June 19, 1923. 1,459,308

D. G. McCAA

SIGNALING APPARATUS

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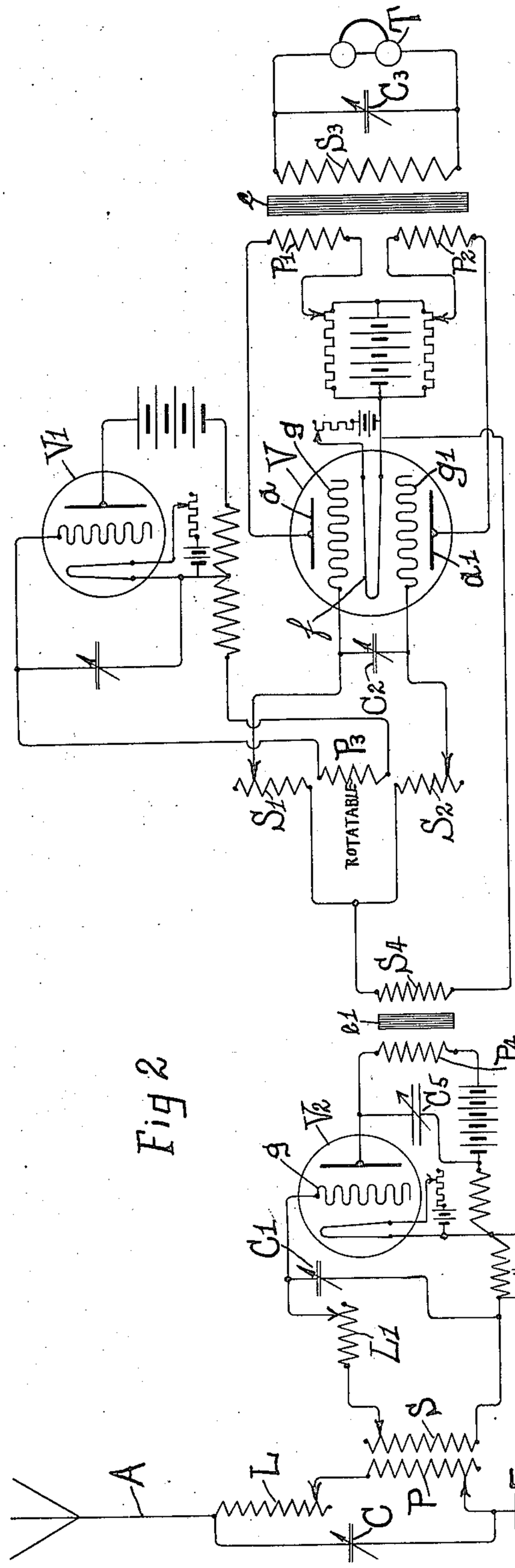

Fig 2

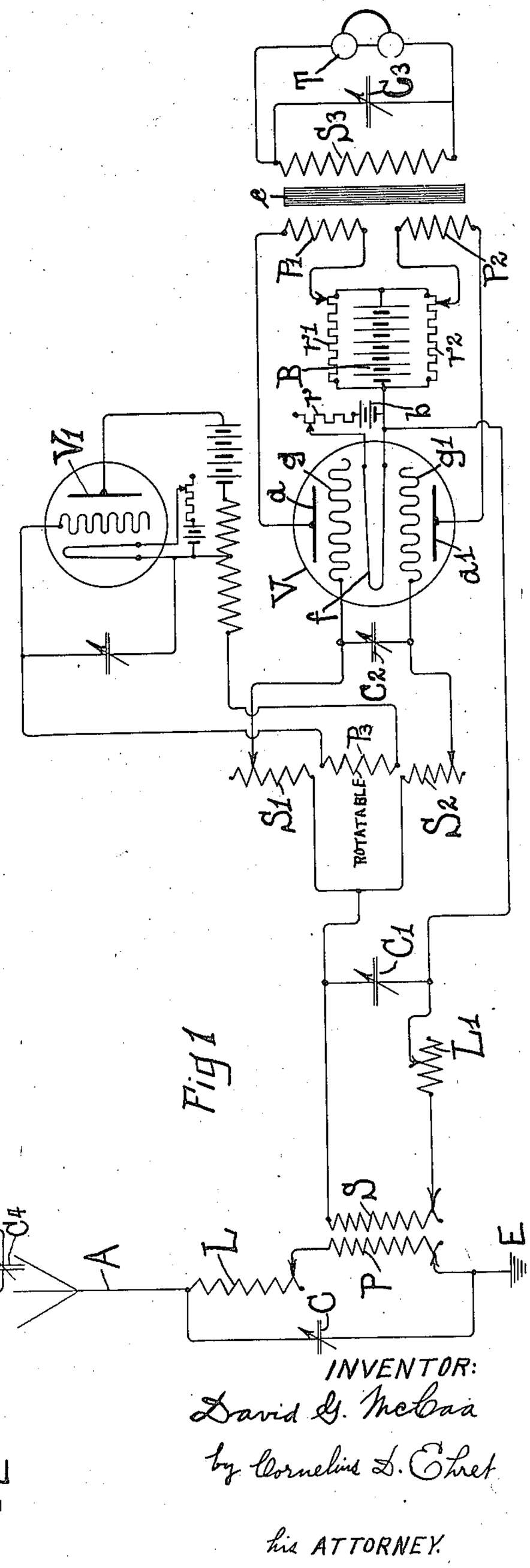

Fig 1

INVENTOR:
David G. McCaa
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his ATTORNEY.

Patented June 19, 1923. 1,459,308

UNITED STATES PATENT OFFICE.

DAVID G. McCAA, OF LANCASTER, PENNSYLVANIA, ASSIGNOR OF ONE-THIRD TO FEDERAL TELEGRAPH COMPANY, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

SIGNALING APPARATUS.

Application filed April 6, 1920, Serial No. 371,674. Renewed November 3, 1921. Serial No. 512,572.

To all whom it may concern:

Be it known that I, DAVID G. McCAA, a citizen of the United States, residing in the city of Lancaster, county of Lancaster, State of Pennsylvania, have invented a new and useful Signaling Apparatus, of which the following is a specification.

My invention relates to electrical communication of signals or intelligence, telegraphically, telephonically, or otherwise, by recourse to high frequency waves, whose energy is transmitted in electro-radiant form through the natural media between stations.

It is the object of my invention to render practically harmless in or substantially eliminate from radio receiving systems the effects of natural electricity, as atmospheric disturbances, static, strays, etc., or other interfering electrical effects.

In accordance with my invention, and as described in my original application Ser. No. 342,355, filed December 4, 1919, the oscillations in the radio receiving system corresponding with the undamped waves representing a desired signal and the oscillations present in the receiving system and corresponding with or due to static, atmospherics, strays or undesired signals, are caused to act through the employment of a plurality of detectors differentially or in such wise upon the signal translating instrument, as a telephone, to produce no audible effect; and locally produced oscillations are so utilized, however, as to produce beats with the oscillations representative of the desired signal, and these beats operate cumulatively upon the signal translating instrument to produce an audible signal, the locally produced oscillations so reacting with the other aforesaid oscillations in the receiving system as to produce in the signal translating instrument no audible effect, or an effect which is small or not materially interfering with the desired audible signal.

Further in accordance with my invention, the locally produced oscillations are adjusted as to their amplitude in their reaction with the oscillations in the receiving system representative of the desired signal and disturbing electrical effects whereby the audibility of the beats effected by the oscillations representing the desired signal is rendered sufficiently great compared with the audibility of the beat effects due to the oscillations representing the disturbing effects that the desired signal is readily heard and differentiated from any audible effects due to the disturbances, even when the oscillations in the receiving system due to the disturbances have amplitudes far greater than the amplitude of the oscillations representing the desired signal.

For an illustration of some of the various forms my invention may take, reference is had to the accompanying drawing, in which:

Fig. 1 is a diagrammatic view of receiving apparatus embodying my invention and involving primary beats.

Fig. 2 is a diagrammatic view of a modification involving both primary and secondary beats.

Referring to Fig. 1, A represents generically any receiving conductor, as an antenna, of open circuit, loop, coil or any other suitable type, or a line conductor extending to the receiving station.

In series between the antenna and earth or other capacity E are serially connected the adjustable loading inductance L and the adjustable primary P of an oscillation transformer, a variable condenser C being connected in parallel with L and P if suitable or desirable, particularly for tuning to the frequency of the received signal waves.

Inductively coupled with the primary P is the adjustable secondary S connected in a circuit with adjustable inductance L^1 and variable condenser C^1 for bringing said circuit into resonance with the circuit or path of the primary P.

S^1 and S^2 are substantially equal or similar inductances or oscillation transformer secondaries, one terminal of each of which is conductively connected with the circuit of the secondary S, preferably to one terminal of the condenser C^1. The other terminals of the coils S^1 and S^2 are connected, respectively, with the grids g and g^1 of thermionic devices whose electrodes may be in different bulbs or tubes or, as indicated, may be disposed within the same vacuum in the bulb or tube V. In series with the coils S^1 and S^2, or connected across the grids g and g^1, is the variable condenser C^2 for rendering the circuit resonant with the locally produced oscillations. Co-acting with the grid g is the plate or anode a in whose external circuit is connected the transformer primary P^1 and a variable portion of the resistance r^1

bridging the anode circuit battery B, the circuit being completed to the hot cathode or filament f, the latter being traversed by current from the battery b, the current strength being variable by the adjustable resistance r. Similarly, the anode a^1 co-acting with grid g^1 has its external circuit connected through the primary P^2 and the variable resistance r^2.

A second connection is made from the circuit of the secondary S, preferably from the other terminal of the condenser C^1, to the cathode or filament f.

The primaries P^1 and P^2 produce equal and opposite effects upon the secondary S^3, which may be bridged by the variable tuning condenser C^3, and in whose circuit is connected the translating instrument, as a telephone T. With the primaries P^1, P^2 and secondary S^3 may be employed, if suitable or desirable, the magnetizable core structure c.

The apparatus as thus far described operates as follows:

The energy received upon the antenna structure A and through the coils S^1 and S^2 impress equal electro-motive-forces upon the grids g and g^1, which effect equal current changes in the circuits of their associated anodes. The current changes in the primaries P^1 and P^2 are therefore equal, and since these primaries oppose each other in their inductive effects upon the secondary S^3, no current is induced in the secondary S^3, and there is no response by the telephone T. In other words, the effects of the received energy and any effects, oscillatory or otherwise, produced by atmospheric disturbances, natural electricity, strays, static, etc., have no effect upon the telephone T.

To vitalize the system and to cause response to the received signal energy to the substantially complete elemination or exclusion of all other disturbing effects, there is inductively related to the secondaries S^1 and S^2 the primary P^3, so connected or disposed as to affect the secondaries S^1 and S^2 oppositely and substantially equally. The coil P^3 is preferably rotatable toward and from the position in which maximum inductive effects are produced upon the secondaries S^1 and S^2, whereby those inductive effects are variable.

The primary P^3 is traversed by oscillations preferably of radio or inaudible frequency, differing from the frequency of the received energy, produced by the thermionic oscillator V^1 or any other other suitable source of oscillations, as an arc, dynamo-electric generator, etc.

When the primary P^3 is traversed by oscillations as aforesaid, the operation is as follows:

The oscillations in the secondaries S^1 and S^2 due to the received energy react with the oscillations induced therein by the primary P^3 to form beats which for telegraphy are of audible frequency and for telephony of inaudible frequency. The beats in the secondaries S^1 and S^2 are opposite in phase and substantially equal, with the result that the beat electro-motive-forces impressed upon the grids g and g^1 cause the current in the primary P^1 to change in one sense while the current in the primary P^2 changes in opposite sense, and to equal extent, with the result that the primaries P^1 and P^2 as regards the best effects operate cumulatively upon the secondary S^3, whose circuit may be attuned to the beat frequency by the condenser C^3, and which produces current of beat frequency in the telephone T, which reproduces sound of beat frequency, the sound being of audio frequency in the case of telegraphy and being speech in the case of telephony when the beats era of inaudible frequency.

The effects of atmospheric disturbances, static, strays, etc. are such as not to react effectively with the oscillations induced by primary P^3 in the secondaries S^1 and S^2, the disturbing effects being balanced out as regards the detector action of the thermionic device V or other rectifying or equivalent detecting means, while the received signal energy reacts to produce the beats aforesaid, which makes possible the reception of desired signal energy.

The rotation of primary P^3 and adjustment of condenser C^2 makes possible relatively different effects. With the condenser C^2 adjusted to zero or substantially zero capacity, and the coil P^3 rotated to such position that its inductive effect upon S^1 and S^2 is very small, weak locally produced electro-motive-forces are impressed upon the grids g and g^1. This relation is desirable in the case of weak received signals during existence of strong static or other disturbances. Or the condenser C^2 may be adjusted to such capacity as to tune the circuit of the secondaries S^1 and S^2 to the locally produced oscillations and the coil P^3 rotated to position to strongly affect coils S^1 and S^2, this latter relation being suitable for a condition when received signaling energy is relatively strong.

It will therefore be apparent that, as in my aforesaid application Ser. No. 342,355, the desirable effects are procured by suitably relating the amplitude of the locally produced oscillations to the amplitude of the received signal energy. Preferably the amplitude of oscillations induced in the coils S^1 and S^2 by the primary P^3 is adjusted, as by adjusting the position of the coil P^3, or by any other equivalent means, to substantial equality with the amplitude of the oscillations in coils S^1 and S^2 due to the received energy. With this relation existing, weak

signals are readily receivable through strong static or other disturbances, the ratio of the amplitude of the current in coils S^1 and S^2 induced therein by the primary P^3 being small as compared with the amplitude of the current in the coils S^1 and S^2 due to the strong static or other disturbances. Accordingly, the beat effect as between received signal energy and the locally produced energy is of a character more suitable for affecting the telephone T through the couplings P^1, P^2 and S^3 than the imperfect beat effect due to strong static or other disturbances reacting with the locally produced oscillations; in other words, the sustained waves of the received energy affect the telephone T only by beat effect, while the strong static simultaneously occuring produces imperfect beat effect, the static effects operating chiefly by detector action which is substantially perfectly balanced out, and such balance is but slightly disturbed by the presence of weak locally produced oscillations.

Accordingly, it is desirable, as above stated, to cause the amplitude of the locally produced oscillations to be substantially equal to the amplitude of the oscillations representing the desired signal, whereby in their reaction in the production of beats the beat-representing current fluctuates between zero value and a value substantially twice the amplitude of the oscillations representing the received signal. If the oscillations simultaneously existing in the receiving circuit due to received energy other than that of the desired signal are of relatively greater amplitude, though of the same frequency as the oscillations representing the desired signal, the reaction with the locally produced oscillations of amplitude substantially equal to the amplitude of the weaker received signal oscillations causes beats which are imperfect in the sense that the beat-representing current fluctates between magnitudes equal to the sum of the amplitude of the locally produced oscillations and the amplitude of the oscillations of the distrubing effects and a minimum value which is the difference between those amplitudes. That is to say, the change in amplitude of the beat-representing current is substantially the same as the change between zero and maximum amplitude of the beat-representing current due to the oscillations representing the desired signal. In consequence, the effect upon the signal translating instrument, as a telephone, may be about the same as regards the effects of the desired signal and the disturbances, with the result that the relatively weak signal produces an effect substantially equal to the considerably stronger disturbing effect. In other words, the ratio of the effect produced by the received signal to the effect produced by the disturbances is increased, so that the signal may be readily read, though the static or other disturbances be of an amplitude many times the amplitude of the relatively weak received signal. It will be understood, also, that the beats produced with the oscillations representing the static, strays, atmospherics and the like are at a disadvantage in their effect upon the signal translating instrument because such oscillations are decadent, and relatively imperfect beats are produced which affect the signal translating instrument to relatively less extent that the perfect beats produced with the undamped oscillations representing the desired signal.

It will be understood that the condenser C^2 is not essential; it is employed, as stated, when it is suitable or desirable for tuning the circuit of the coils S^1 and S^2 to the frequency of the locally produced oscillations.

While the foregoing has dealt with the reception of signals represented by undamped or sustained waves, the apparatus described is utilizable also for receiving signals from stations emitting decadent wave trains, as for example, in the case of transmitting apparatus employing spark gaps. Assuming the spark signals to be weak with simultaneously existing strong static effects, the frequency of the locally produced oscillations is made substantially equal to the frequency of the received decadent signal waves, and the amplitude of the effects on the coils S^1 and S^2 by the locally produced oscillations is made weak, in which case both the disturbing static or other effects and the received signals are manifested in the telephone T, but are of equal strength or amplitude, and for that reason the signals are readily distinguishable from the static or other disturbances. In this case, while static is not eliminated, its effect is so greatly reduced as to permit reading of the spark signals.

In Fig. 2 there is illustrated an arrangement whereby both primary and secondary beat effects may be produced. In this case the electro-motive-forces in the circuit of the secondary S, tuned to the sustained received energy by adjustable inductance L^1 and variable condenser C^1, are impressed upon the grid g of the thermionic oscillator V^2, whose variable condensers are C^4 and C^5, producing oscillations of radio or inaudible frequency differing from the frequency of the received energy to produce beats of inaudible frequency in the case of telegraphy and in the case of telephony. The beat current in the anode circuit of the oscillator V^2 traverses the primary P^4 coupled with the secondary S^4, the magnetizable core structure c^1 being employed when suitable or desirable, particularly in the case of audio frequencies. The connection of the second-

ary S^4 to the remainder of the apparatus is similar to the connection of the secondary S with the remainder of the apparatus of Fig. 1, the circuit of secondary S^4 being aperiodic. There exist in the secondaries S^1 and S^2 currents of beat frequency, and the circuit of these secondaries may be turned to the frequency of the oscillations produced by V^1 by the variable condenser C^2, it being understood that condenser C^2 may be omitted, in which case said circuit is aperiodic. The oscillator V^1 again produces oscillations of a frequency causing production in the grid circuits of the secondaries S^1 and S^2 of secondary beats of audible frequency for telegraphy and inaudible frequency for telephony.

When the oscillator V^1 is inoperative, the effects of the received energy and the beats produced therewith by the oscillator V^2 upon the secondary S^3 and telephone T is zero. When the oscillator V^1 is in operation, however, the secondary beats, which are opposite in phase and substantially equal, are caused by primaries P^1 and P^2 cumulatively to affect the secondary S^3, with resultant production of sound by the telephone T, such sound being an audible note for telegraphy and speech in the case of telephony when the secondary beats are above audibility.

By this arrangement also the effects of static or other disturbances are eliminated, while the desired signal energy causes response by the telephone T.

The system of Fig. 2 is in general similar to that of Fig. 1, except that the secondaries S^1 and S^2 are traversed by primary beat currents which react with the oscillations induced therein by the primary P^3 to produce secondary beats. The effect of static or like disturbances is to cause the production in the circuit of the primary P^4 of great current changes of audible frequency as a result of detector action of the thermionic device V^2, and such action overshadows any reaction of the static energy with the oscillations locally produced by the oscillator V^2. In consequence, there is induced in the circuit of the secondary S^4 like currents of large amplitude of audio frequency, such audio frequency being, due to the nature of static effects, relatively low. Such relatively low audio frequency in the coils S^1, S^2 will not react with the oscillations locally produced by the device V^1 to produce a beat effect audible in the telephone T. But the sustained signal waves produce beats of inaudible frequency with the oscillations from the oscillator V^2, with transfer to the circuit of the secondary S^4 of beat currents of similar inaudible frequency, which approaches the frequency of the oscillations produced by the device V^1 far more closely than the aforesaid low audio frequency due to the static effects. The result is the production of secondary beats of audible frequency for telegraphy and inaudible frequency for telephony which affect the telephone T, which reproduces the signals.

It will be understood that between the secondaries S^3 of Figs. 1 and 2 and the telephone T may intervene any suitable amplifying devices, as thermionic amplifiers, of one or any other suitable number of steps.

While in Fig. 1 an inductive coupling PS intervenes between the circuit containing coils S^1, S^2 and the antenna circuit or path, it will be understood that such inductive coupling may be supplanted by a conductive coupling. And similarly, in Fig. 2, in lieu of the inductive coupling P^4, S^4 a conductive coupling may be made between the circuit containing coils S^1, S^2 and the anode or plate circuit of the thermionic device V^2.

What I claim is:

1. Apparatus for receiving signals represented by undamped waves of radio frequency and for reducing the disturbing effects of simultaneously received energy comprising a receiving structure, signal translating means, detecting circuits differentially affecting said signal translating means, a local source producing oscillations reacting with the received oscillations representing the desired signal and the simultaneously received energy to produce opposing beats cumulatively affecting said signal translating means, and means for adjusting the amplitude of said locally produced oscillations in their reaction with said oscillations for relatively increasing the effect upon said signal translating means of the beats representing the desired signal.

2. Apparatus for receiving signals represented by undamped waves of radio frequency and for reducing the disturbing effects of simultaneously received energy comprising a receiving structure, signal translating means, detecting-rectifying circuits differentially affecting said signal translating means, a local source producing oscillations reacting with the received oscillations representing the desired signal and the simultaneously received energy to produce opposing beats cumulatively affecting said signal translating means, and means for adjusting the amplitude of said locally produced oscillations in their reaction with said oscillations for relatively increasing the effect upon said signal translating means of the beats representing the desired signal.

3. Apparatus for receiving signals represented by undamped waves of radio frequency and for reducing the disturbing effects of simultaneously received energy comprising a receiving structure, signal translating means, detecting circuits differentially affecting said signal translating means, a

secondary winding for each of said circuits, a primary winding coacting with said secondary windings, and a local source producing oscillations in said primary winding reacting with the received oscillations representing the desired signal and the simultaneously received energy to produce opposing beats cumulatively affecting said signal translating means, said primary and secondary windings being relatively movable for adjusting the amplitude of the oscillations induced in said secondary windings for relatively increasing the effect upon said signal translating means of the beats representing the desired signal.

4. Apparatus for receiving signals represented by undamped waves of radio frequency and for reducing the disturbing effects of simultaneously received energy comprising a receiving structure, signal translating means, detecting circuits differentially affecting said signal translating means, a secondary winding for each of said circuits, a primary winding coacting with said secondary windings, and a local source producing oscillations in said primary winding reacting with the received oscillations representing the desired signal and the simultaneously received energy to produce opposing beats cumulatively affecting said signal translating means, said primary winding being rotatable relatively to said secondary windings for adjusting the amplitude of the oscillations induced in said secondary windings for relatively increasing the effect upon said signal translating means of the beats representing the desired signal.

5. Apparatus for receiving signals represented by waves of radio frequency comprising a receiving conductor, a plurality of windings, a conductive connection from a terminal of each of said windings to a circuit affected by the received energy, detectors each having a terminal connected to another terminal of each of said windings, the other terminals of said detectors conductively connected to said circuit, signal translating means, a source of oscillations producing in said windings oscillations reacting with received energy to produce therein opposing beats, means co-operating with said detectors and said signal translating means rendering said beats cumulative upon said signal translating means and the received energy of substantially no effect upon said signal translating means, and means for attuning a circuit including said windings to the frequency of said oscillations.

6. Apparatus for receiving signals represented by waves of radio frequency comprising a receiving conductor, a plurality of secondary windings, a conductive connection from a terminal of each of said secondary windings to a circuit affected by the received energy, detectors each having a terminal connected to another terminal of each of said windings, the other terminals of said detectors connected to said circuit, signal translating means, a primary winding movable with respect to said secondary windings, a source of oscillations associated with said primary winding producing therein oscillations of a frequency differing from the frequency of the received energy, means for rendering the resultant beats cumulative upon said signal translating means and the received energy of substantially no effect upon said signal translating means, and means for attuning a circuit including said secondary windings to the frequency of said oscillations.

7. Apparatus for receiving signals represented by waves of radio frequency comprising a receiving conductor, a plurality of windings, a conductive connection from a terminal of each of said windings to a circuit affected by the received energy, thermionic detectors one terminal of whose grids is connected with another terminal of each of said windings and whose electron-emitting means are connected to said circuit, signal translating means, means for impressing upon said windings oscillations reacting with received energy to produce opposing beats, means co-acting with the anode circuits of said detectors and said signal translating means for rendering said beats cumulative upon said signal translating means and the received energy of no effect upon said signal translating means, and means for attuning a circuit including said windings to the frequency of said oscillations.

8. Apparatus for receiving signals represented by waves of radio frequency comprising a receiving conductor, a source of oscillations associated therewith and reacting with the received energy to produce beats, a plurality of windings each having one terminal conductively connected with a circuit traversed by said beats, a plurality of detectors each having one terminal connected to another terminal of each of said windings, the other terminals of said detectors connected with said circuit, a second source of oscillations producing in said windings opposing beats, signal translating means, means associated with said detectors and said signal translating means rendering said second named beats cumulative upon said signal translating means and said first beats of substantially no effect upon said signal translating means, and means for attuning a circuit including said windings to the frequency of said second named oscillations.

9. Apparatus for receiving signals represented by waves of constant radio frequency and for reducing the disturbing effects of simultaneously received energy,

comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, means for locally producing oscillations reacting with the oscillations representative of the desired signal and the oscillations representing the simultaneously received energy, the frequency of the locally produced oscillations being such that the resulting beats have a constant super-audible frequency, signal translating means, detecting circuits differentially affecting said translating means under the influence of said super-audible beats, and a local source producing oscillations reacting with said super-audible beats to produce secondary opposing beats of constant frequency cumulatively affecting said signal translating means.

10. Apparatus for receiving signals represented by waves of constant radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, means for locally producing oscillations reacting with the oscillations representative of the desired signal and the oscillations representing the simultaneously received energy, the frequency of the locally produced oscillations being such that the resulting beats have a constant super-audible frequency, signal translating means, detecting circuits differentially affecting said translating means under the influence of said super-audible beats, and a local source producing oscillations reacting with said super-audible beats to produce secondary opposing beats of constant audible frequency cumulatively affecting said signal translating means.

11. Apparatus for receiving signals represented by waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, means for locally producing oscillations reacting with the oscillations representative of the desired signal and the oscillations representing the simultaneously received energy, the frequency of the locally produced oscillations being such that the resulting beats have a super-audible frequency, signal translating means, detecting circuits differentially affecting said translating means under the influence of said super-audible beats, a local source producing oscillations reacting with said super-audible beats to produce secondary opposing beats cumulatively affecting said signal translating means, and means for adjusting the amplitude of the oscillations of said secondary source for relatively increasing the effect upon said signal translating means of the secondary beats representing the desired signal.

12. Apparatus for receiving signals represented by waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, means for locally producing oscillations reacting with the oscillations representative of the desired signal and the oscillations representing the simultaneously received energy, the frequency of the locally produced oscillations being such that the resulting beats have a super-audible frequency, signal translating means, detecting circuits differentially affecting said translating means under the influence of said super-audible beats, a local source producing oscillations reacting with said super-audible beats to produce secondary opposing beats of audible frequency cumulatively affecting said signal translating means, and means for adjusting the amplitude of the oscillations of said secondary source for relatively increasing the effect upon said signal translating means of the secondary beats representing the desired signal.

13. Apparatus for receiving signals represented by waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, signal translating means, detecting circuits differentially affecting said signal translating means, a local source

producing oscillations having an amplitude approximately equal to and reacting with the aforesaid oscillations representing the desired signal to produce opposing beats of constant frequency cumulatively affecting said signal translating means, whereby the desired signal is more readily distinguished from the effects produced by said simultaneously received energy.

14. Apparatus for receiving signals represented by waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, signal translating means, detecting circuits differentially affecting said signal translating means, a local source producing oscillations reacting with the aforesaid oscillations to produce opposing beats of constant audible frequency cumulatively affecting said signal translating means, whereby the desired signal is more readily distinguished from the effects produced by said simultaneously received energy.

15. Apparatus for receiving signals represented by waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, signal translating means, detecting circuits differentially affecting said signal translating means, a local source producing oscillations reacting with the aforesaid oscillations to produce opposing beats cumulatively affecting said signal translating means, whereby the desired signal is more readily distinguished from the effects produced by said simultaneously received energy, and means for adjusting the amplitude of said locally produced oscillations in their reaction with said oscillations for increasing relatively to the effect of said simultaneously received energy upon said signal translating means the effect upon said signal translating means of the beats representing the desired signal.

16. Apparatus for receiving signals represented by waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, signal translating means, detecting circuits differentially affecting said signal translating means, a local source producing oscillations reacting with the aforesaid oscillations to produce opposing beats of audible frequency cumulatively affecting said signal translating means, whereby the desired signal is more readily distinguished from the effects produced by said simultaneously received energy, and means for adjusting the amplitude of said locally produced oscillations in their reaction with said oscillations for increasing relatively to the effect of said simultaneously received energy upon said signal translating means the effect upon said signal translating means of the beats representing the desired signal.

17. Apparatus for receiving signals represented by waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received energy have a frequency corresponding with the frequency of said oscillations, signal translating means, detecting circuits differentially affecting said signal translating means, a local source producing oscillations reacting with the aforesaid oscillations to produce opposing beats cumulatively affecting said signal translating means, whereby the desired signal is more readily distinguished from the effects produced by said simultaneously received energy, and means for adjusting the amplitude of said locally produced oscillations in their reaction with said oscillations representing the desired signal to substantial equality with the amplitude of said oscillations representing the desired signal, whereby the ratio of the magnitude of effect upon said signal translating means of the beats representing the desired signal to the magnitude of effect upon said signal translating means of said simultaneously received energy is increased.

18. Apparatus for receiving signals represented by waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, whereby the amplitude of the oscillations representing the desired signal is increased and the oscillations representing the simultaneously received en-

ergy have a frequency corresponding with the frequency of said oscillations, signal translating means, detecting circuits differentially affecting said signal translating means, a local source producing oscillations reacting with the aforesaid oscillations to produce opposing beats of audible frequency cumulatively affecting said signal translating means, whereby the desired signal is more readily distinguished from the effects produced by said simultaneously received energy, and means for adjusting the amplitude of said locally produced oscillations in their reaction with said oscillations representing the desired signal to substantial equality with the amplitude of said oscillations representing the desired signal, whereby the ratio of the magnitude of effect upon said signal translating means of the beats representing the desired signal to the magnitude of effect upon said signal translating means of said simultaneously received energy is increased.

19. Apparatus for distinguishing between oscillations representing a desired signal and oscillations of the same frequency but greater amplitude, comprising signal translating means, detecting circuits similarly influenced by said oscillations and differentially related to said signal translating means, a local source producing oscillations reacting with said oscillations of different amplitudes to produce opposing beats cumulatively affecting said signal translating means, and means for adjusting the amplitude of said locally produced oscillations in their reaction with said oscillations of different magnitudes to a magnitude materially less than the magnitude of the amplitude of said oscillations of greater amplitude, and approaching equality with the magnitude of amplitude of the oscillations representing the desired signal, whereby the effect upon said signal translating means of the beats representing the desired signal is increased.

20. The method of distinguishing between a desired signal represented by undamped electro-radiant energy and aperiodic or decadent energy simultaneously existing in the natural media, which comprises converting the electro-radiant energy into sustained oscillations and said simultaneously existing energy into decadent oscillations of the same frequency, causing locally produced oscillations of different frequency to react with said sustained oscillations and said decadent oscillations to produce beats of constant audible frequency having different characteristics, impressing said sustained and decadent oscillations upon different circuits, impressing said beats in opposite senses upon said circuits, causing the effects of said oscillations in said circuits to substantially nullify each other, and cumulating and translating the effects of said beats upon said circuits.

21. The method of distinguishing between oscillations representing a desired signal and oscillations of the same frequency but of greater amplitude, which comprises causing locally produced oscillations of different frequency to react with said oscillations of different amplitudes to produce beats, graduating the amplitude of said locally produced oscillations to substantial equality with the amplitude of said oscillations representing the desired signal and differing greatly from the amplitude of said oscillations of greater amplitude, impressing said oscillations of different amplitudes upon different circuits, impressing said beats in opposite senses upon said circuits, causing the effects of said oscillations in said circuits to substantially nullify each other, and cumulating and translating the effects of said beats upon said circuits.

22. Apparatus for receiving signals represented by undamped waves of radio frequency and for reducing the disturbing effects of simultaneously received energy, comprising a receiving circuit, means for attuning said circuit to the frequency of the waves representing the desired signal, signal-translating means, detecting circuits differentially affecting said signal-translating means, a local source producing oscillations reacting with the oscillations representative of the desired signal to produce opposing beats of constant frequency cumulatively affecting said signal-translating means, means for effecting an amplitude of the locally produced oscillations in producing said beats differing from the amplitude of the oscillations representing the undesired received energy and more nearly equaling the amplitude of the oscillations representing the desired signal, whereby the ratio of the effects upon said signal-translating means produced by the desired signal to the effects upon said signal-translating means produced by the undesired received energy is materially increased.

23. In the art of receiving signals represented in transmission by undamped electro-radiant energy waves, the method of increasing the ratio of the effects due to the desired signal to the effects due to static and similar natural electrical disturbances, which comprises locally producing oscillations of frequency differing from the frequency of the received energy and of the oscillations produced by the static disturbance, causing the locally produced oscillations to react with the oscillations representing the desired signal to produce beats of constant frequency and while so reacting to have an amplitude differing from the amplitude of the oscillations due to the static disturbance and more nearly equal to the amplitude of

the oscillations representing the desired signal, impressing the oscillations due to the desired signal and due to the static disturbance upon a pair of circuits, impressing said beats in opposite senses upon said circuits, causing the effects of said oscillations in said circuits to substantially nullify each other, and cumulating and translating the effects of said beats upon said circuits.

In testimony whereof I have hereunto affixed my signature this 2nd day of April, 1920.

DAVID G. McCAA.