprises absorbing electro-magnetic energy from the atmosphere in two receiving antennas, periodically and alternately tuning said receiving antennas to and slightly detuning them from the signal wave, said periodic tuning and detuning being at audio frequency, rectifying the currents originating in each of the antenna systems, and combining the rectified currents in opposition in a connecting circuit.

4. A radio receiving system, comprising in combination two receiving antennas, means for periodically tuning and slightly detuning each antenna with respect to the frequency of the signal wave, one antenna being detuned while the other is tuned to the signal wave and the periodic tuning and detuning being at an audible frequency, means for rectifying oscillatory currents produced by the energy absorbed by each of said antennas, and means for combining the rectified currents in opposition.

5. A radio receiving system, comprising in combination two receiving antennas designed to absorb substantially equal amounts of wave energy of high damping and unequal amounts of signal wave energy of low damping, means for periodically tuning and slightly detuning each antenna with respect to the frequency of the signal wave, one antenna being detuned while the other is tuned to the signal wave and the periodic tuning and detuning being at an audible frequency, means for rectifying oscillatory currents produced by the energy absorbed by each of said antennas, means for combining in opposition forces due to the rectified currents, and indicating means operated by the resultant force.

6. A radio receiving system, comprising in combination two receiving antennas designed to absorb substantially equal amounts of wave energy of high damping and unequal amounts of signal wave energy of low damping, means for periodically tuning and

slightly detuning each antenna with respect to the frequency of the signal wave, one antenna being detuned while the other is tuned to the signal wave and the periodic tuning and detuning being at an audible frequency, means for rectifying oscillatory currents produced by the energy absorbed by each of said antennas, and means for applying the rectified currents in opposition to a common indicating circuit.

7. A radio receiving system, comprising two receiving antennas in close proximity and means for electrically and magnetically decoupling said antennas, said antennas having similar directional receiving characteristics and being arranged for the same directional reception and one being tuned to the signal wave and the other being slightly detuned therefrom in combination with means for rectifying oscillatory currents produced by the energy absorbed by each of said antennas, and means for combining the rectified currents in opposition.

8. A radio receiving system, comprising two receiving antennas in close proximity and means for electrically and magnetically decoupling said antennas, said antennas having low damping and directionally equal radiation receptivity and the same electrical characteristics except that one is tuned to the signal wave and the other is slightly detuned therefrom, in combination with means for rectifying oscillatory currents produced by the energy absorbed by each of said antennas, and means for combining the rectified currents in opposition.

9. A radio receiving system, comprising two receiving antennas in close proximity, means for electrically and magnetically decoupling said antennas, means for periodically tuning and slightly detuning each antenna with respect to the frequency of the signal wave, one antenna being detuned while the other is tuned to the signal wave and the periodic tuning and detuning being at an audible frequency, means for separately rectifying the oscillatory currents originating in each of the antenna circuits, and means for applying the rectified currents in opposition to a common indicating circuit, whereby the electro-motive forces of the two rectified currents counterbalance each other when said currents are equal in amplitude and phase.

10. A radio receiving system, comprising in combination two receiving antennas in close proximity and electrically and magnetically decoupled one from the other, means for periodically tuning and slightly detuning each antenna with respect to the frequency of the signal wave, one antenna being detuned while the other is tuned to the signal wave and the periodic tuning and detuning being at an audible frequency,

two rectifying circuits one fed from each of the antenna circuits, and a common indicating circuit to which currents from said rectifying circuits are applied in opposition.

11. A radio receiving system, comprising in combination two like loop antennas in close proximity and pointing in the same direction, means for electrically and magnetically decoupling said antennas, means for rectifying oscillatory currents produced by the energy absorbed by each of said antennas, and means for combining the rectified currents in opposition.

12. A radio receiving system, comprising in combination two like loop antennas in close proximity and pointing in the same direction, means for electrically and magnetically decoupling said antennas, means for periodically tuning and slightly detuning each antenna with respect to the frequency of the signal wave, one antenna being detuned while the other is tuned to the signal wave, and the periodic tuning and detuning being at an audible frequency, means for separately rectifying oscillatory currents originating in each of the antenna circuits, and means for applying the rectified currents in opposition to a common indicating circuit, whereby the electro-motive forces of the two rectified currents counterbalance each other when said currents are equal in amplitude and phase.

13. A radio receiving system, comprising in combination two like unilateral antennas in close proximity set for reception from the same direction, means for electrically and magnetically decoupling said antennas, means for rectifying oscillatory currents produced by the energy absorbed by each of said antennas, and means for combining in opposition forces due to the rectified currents.

14. A radio receiving system, comprising in combination two like unilateral antenna systems each comprising a tuned loop antenna of low damping and a tuned open antenna of high damping capacitively coupled thereto, said antenna systems being set for reception from the same direction, means for electrically and magnetically decoupling said antennas, means for rectifying oscillatory currents produced by the energy absorbed by each of said antennas, and means for combining in opposition forces due to the rectified currents.

15. A unilateral receiving antenna system comprising a tuned loop antenna of low damping and a tuned open antenna of high damping capacitively coupled thereto.

16. A radio receiving system, comprising two loop antennas mounted in spaced relation on a support which is rotatable about an upright axis.

17. A radio receiving system, comprising

two loop antennas mounted on a support which is rotatable about an upright axis, each loop antenna being mounted to rotate about its own axis.

- 5 18. A radio receiving system, comprising two loop antennas mounted on a rotatable support, means for electrically and magnetically decoupling said antennas, tuning means for said loops, means for rectifying
10 oscillatory currents produced by the energy absorbed by each of said antennas, and

means for combining the rectified currents in opposition, all said means being mounted on said rotatable support.

In testimony whereof I have hereunto 15 set my hand in the presence of two subscribing witnesses.

LESTER L. ISRAEL.

Witnesses:

ETHEL JOHNES,
A. L. KENT.