

June 29, 1926.

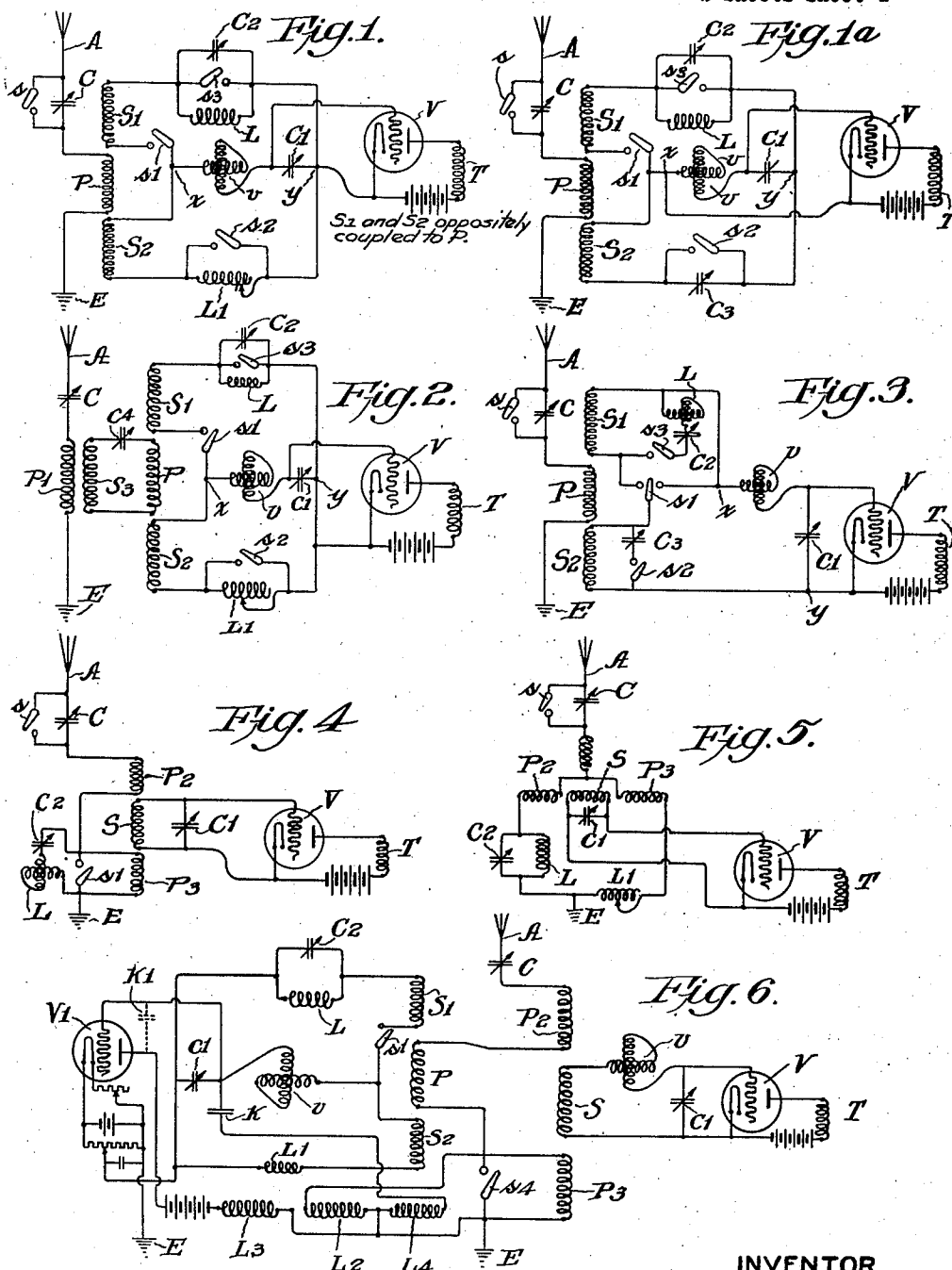
1,590,635

D. G. McCAA

RADIO SYSTEM

Filed May 5, 1925

2 Sheets-Sheet 1



INVENTOR

David G. McCaa

BY

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June 29, 1926.

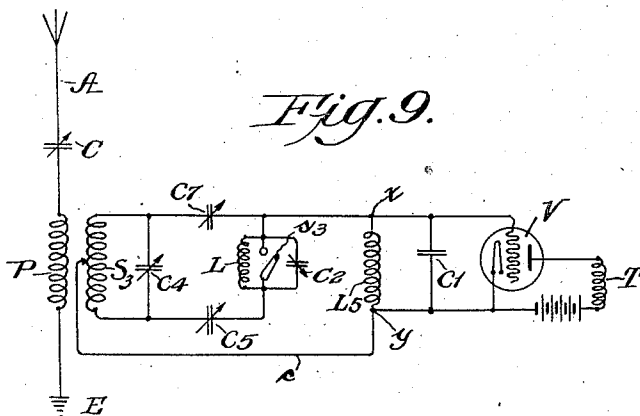
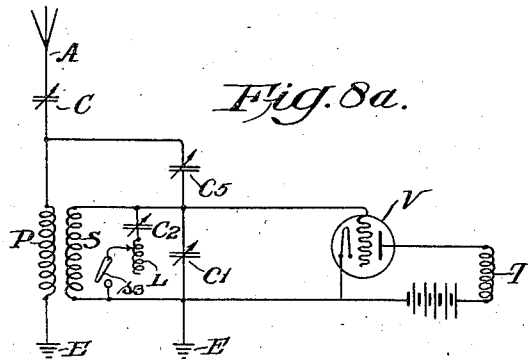
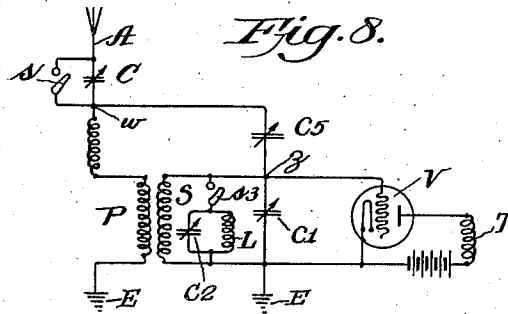
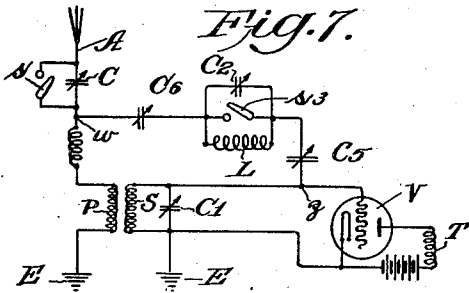
D. G. McCAA

1,590,635

RADIO SYSTEM

Filed May 5, 1925

2 Sheets-Sheet 2



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Patented June 29, 1926.

1,590,635

UNITED STATES PATENT OFFICE.

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RADIO SYSTEM.

Application filed May 5, 1925. Serial No. 28,067.

My invention relates to the reception of radio or high frequency energy, in radio systems or in systems in which high frequency energy is transmitted over a conductor or conductors extending between transmitting and receiving stations, without substantial interference or disturbance due to other radio or high frequency energy produced either artificially or by natural electricity, as by static, atmospherics, etc.

It is characteristic of my invention that there is effected clear or sharp differentiation, in the reception of high or radio frequency energy, representing controls or telephonic or telegraphic signals, between signal- or control-representing energy of low amplitude, notwithstanding the simultaneous existence of disturbing high frequency oscillations of high amplitude, and such as are caused by static, atmospherics or other forms of natural or artificial electricity.

In accordance with my present invention, a circuit or path is detuned with respect to the frequency of the desired oscillations, and preferably in such sense that the undesired oscillations will have a frequency lower than the frequency of the desired oscillations, and there is operatively related to the detuned circuit or path a plurality of couplings, either magnetic or capacitive, or in part magnetic and in part capacitive, said couplings opposing and neutralizing each other as regards the undesired oscillations and all other oscillations differing in the same sense from the desired oscillations, as regards their effect upon a signal-translating circuit or device, while as regards oscillations of the desired frequency said couplings do not neutralize each other and there are accordingly effective in the signal-translating circuit or device oscillations of the desired frequency, which are accordingly translated into signals or controls without substantial disturbance by the undesired oscillations.

In accordance with my invention, a balance is effected for both the desired and undesired oscillations by opposing and neutralizing couplings, and the balance is destroyed by a path tuned to one of said kinds of oscillations, as regards the desired oscillations, whereby they only will affect the signal-translating circuit or instrument.

Further in accordance with my invention,

the circuit or path of one of the couplings is tuned to the desired oscillations, while the circuit or path of another of the couplings is rendered opaque to the desired oscillations, as by parallel resonance to the frequency of the desired oscillations introducing substantially infinite impedance, which impedance, however, does not effect the neutralization or balance of oscillations of undesired frequency, since it is not opaque thereto.

My invention resides in the method and apparatus of the character hereinafter described and claimed.

For an understanding of my method, and for an illustration of some of the various forms my apparatus may take, reference may be had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of radio receiving apparatus embodying my invention.

Fig. 1^a is a diagrammatic view of a modification utilizable in case the static oscillations have a higher frequency than the desired or signal oscillations.

Fig. 2 is a diagrammatic view of a modification of Fig. 1, in which the detuned circuit or path is not in immediate or direct energy-transfer relation with the natural or other transmitting medium.

Figs. 3, 4, 5 and 6 are diagrammatic views of further modifications embodying my invention.

Figs. 7, 8 and 8^a are diagrammatic views of modifications utilizing couplings in part magnetic and in part capacitive.

Fig. 9 is a diagrammatic view of a modification in which the balancing and neutralizing couplings are all capacitive.

In the drawings, A represents generically any absorption structure of a radio receiving system, either an open antenna path, or, if desired, a closed circuit or loop, and broadly, any circuit or path receiving energy from the natural media or more or less remotely coupled to such a circuit or path, and representing also a conductor system extending between transmitting and receiving stations as utilized, for example, in high frequency or carrier wave conductor systems. For brevity, however, my invention will be described in connection with radio receiving systems utilized for any purpose, as for controls, but more particularly for signaling, including telegraphic and telephonic

signaling, it being understood that the translating instrument T, hereinafter referred to, represents generically any translating instrument, as a telephone, loud speaker or a control instrument of any character.

Referring to Fig. 1, in the path between the antenna A and earth or counter-capacity E are included the variable tuning condenser C, which may be omitted, if suitable or desirable, and the primary P. Coupled to the primary P, preferably closely, are the secondaries S^1 and S^2 , whose circuits may be regarded as in parallel with each other or having in common the tuning condenser C^1 and the variable inductance or variometer v , which may or may not be used, as circumstances may require. Serially in the circuit of the secondary S^1 are included the inductance L and condenser C^2 in parallel with each other and either or both variable for tuning the circuit L, C^2 to resonance with the frequency of the desired or signal oscillations. In circuit with the secondary S^2 is a variable inductance L^1 .

In shunt to the condenser C^1 may be connected any signal-translating circuit or a detector, as a crystal detector or equivalent. In the example illustrated, however, there is connected across the condenser C^1 the grid or input circuit of a thermionic vacuum tube V, which represents generically either a detector tube or the first of one or more stages of radio frequency amplifier tubes. In the anode or plate circuit of the tube V is a winding T, which represents generically a signal-translating instrument, as a telephone or the like, or the primary of a transformer whose secondary is connected either to the grid circuit of a succeeding vacuum tube operating either as a radio frequency amplifier, detector, or audio frequency amplifier.

The antenna path A—E is detuned with respect to the frequency of the high frequency energy representing the desired signal or control, and this may be accomplished, if suitable or desirable, by suitably adjusting the condenser C, which, however, may be omitted, or cut out as by closing the switch s , in which case the inductance of the primary P may be of such magnitude as to effect with the other constants of the antenna path the aforesaid detuning. The natural period of the antenna path may be either longer or shorter than the period of the energy it is desired to receive, and in either case static or the like excites the antenna system or path by supplying energy thereto, which then takes the form of oscillations whose predominant frequency is determined by the capacity and inductance of the antenna path or other circuit or path which absorbs the static energy. In the example illustrated by Fig. 1, however, the natural period of the antenna path is longer

than the period of the signal oscillations to be received.

With the switch s^1 open and the switch s^2 closed, thereby short circuiting the inductance L^1 , the circuit S^2 , v , C^1 is tuned to resonance with the desired oscillations, which are present in the antenna path as forced oscillations, by varying the inductance of v or the capacity of the condenser C^1 , or both. Under these circumstances, both desired and undesired oscillations will affect the grid circuit of the tube V, and currents representing both the desired and undesired effects will be present in the instrument or winding T.

Switches s^1 and s^3 may now be closed, which in effect places the secondary S^1 in parallel with the secondary S^2 , both coils being now related in common to the inductance v and condenser C^1 , and setting up equal and opposite electromotive-forces across v , C^1 , thereby in effect causing zero difference of potential between the points x and y , by virtue of the equal and opposite couplings of S^1 and S^2 to the primary P, with no effect by either desired or undesired oscillations upon the input circuit of the tube V.

Switch s^1 is now left closed and switch s^3 is opened, whereupon there is introduced into the circuit of the secondary S^1 high or substantially infinite impedance, with respect to oscillations of the desired or signal frequency, because the parallel resonant circuit L, C^2 is tuned to the frequency of the signal oscillations.

Whereas the parallel resonant circuit L, C^2 offers high or infinite impedance to the desired frequency, it offers far lower impedance to the oscillations caused by or representing static or other disturbances, and as to them the reactance of the combination of L and C^2 is inductive, and because of this fact there is introduced into the circuit of the secondary S^2 , for balancing purposes, a small inductance L^1 , this being effected by opening the switch s^2 . With the switch s^2 open, the inductance L^1 may be adjusted to effect or restore the neutralizing balance as regards oscillations of a frequency of undesired oscillations, to wit, those of all frequencies lower than the frequency of the desired signal oscillations. When the inductance L^1 is brought into circuit, there may be necessitated small readjustment of the inductance v and/or condenser C^1 , for it is essential with the switch s^1 open that the circuit S^2 , L^1 , C^1 , v be in resonance with the desired oscillations, and simultaneously the parallel resonance path L, C^2 is in resonance with the desired oscillations.

With the switches in the position last described, the circuit is in its operative condition, with the result that all undesired oscillations, namely, those of a frequency

lower than the frequency of the desired oscillations, are neutralized and balanced out and have no effect upon the input circuit of the tube V, while on the contrary, the system is unbalanced as regards oscillations of the desired frequency only, due to the high impedance in one of the circuits as caused by the inductance L and its capacity C², and there are accordingly impressed upon the input circuit of the tube V oscillations of the desired frequency, with the result that in the ultimate signal-translating instrument T the desired signals are manifested or heard, to the substantial or entire exclusion of effects due to undersired oscillations.

While the circuit L, C² introduces high or infinite impedance to oscillations of the desired frequency, oscillations of frequency higher than that of the desired oscillations may also be present, but these are effectually suppressed by the usual tuning operation as effected by the inductance v and/or condenser C¹.

Referring to Fig. 1^a, there is utilized in lieu of the inductance L¹ of Fig. 1 an adjustable condenser C³. This is to provide for the case where the antenna path is detuned to a natural frequency higher than the frequency of the desired signal oscillations. In such case, the parallel resonant circuit L, C² is in effect a capacitive reactance for all frequencies higher than the frequency of the desired oscillations, and in consequence, there is required to effect a balance a capacitive reactance in the circuit of the secondary S², and such is provided by the adjustable condenser C³.

Referring to Fig. 2, the primary P is no longer in the antenna or other absorption path, but is in a circuit coupled thereto through the transformer P¹, S³, the circuit P, S³ being detuned with respect to the frequency of the desired or signal oscillations, and this may be effected by the variable condenser C⁴. The circuits coupled to the primary P are similar to those described in connection with Fig. 1, and their operation is that above described, for in this case again there is detuning with respect to the signal oscillations, not directly in the absorbing circuit or path, but in a circuit more or less remote therefrom.

In the example of Fig. 2, the antenna path may be tuned to the frequency of the desired signal oscillations by adjusting the condenser C or the primary P¹ or either of them, though it will be understood also that the antenna path may be detuned to the same frequency to which the circuit P, S³, C⁴ is detuned. Preferably, however, the antenna path is tuned to the signal frequency, while the intervening circuit or path is detuned, for under these circumstances static or disturbing effects small or moder-

ate in magnitude will effect oscillations in the antenna path of the same frequency as the desired oscillations, but will have small effect upon the detuned circuit P, S³, C⁴, whereas static or disturbing effects of great magnitude will, notwithstanding the tuning of the antenna to the signal frequency, shock-excite the detuned circuit P, S³, C⁴, setting up therein oscillations of frequency different from that of the desired oscillations.

It will be understood, of course, that in case the detuning is to a frequency higher than the frequency of the desired oscillations, the inductance L¹ will again be supplanted by a capacity such as C³, as and for the reasons indicated in connection with Fig. 1^a.

Referring to Fig. 3, the arrangement is fundamentally that described in connection with Figs. 1 et seq. in that the circuit of the secondary S² is, with the switch s² open and the switch s¹ closed toward the right, tuned to the desired oscillations by the variable condenser C¹ with or without the assistance of the variable inductance v . By throwing the switch s¹ toward the left and maintaining switch s³ open, the secondary S¹ is brought into series with the secondary S², thereby detuning the circuit S², v , C¹, and the secondaries are coupled in such sense to the primary P that their electro-motive forces as applied to the terminals of the condenser C¹ are in opposition to each other. Under these circumstances, a balance is effected, and neither desired nor undesired oscillations have any effect upon the input circuit of the tube V. However, leaving the switch s¹ in its left hand position and closing the switch s³, and by adjusting the variable condenser C² or the variable inductance L, or both of them, to resonance for the frequency of the desired oscillations, there is effected a substantial short circuit of the secondary S¹ as regards oscillations of desired or signal frequency, thereby upsetting the previously obtained balance and causing oscillations of desired or signal frequency to reach and influence the input circuit of the tube V, with resultant manifestation of the desired signal in or by the instrument T. Bringing the inductance L and condenser C² into shunt with the secondary S¹, and thereby effecting a path of zero reactance for the frequency of the desired oscillations, has the further effect of retuning the circuit of the secondary S² to the desired frequency. The branch L, C² when so adjusted to resonance for the signal frequency, offers capacitive reactance to all longer waves, including those of static due to detuning of the antenna path to a longer period. To compensate for this capacitive reactance, there is utilized in the circuit of the secondary S², for the same rea-

son that the capacity C^3 is utilized in Fig. 1^a, a variable condenser C^3 brought into circuit by closure of the switch s^2 .

Referring to Fig. 4, there are in the antenna or absorption path, detuned, with the switch s^1 open, to a wave length longer than that of the desired oscillations, two primaries P^2 , P^3 , equally and oppositely closely coupled to the secondary S whose circuit, tuned by the condenser C^1 to the desired signal frequency, is the input circuit of the tube V . In shunt to either of the primaries P^2 or P^3 are connected the variable condenser C^2 and variable inductance L , in series with each other, brought into circuit by opening the switch s^1 , in which case the antenna path is still detuned with respect to the signal oscillations. The inductance L and capacity C^2 effect across the terminals of the primary P^3 a branch tuned to the frequency of the desired oscillations.

Here again the branch L , C^2 , when brought into circuit, upsets the previous balance, during which neither signal nor static oscillations affected tube V , and oscillations of signal frequency are now withheld from the primary P^3 , and the secondary S is influenced by oscillations of signal frequency in the primary P^2 .

In Fig. 5 the primaries P^2 and P^3 are again equally and oppositely closely coupled to the secondary S , but they are disposed in parallel branches in the antenna path, which as before is detuned to longer wave length than that of the desired oscillations. In series with one of the primaries, as P^2 , is the parallel resonance circuit L , C^2 , and in the branch containing the primary P^3 is introduced the compensating inductance L^1 , as described in connection with Fig. 1.

Referring to Fig. 6, there is shown an arrangement in general similar to that of my prior application Serial No. 722,246, filed June 25, 1924, modified by application thereto of the principles of my present invention, and particularly an arrangement of the character of Fig. 1 hereof.

As in my aforesaid prior application, the signal-translating circuit is coupled through the secondary S equally and oppositely with the primaries P^2 and P^3 in the antenna path, which in this case is again detuned with respect to the signal frequency, and particularly to a frequency lower than the frequency of the signal oscillations. Brought into parallel with the primary P^3 , as upon opening the switch s^1 , is an inductance L^2 , which, with switch s^1 open, still leaves the antenna path detuned to the desired frequency. Coupled to the inductance L^2 is the inductance or coil L^3 , in the anode circuit of a radio frequency amplifier tube V^1 , whose input circuit is related to the antenna path substantially in the same manner as the input circuit of the tube V in Fig. 1. For this

purpose, the primary P , in the antenna path, is again associated with the secondaries S^1 and S^2 , with which are associated the tuning inductance v , and tuning capacity C^1 , with the parallel resonance path L , C^2 in circuit with S^1 and a compensating inductance L^1 in circuit with the secondary S^2 . By this system, comparable to that of Fig. 1, only oscillations of desired frequency can influence the input circuit of the amplifier tube V^1 , and in consequence, the amplified oscillations of desired frequency in the coil L^3 in the anode circuit reduces the inductive reactance of the coil L^2 , whereby the primary P^3 is robbed of oscillations of signal frequency, permitting the primary P^2 at signal frequency to influence the input circuit of the tube V . Any oscillations of undesired frequency, such as those due to static, in the coil L^2 , may reach the grid or control electrode of the amplifier tube V^1 through its anode circuit, and thence through the grid-plate capacity of the tube, the latter indicated in dotted lines at K^1 . To annul such coupling to the grid of the tube V^1 , as regards undesired frequencies, there is utilized the coil or inductance L^4 , coupled to the coil L^2 , and therefore influenced by static or other undesired oscillations, together with the condenser K , thereby impressing upon the grid of the tube V^1 , as regards undesired or static frequencies, electro-motive-forces equal and opposite to those impressed thereon through the intra-tube capacity K^1 .

Referring to Fig. 7, there is an embodiment of my invention in which the couplings are in part magnetic and in part capacitative. The magnetic coupling between the detuned antenna and the signal-translating instrument is provided by the primary P and secondary S , the condenser C^1 as before tuning the secondary circuit to the frequency of the desired oscillations. From a point w of elevated or suitable potential in the antenna, absorption or other detuned path, there is effected a capacitative coupling to the point z by and through the coupling capacities C^5 and C^6 , or either of them alone, whereby, with the switch s^3 closed, the magnetic coupling P , S , if in proper sense, which may be determined by the direction of winding or sense of connection of either P or S , is opposed and neutralized by the capacitative coupling as regards oscillations of both desired and undesired frequencies, whereby the input circuit of the tube V is not affected by either the desired signal or the disturbances. By opening the switch s^3 , however, there is brought into series in the capacitative coupling path a high or substantially infinite impedance when the parallel resonance path L , C^2 is tuned to the frequency of the desired oscillations, with the result that the balance upon the input circuit of the tube V as regards oscillations of desired fre-

quency is upset, and the desired signal or control energy influences the tube V through the magnetic coupling P, S. Simultaneously, however, the balance still is maintained as regards the static or undesired oscillations and all other oscillations of a frequency lower than the desired frequency, and for such other oscillations of lower frequency the path L, C² is not opaque, and the capacitative coupling continues to function and effect a balance in co-operation with the magnetic coupling P, S.

Referring to Fig. 8, there is shown a generally similar system in that there are involved both magnetic and capacitative couplings for balancing out both desired and undesired oscillations as regards the input circuit of the tube V. In this case, however, the parallel resonance circuit L, C² is applied to the magnetic coupling, and, as shown, in a path or branch in parallel to the secondary S, upon closure of the switch s². In this case, when the switch s² is closed and the closed circuit L, C² attuned to the desired frequency, there is infinite impedance across the terminals of the secondary S, permitting the transfer of energy of desired frequency from the antenna path into the input circuit of the tube V at substantially its full or normal value through the coupling P, S. The oscillations of undesired frequency, transferred through the magnetic coupling P, S, find a path of low reactance through the switch s² and L, C², which is not opaque to them, and in consequence the oscillations of undesired frequency effect only reduced electro-motive-forces as impressed upon the terminals of the condenser C¹. Such electro-motive-force as is impressed by the undesired oscillations upon the terminals of the condenser C¹ is neutralized by suitable adjustment of the capacitative coupling condenser C⁵. In consequence, with the switch s² closed, the undesired oscillations have no effect upon the input circuit of the tube V, while the oscillations of desired frequency are impressed upon that input circuit substantially at their full magnitude through the magnetic coupling.

When capacitative couplings of the character indicated in Figs. 7 and 8 are utilized, it is of some benefit to connect the secondary circuits to earth or counter-capacity E, as indicated. In Fig. 8* there is shown an arrangement in general similar to that of Fig. 8, except that the inductance L and C², in series with each other, and attuned to the undesired frequency or to the same natural period as that of the antenna path, forms, as regards the undesired oscillations, a short circuit of the secondary S. Here again the antenna is detuned as above described, and the secondary circuit S, C¹ is attuned to the desired frequency. Upon closure of the switch s², and L, C² being attuned to the aforesaid natural period of the antenna, substantially only oscillations of desired frequency transferred by the magnetic coupling P, S are impressed upon the input circuit of the tube V, since while the path L, C² is of zero reactance for the undesired frequency, it is of high impedance or reactance for the desired frequency. With the switch s² closed, such electro-motive-forces as may be impressed upon the terminals of the condenser C¹ through the magnetic coupling by the undesired frequency is or may be neutralized by adjustment of the capacitative coupling condenser C⁵. In this instance again, therefore, the undesired oscillations have little or no effect upon the input circuit of the tube V, while oscillations of desired frequency have substantially full effect.

In Fig. 9 is shown an arrangement in which the effective couplings are both capacitative. In this case, the antenna or absorption path is preferably tuned to the desired frequency, though it may be detuned therefrom. Through the coupling P, S², corresponding in a general way with the arrangement of Fig. 2, there is influenced a secondary circuit S², C⁴, detuned with respect to the desired frequency, in this instance to a wave length longer than that of the desired oscillations. The input circuit of the tube V includes again the tuning condenser C¹ and the inductance L¹. Energy of both desired and undesired frequencies is transferred from the circuit S², C⁴ to the input circuit of the tube V through the oppositely disposed capacitative coupling condensers C⁵ and C⁷, the halves of the secondary S² and the conductor c. In the capacitative coupling branch including either of the condensers C⁵ or C⁷, but, as indicated, in the branch with C⁵, is the parallel resonance path comprising the inductance L and condenser C² to be attuned to the frequency of the desired oscillations. With the switch s² closed, rendering L, C² ineffective, and with the circuit S², C⁴ detuned with respect to the desired frequency, and the capacitative couplings C⁵, C⁷ unbalanced, electro-motive-forces corresponding with both the desired and undesired frequencies are impressed across the terminals x, y, that is, upon the input circuit of the tube V. By adjustment of either or both of the couplers C⁵, C⁷, a balance is effected, whereby no electro-motive-force of either the desired or undesired frequency is impressed across the points x and y. Upon opening the switch s², there is then brought into the capacitative coupling branch with the condenser C⁵ a high or substantially infinite impedance as regards oscillations of desired frequency, with the result that the

former balance of the capacitative couplings is upset, and oscillations of desired frequency are transferred through the capacitative coupling including the condenser C^7 to the input circuit of the tube V. Simultaneously, however, the branch C^2, L offers low impedance to the undesired oscillations, which permits the condenser C^5 to continue to effect with the condenser C^7 a balance as regards the undesired oscillations, which are accordingly withheld from the tube V.

From the foregoing description of several examples of embodiments of my invention, it is apparent that the circuit for translating the oscillations of desired frequency into signals or controls is in effect, by suitably related couplings, out of energy-absorbing relation with respect to the antenna or other absorption path or conductor for all frequencies other than the desired frequency. The width of the band or range of desired frequencies which will reach the translating circuit becomes narrower or smaller as the capacity of the condenser C^2 is made great as compared with the inductance of L in the parallel resonance paths of the character utilized in Figs. 1, 1^a, 2, 5, 6, 7, 8 and 9; and such band or range of desired frequencies reaching the translating circuit will become narrower or smaller as the inductance L is great as compared with the condenser C^2 in the series arrangements such as utilized in Figs. 3 and 4. And in an arrangement of the character indicated in Fig. 8^a, where L and C^2 are in series with each other but tuned to the static frequency, it is preferable that the band or range of static frequencies withheld from the signal-translating circuit shall be relatively broad, and for this purpose the capacity of condenser C should be relatively greater and the inductance L relatively smaller than in the cases of Figs. 3 and 4.

It is further preferable that the circuit or path which is detuned with respect to the desired frequency should have a natural period differing widely from the period of the desired oscillations and the couplings, whether magnetic or capacitative, or both, are of such degrees of closeness or tightness that nevertheless a signal or response in the translating circuit of practically the usual or normal magnitude may be obtained.

In the case of absorption by the antenna or equivalent of energy of frequency higher than the desired frequency, and especially when, as aforesaid, the condenser C^2 has large capacity while the inductance L is small, in those arrangements in which they form a parallel resonance path, as in Figs. 1 etc., the parallel resonance path offers low impedance and the characteristic balance described still obtains as to such higher frequencies.

For the sake of brevity in the appended

claims, the term "signal" is employed generically to include signals of any character, including telegraphic and telephonic signals, and any other analogous effect, including controls; and the term "static" is generically employed to include static and other natural electrical effects and other effects having artificial origin and such as cause or are represented by waves or oscillations other than those representing the desired signal or control.

What I claim is:

1. In the reception of signals represented by high frequency energy, the method which comprises receiving the signal energy in a path having a natural frequency differing from the frequency of the received oscillations, effecting between a signal-translating circuit and said path opposing couplings preventing impression of signal oscillations and oscillations of different frequency upon said translating circuit, and changing one of said couplings as regards its balancing effect for signal oscillations to effect their impression upon said translating circuit to the substantial exclusion of the oscillations of different frequency.

2. The method of reducing the effect of static in the reception of signals, which comprises receiving the signal oscillations in a path detuned to the signal frequency and in which occur static oscillations of frequency different from the frequency of the signal oscillations, effecting between a signal-translating circuit and said path opposing couplings preventing impression of signal and static oscillations upon said translating circuit, and changing one of said couplings as regards its balancing effect for signal oscillations to effect their impression upon said translating circuit to the substantial exclusion of static oscillations.

3. In the reception of signals represented by high frequency energy, the method which comprises receiving the signal energy in a path having a natural frequency differing from the frequency of the received oscillations, effecting between a signal-translating circuit and said path opposing couplings preventing impression of signal oscillations and oscillations of different frequency upon said translating circuit, and changing one of said couplings as regards its balancing effect for signal oscillations without affecting the natural period of said path to effect their impression upon said translating circuit to the substantial exclusion of the oscillations of different frequency.

4. The method of reducing the effect of static in the reception of signals, which comprises receiving the signal oscillations in a path detuned to the signal frequency and in which occur static oscillations of frequency different from the frequency of the signal

oscillations, effecting between a signal-translating circuit and said path opposing couplings preventing impression of signal and static oscillations upon said translating circuit, and changing one of said couplings as regards its balancing effect for signal oscillations without affecting the natural period of said path to effect their impression upon said translating circuit to the substantial exclusion of static oscillations.

5. In the reception of signals represented by high frequency energy, the method which comprises receiving the signal energy in a path having a natural frequency differing from the frequency of the received oscillations, effecting between a signal-translating circuit and said path opposing couplings preventing impression of signal oscillations and oscillations of different frequency upon said translating circuit, and changing one of said couplings by a path comprising inductance and capacity tuned substantially to one of said frequencies to effect impression of the signal oscillations upon said translating circuit substantially to the exclusion of oscillations of different frequency.

6. In the reception of signals represented by high frequency energy, the method which comprises receiving the signal energy in a path having a natural frequency differing from the frequency of the received oscillations, effecting between a signal-translating circuit and said path opposing couplings preventing impression of signal oscillations and oscillations of different frequency upon said translating circuit, and changing one of said couplings by a path comprising inductance and capacity tuned substantially to the frequency of the signal oscillations to effect impression of the signal oscillations upon said translating circuit substantially to the exclusion of oscillations of different frequency.

7. In the reception of signals represented by high frequency energy, the method which comprises receiving the signal energy in a path having a natural frequency lower than the frequency of the received oscillations, effecting between a signal-translating circuit and said path opposing couplings preventing impression of signal oscillations and the oscillations of lower frequency upon said translating circuit, and changing one of said couplings by a path comprising inductance and capacity tuned substantially to one of said frequencies to effect impression of the signal oscillations upon said translating circuit substantially to the exclusion of oscillations of lower frequency.

8. In the reception of signals represented by high frequency energy, the method which comprises receiving the signal energy in a path having a natural frequency lower than the frequency of the received oscillations, effecting between a signal-translating circuit

and said path opposing couplings preventing impression of signal oscillations and the oscillations of lower frequency upon said translating circuit, and changing one of said couplings by a path comprising inductance and capacity tuned substantially to the frequency of the signal oscillations to effect impression of signal oscillations upon said translating circuit substantially to the exclusion of oscillations of lower frequency.

9. The method of reducing the effect of static in the reception of signals, which comprises receiving the signal oscillations in a path having a natural frequency differing from the frequency of the received oscillations, effecting between a signal-translating circuit and said path a balance preventing impression of signal oscillations and static oscillations upon said translating circuit, and destroying balance by a parallel resonance path comprising inductance and capacity tuned substantially to one of the frequencies to effect impression of the signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.

10. The method of reducing the effect of static in the reception of signals, which comprises receiving the signal oscillations in a path having a natural frequency lower than the frequency of the received oscillations, effecting between a signal-translating circuit and said path a balance preventing impression of signal oscillations and static oscillations upon said translating circuit, and destroying the balance by a parallel resonance path comprising inductance and capacity tuned substantially to the signal oscillations to effect impression of the signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.

11. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a system balanced as to signal and static oscillations to prevent their impression upon said translating circuit, and means for upsetting the balance of said system with respect to signal oscillations to effect their impression upon said translating circuit substantially to the exclusion of static oscillations.

12. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a plurality of couplings between said translating circuit and said path and acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means for upsetting said balance to effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.

13. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a plurality of couplings between said translating circuit and said path and co-acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means comprising inductance and capacity tuned substantially to one of said frequencies to upset said balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.
14. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a plurality of couplings between said translating circuit and said path and co-acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means comprising inductance and capacity tuned substantially to the frequency of the signal oscillations to upset said balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.
15. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a plurality of couplings between said translating circuit and said path and co-acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means comprising a parallel resonance path attuned to the signal oscillations to upset said balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.
16. A receiving system comprising a path traversed by signal oscillations and tuned to a frequency lower than the frequency of the signal oscillations, a signal-translating circuit, a plurality of couplings between said translating circuit and said path and co-acting to effect a balance with respect to said signal and static oscillations to prevent their impression upon said translating circuit, and means comprising inductance and capacity tuned substantially to the frequency of the signal oscillations to upset said balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.
17. A receiving system comprising a path traversed by signal oscillations and tuned to a frequency lower than the frequency of the signal oscillations, a signal-translating circuit, a plurality of couplings between said translating circuit and said path and co-acting to effect a balance with respect to said signal and static oscillations to prevent their impression upon said translating circuit, and means comprising a parallel resonance path tuned to the signal oscillations to upset said balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.
18. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a magnetic coupling and another coupling between said translating circuit and said path and co-acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means for upsetting said balance to effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.
19. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a plurality of magnetic couplings between said translating circuit and said path and co-acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means for upsetting said balance to effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.
20. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a magnetic coupling and another coupling between said translating circuit and said path and co-acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means comprising inductance and capacity tuned substantially to one of said frequencies to upset said balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.
21. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a plurality of magnetic couplings between said translating circuit and said path and co-acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means comprising inductance and capacity tuned substantially to one of said frequencies to upset said balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.

22. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a plurality of magnetic couplings between said translating circuit and said path and co-acting to effect a balance with respect to signal and static oscillations to prevent their impression upon said translating circuit, and means comprising a parallel resonance path attuned to the signal oscillations to upset their balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.

23. A receiving system comprising a path traversed by signal oscillations and tuned to a frequency lower than the frequency of the signal oscillations, a signal-translating circuit, a plurality of magnetic couplings between said translating circuit and said path and co-acting to effect a balance with respect to said signal and static oscillations to prevent their impression upon said translating circuit, and means comprising a parallel resonance path tuned to the signal oscillations to upset said balance and effect impression of signal oscillations upon said translating circuit substantially to the exclusion of static oscillations.

24. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a system comprising a plurality of couplings balanced as to signal and static oscillations to prevent effect thereby upon said translating circuit, and means in circuit with one of said couplings tuned to one of the frequencies for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

25. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a coupling between said translating circuit and said path, an opposing coupling between said translating circuit and said path for effecting balance with respect to signal and static oscillations to prevent effect thereby upon said translating circuit, and means in circuit with one of said couplings tuned to one of the frequencies for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

26. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a system comprising a plurality of couplings balanced as to signal and static oscillations to prevent effect thereby upon said translating circuit, and means in circuit with one of said couplings tuned to the frequency of the signal oscillations for up-

setting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

27. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a system comprising a plurality of couplings balanced as to signal and static oscillations to prevent effect thereby upon said translating circuit, and inductance and capacity in parallel with each other and in series in the circuit of one of said couplings and attuned to one of the frequencies for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

28. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a system comprising a plurality of couplings balanced as to signal and static oscillations to prevent effect thereby upon said translating circuit, and inductance and capacity in parallel with each other and in series in the circuit of one of said couplings and attuned to the frequency of the signal oscillations for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

29. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a system comprising a plurality of couplings balanced as to signal and static oscillations to prevent effect thereby upon said translating circuit, means in circuit with one of said couplings for attuning to the signal oscillations, and means in circuit with another of said couplings tuned to one of the frequencies for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

30. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a coupling between said translating circuit and said path, an opposing coupling between said translating circuit and said path for effecting balance with respect to signal and static oscillations to prevent effect thereby upon said translating circuit, means in circuit with one of said couplings for tuning to the signal oscillations, and means in circuit with another of said couplings tuned to one of the frequencies for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

31. A receiving system comprising a path traversed by signal oscillations and detuned

with respect thereto, a signal-translating circuit, a system comprising a plurality of couplings balanced as to signal and static oscillations to prevent effect thereby upon
 5 said translating circuit, means in circuit with one of said couplings for tuning to the signal oscillations, and means in circuit with another of said couplings tuned to the frequency of the signal oscillations for upsetting the balance and to effect impression on
 10 said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

32. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a system comprising a plurality of couplings balanced as to signal and static oscillations to prevent effect thereby upon
 20 said translating circuit, means in circuit with one of said couplings for tuning to the signal oscillations, and inductance and capacity in parallel with each other and in series in the circuit of another of said couplings and attuned to one of the frequencies for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

33. A receiving system comprising a path traversed by signal oscillations and tuned to a frequency lower than the frequency of the signal oscillations, a signal-translating circuit, a system comprising a plurality of
 35 couplings balanced as to signal and static oscillations to prevent effect thereby upon said translating circuit, means in circuit with one of said couplings for attuning to the signal oscillations, and means in circuit
 40 with another of said couplings tuned to the frequency of the signal oscillations for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

34. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating circuit, a system comprising a plurality of
 50 couplings balanced as to signal and static oscillations to prevent effect thereby upon said translating circuit, means in circuit with one of said couplings for attuning to the signal oscillations, means in circuit with
 55 another of said couplings tuned to one of the frequencies for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations, and a
 60 reactance in circuit with said one of said

couplings for compensating for said means in said other of said circuits.

35. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating
 65 circuit, a plurality of circuits between said translating circuit and said path, means for coupling each of said intervening circuits to said path in senses to effect balance as to signal and static oscillations to prevent effect
 70 thereby upon said translating circuit, and means in one of said intervening circuits tuned to one of the frequencies for upsetting the balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

36. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating
 80 circuit, a circuit intervening between said translating circuit and said path, means magnetically coupling said intervening circuit to said path, means for tuning said intervening circuit to the frequency of the
 85 signal oscillations, a third circuit coupled to said path and co-acting with said intervening circuit to effect balance as to signal and static oscillations to prevent effect thereby upon said translating circuit, and
 90 means in said third circuit tuned to the signal oscillations to upset said balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

37. A receiving system comprising a path traversed by signal oscillations and detuned with respect thereto, a signal-translating
 100 circuit, a circuit intervening between said translating circuit and said path, means magnetically coupling said intervening circuit to said path, means for tuning said intervening circuit to the frequency of the signal oscillations, a third circuit magnetically coupled to said path and co-acting
 105 with said intervening circuit to effect balance as to signal and static oscillations to prevent effect thereby upon said translating circuit, and inductance and capacity in parallel with each other in series in said third
 110 circuit tuned to the frequency of the signal oscillations to upset said balance and to effect impression on said translating circuit of signal oscillations substantially to the exclusion of static oscillations.

In testimony whereof I have hereunto affixed my signature this 24th day of April, 1925.

DAVID G. McCAA.