

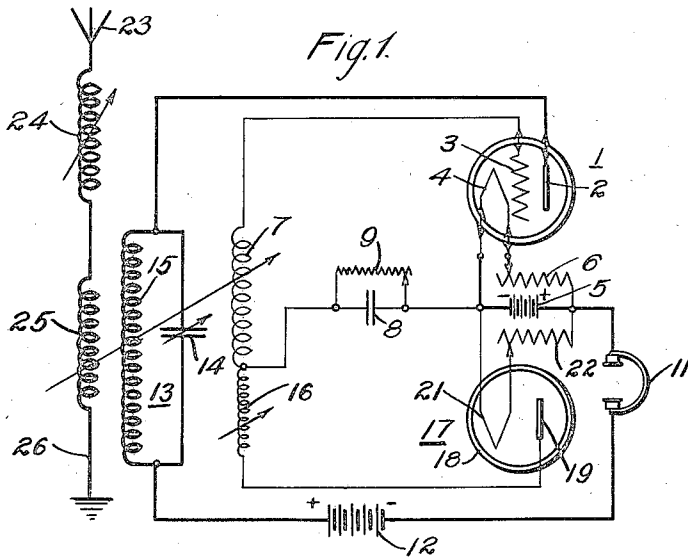
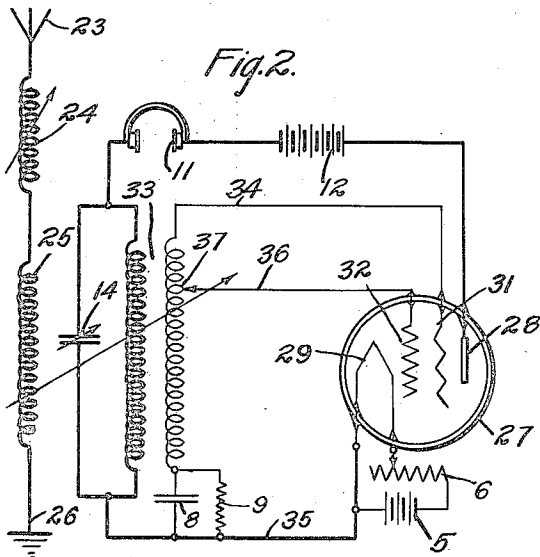
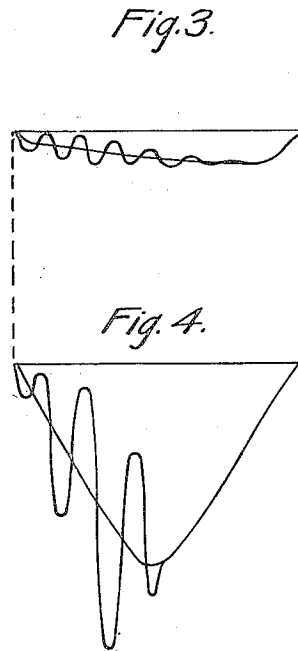
May 15, 1923.

1,455,768

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WIRELESS RECEIVING SYSTEM

Filed Jan. 20, 1922



WITNESSES:

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UNITED STATES PATENT OFFICE.

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WIRELESS RECEIVING SYSTEM.

Application filed January 20, 1922. Serial No. 530,615.

To all whom it may concern:

Be it known that I, JOSEPH SLEPIAN, a citizen of the United States, and a resident of Swissvale, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Wireless Receiving Systems, of which the following is a specification.

My invention relates to methods and means for amplifying currents and particularly to wireless receiving systems.

In its broad aspect, the object of my invention is to provide an improved wireless receiving system which has highly desirable operating characteristics and which is responsive to signal impulses radiated from either damped or undamped wireless transmission systems without the customary heterodyning step.

More specifically, one object of my invention is to provide a receiving system which admits of an extremely high amplification of received signal impulses.

These and other objects of my invention will be apparent from the following description of the nature, the mode of operation and the advantages of my invention.

It is well known that, in a regenerative feed-back system employing a grid condenser having insufficient grid leak, the system oscillates intermittently, as indicated by a howling in the telephone receivers. That is to say, upon some slight unbalancing of the system, the tube is set to oscillating, the oscillations increasing in amplitude. When the amplitude of the oscillations stops increasing, the oscillations become unstable, since any slight decrease in their amplitude fails to produce a corresponding decrease in the charge in the grid condenser; hence the oscillations continue to decrease in amplitude and finally stop. When the charge on the grid condenser has decreased to a sufficiently low value, as determined by the constants of the system, the oscillations again build up, as before, and the blocking action is repeated. It will be noted that the oscillations must build up to approximately the maximum limits of the tube before the blocking action becomes effective.

I have found that, by increasing the charge on the grid to values higher than the peak value of the alternating grid potential, in accordance with the varying intensity of a signal impulse to be detected, the blocking

action may be manifested before the oscillations reach their maximum value, as determined by the constants of the tube, and that the maximum amplitude of the intermittent oscillations obtaining in the system is directly dependent upon the varying intensity of said signal impulse, all as will be explained more fully hereinafter.

With these and other objects in view, my invention further consists in the details of construction and operation and circuit arrangement hereinafter described and claimed and illustrated in the accompanying drawing, wherein:

Figure 1 is a diagrammatic view of circuits and apparatus embodying my invention;

Fig. 2 is a similar view showing a modification;

Figs. 3 and 4 are curve diagrams illustrating the potential variations of the grid during the intermittent oscillation of the tube for relatively weak and strong disturbing effects or signals, respectively.

In Fig. 1, a regenerative feed-back system having an extremely large negative damping effect is shown as comprising a three-electrode tube 1 of well known design and input and output circuits therefor.

The three-electrode tube 1 comprises an anode 2, a controlling grid member 3 and a hot cathode 4, the latter being energized from a source of direct-current energy 5 through a resistor 6. The input circuit includes a coupling coil 7 and a shunt-connected grid condenser 8 and adjustable grid leak 9. The grid leak is so adjusted as to cause said feed-back system to oscillate intermittently at a predetermined frequency upon the receipt of an initial impulse, as by a received signal impulse.

The output or plate-filament circuit includes a translating device shown as a telephone receiver 11, a source of direct-current energy 12 and a tuned circuit 13. The tuned circuit 13 comprises a condenser 14 and a coupling coil 15 connected in shunt relation, the latter being inductively coupled to the coupling coil 7 which is included in the grid-filament circuit. The feed-back coupling between the coils 15 and 7 is so adjusted as to provide a regenerative system having an extremely large negative-resistance effect.

An auxiliary grid-biasing means is provided for increasing the negative charges on

the grid condenser 8 to values greater than the peak-value of the alternating-grid potential in accordance with the varying intensity of the disturbing impulses tending to unbalance the feed-back system, and comprises a coupling coil 16 inductively coupled to the tuned circuit 13 and deriving alternating voltage therefrom and translating means 17 for rectifying said voltage, all of which are serially included in a circuit connected in shunt relation to the grid condenser 8. The translating device 17 is shown in the form of a two-electrode tube 18 comprising an anode 19 and a hot cathode 21, the latter being energized from the source of energy 5 through a resistor 22.

An antenna circuit for impressing the received signal impulses upon the feed-back system comprises an antenna 23, a tuning inductance coil 24, a coupling coil 25 and a ground conductor 26, the coupling coil 25 being operatively connected to coupling coils 15, 16 and 7.

In order to complete the disclosure of my invention, the operation thereof will be further explained in accordance with theories which appear most plausible in view of my present knowledge of the underlying phenomena, although I do not wish to be limited to such explanation.

It is desired to so adjust the system that, if a certain signal-current brings the intermittent oscillations up to their full amplitude, a smaller signal-current will give intermittent oscillations of smaller amplitude, and so on, continuously, to infinitesimal amplitude.

With the usual regenerative tube circuit, it would be very difficult, if at all practically possible, to make such adjustment, because the direct-current voltage on the grid condenser is necessarily less than the peak value of the alternating-current voltage impressed upon the grid. Hence, the blocking effect cannot manifest itself until the oscillations have built up to a steady value determined by the limits of the tube.

In the circuit shown in Fig. 1, however, the auxiliary biasing rectifier 18 and voltage-source 16 cause the grid condenser to charge up to a higher direct-current voltage than the peak of the alternating-current grid voltage. By reason of the feed-back coupling connection of the biasing coil 16, the amount of increase in the charge on the grid-condenser 8, and hence the blocking tendency of the system, is dependent upon the magnitude of the oscillations which are initially determined by the magnitude of the disturbing impulse or signal-current.

Thus, when a small signal-current is received, the oscillations may build up relatively slowly and nearly reach a steady state before the system becomes unstable, whereupon the oscillations are rapidly damped, as

indicated in Fig. 3. When the grid charge has decreased to a sufficiently low value, if the disturbing effect is still present, the cycle is repeated.

However, when strong signal-current is impressed upon the system, the amplitude of the oscillations and, as a result, the negative grid charge, as well as the feed-back energy rapidly build up to relatively large values before the feed-back energy becomes insufficient to overcome the positive damping of the system, whereupon the oscillations are blocked, as illustrated in Fig. 4.

The time necessary for the building up and subsequent blocking of the tube oscillations is, in each of the cases illustrated, approximately the same, inasmuch as, in the former case, lower alternating voltages and currents prevail in the plate circuit, while, in the latter case, the increased negative charge is accompanied by greatly increased alternating voltages and currents in the plate circuit. In other words, the frequency of the intermittent oscillations may remain substantially constant while the amplitude varies with the intensity of the signal-current.

In view of the foregoing description, it will be observed that the effect of the auxiliary biasing means is to cause the maximum amplitude of the intermittent oscillations to vary in accordance with the intensity of the disturbing impulses and that my invention is directly applicable to the detection of wireless signals. When receiving undamped-wave telegraph signals, it is desirable to have the intermittent-oscillations occur at an audible frequency, hence eliminating the customary heterodyning step.

However, when receiving continuous-wave telephone signals, a super-audible intermittent-oscillation frequency should be employed. Changes in the intermittent oscillatory frequency may be effected by varying the resistance of the grid leak 9, the auxiliary biasing coil 16 being simultaneously adjusted to maintain the optimum operating conditions. Other applications will readily suggest themselves to those versed in the art.

The modification shown in Fig. 2 differs from that of Fig. 1 in that the functions of tubes 1 and 18 of Fig. 1 have been combined in a single tube 27 employing an anode 28, a hot cathode 29 and a pair of grid members 31 and 32. The grid member 31, which corresponds to the anode 19 of Fig. 1, is either made more remote from the hot cathode 29 than the grid 32, or both, in order to reduce the effect of the grid 31 upon the plate-filament circuit.

The system is further modified by replacing coils 7 and 16 of Fig. 1 with a single coil 33, opposite terminals of which are connected, by conductors 34 and 35, to the grid 31 and the hot cathode 29, respectively. The shunt connected grid condenser 8 and leak

9 are included in series-circuit relation to the conductor 35. The grid 32 is connected, by a conductor 36, to an adjustable tap-point 37 on the coil 33. The grid biasing circuit now includes the coil 33, the conductor 34, the grid 31 and the conductor 35. The operation of this system is similar to that of Fig. 1.

While I have shown but two embodiments of my invention, for the purpose of describing the same and illustrating its principles, it is capable of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereon as are demanded by the prior art or are specifically set forth in the appended claims.

I claim as my invention:—

1. An electrical system having a high negative damping effect tending to cause said system to function as an oscillation generator, means tending to periodically introduce a blocking effect, means associated with said system carrying currents to be detected and means for modulating said blocking effect in accordance with the intensity of said currents.

2. In an electrical system, a regenerative feed-back system adapted to generate sustained oscillating currents, means tending to cause said system to oscillate intermittently, means carrying impulses to be detected and means for controlling the blocking of said system in accordance with the amplitude of said impulses.

3. In an electrical system, a feed-back circuit having a high negative damping effect tending to cause said system to function as an oscillation generator, means tending to periodically introduce a blocking effect, whereby said system oscillates intermittently, means carrying currents to be detected and means inherently modulating the intensity of the blocking effect in accordance with the amplitude of said currents.

4. In an electrical system, a regenerative feed-back system adapted to generate sustained oscillatory currents, means tending to cause said system to oscillate intermittently, means carrying currents to be detected and means associated with said former means and with said system for controlling the amplitude of said intermittent oscillations in accordance with the intensity of said currents to be detected.

5. In an electrical system, a regenerative feed-back system adapted to generate oscillatory currents, means for causing said system to oscillate intermittently, means carrying currents to be detected and means inherently effective to control the maximum amplitude of said intermittent oscillatory currents in accordance with the intensity of said currents to be detected.

6. An electrical system comprising an un-

balanced regenerative feed-back system, means for unbalancing said system, whereby the same may function as an oscillation generator, means for causing said system to oscillate intermittently and means associated with said system, whereby said intermittent oscillations are caused substantially to cease upon the removal of said unbalancing means.

7. An electrical system comprising a regenerative system having a large negative damping factor, a circuit carrying variable currents operatively associated therewith, said currents initially tending to start said regenerative system functioning as an oscillation generator, means for causing the oscillations generated thereby to occur intermittently according to a predetermined frequency and means cooperating with said last-mentioned means, whereby said regenerative system is rendered ineffective upon the elimination of said currents.

8. In an electrical system, a regenerative feed-back system adapted to generate sustained oscillatory currents, means having the effect of a leaky condenser associated therewith for causing said system to oscillate intermittently and auxiliary means for increasing the effect of said first-mentioned means.

9. In a regenerative feed-back system, a tube containing a controlling member, input and output circuits therefor so adjusted as to cause said tube to function as an oscillator, means for causing said controlling member to assume a charge comparable to the normal maximum alternating voltage impressed thereon during the oscillatory periods of said tube and means for greatly increasing said charge during such periods.

10. In a regenerative feed-back system, a tube containing a grid member, input and output circuits therefor, said circuits being so adjusted as to cause said tube to function as an oscillator, means having the effect of a leaky condenser associated with said grid member for causing the same to assume a negative charge comparable to the peak value of the normal alternating grid voltage effective during regenerative action and current-responsive means for increasing said grid-charge to values higher than said peak value.

11. In a regenerative feed-back system, a vacuum-tube device containing a control member, input and output circuits associated with said device, said circuits being so adjusted as to cause said tube to function as an oscillation generator, a shunt-connected capacitive reactance device and grid-leak device serially included in said input circuit, whereby charges are caused to form on said member comparable to the peak value of the alternating voltage impressed thereon, and means for increasing said grid-charge to values higher than said peak values.

12. In a regenerative feed-back system, a

vacuum-tube device containing a control-member, input and output circuits associated with said device, said circuits being so adjusted as to cause said tube to function as an oscillation generator, means having the effect of a leaky condenser included in said input-circuit for causing said member to assume a negative charge comparable to the peak value of the alternating voltage impressed thereon during regenerative action, means for deriving alternating-current energy from said system, means for translating said energy into unidirectional-current energy and circuit connections for impressing said latter energy upon said first-mentioned means.

13. In a regenerative feed-back system, a vacuum-tube device containing a control-member, input and output circuits associated with said device, said circuits being so adjusted as to cause said tube to function as an oscillation generator, means having the effect of a leaky condenser included in said input circuit for causing said member to assume a negative charge comparable to the peak value of the alternating voltage impressed thereon during regenerative action, means deriving alternating-current energy from said system, and a symmetrically conducting path for translating said energy into unidirectional impulses and circuit connections for impressing said impulses upon said first-mentioned means, whereby said grid-charge may be increased to values higher than said peak value.

14. The combination with an amplifier having input and output circuits, of a source of energy therefor, feed-back means associated therewith in such manner as to produce oscillations which are inherently blocked at periodical intervals and means responsive to variations in the amplitude of currents in said input circuit for causing substantially proportionate variations in the amplitude of said oscillations without materially changing the frequency of interruption thereof.

15. The combination, with an amplifier having input and output circuits, of a source of energy therefor, feed-back means associated therewith in such manner as to produce oscillations which are inherently blocked at periodic intervals and means operative upon the amplitude of said oscillations to a greater degree than upon the intermittent frequency thereof for modulating said oscillations in substantial accordance with the current-strength in said input circuit.

16. The combination, with an oscillation-generator system including an electron-tube having a controlling grid member, of means tending to cause static charges to build up on said grid member upon the generation of oscillations, means tending to dissipate

said charges, the constants of the system being so arranged that oscillations are generated and intermittently blocked by the accumulation of said charges, an input circuit operatively associated with said system and carrying oscillatory currents to be amplified and means for causing an increase in the rate of increase of said charges in response to the amplitude of said currents.

17. The combination, with a source of variable oscillatory currents of substantially constant frequency, of an oscillation-generator system of substantially the same frequency coupled thereto, said oscillation-generator system including an electron-tube having coupled output and input circuits, said input circuit including means performing the functions of a grid-condenser and grid-leak, the constants of said system being adjusted to produce oscillations which are inherently blocked at periodic intervals, and auxiliary means responsive to said variable oscillatory currents for impressing unidirectional electromotive force upon said grid-condenser means in such manner as to increase the rate of accumulation of charges thereupon.

18. The combination with a source of variable oscillatory currents of substantially constant frequency, of an oscillation-generator system of substantially the same frequency coupled thereto, said oscillation-generator system including an electron-tube having an anode, a cathode, and two grids, one of said grids operating as a controlling means for the anode current, means having the effect of the grid-condenser with said grid, the other of said grids being so constructed and arranged as to have a relatively slight effect upon said anode-current, and current-responsive means for imposing a unidirectional potential upon said last-mentioned grid in such manner as to increase the charge built upon said grid-condenser means.

19. The method of amplifying currents which consists in causing said currents to control the operation of an oscillation-generator system including an electron-tube having a grid and means for performing the functions of a grid-condenser and grid-leak, adjusting the constants of said system in such manner as to cause the oscillations to be intermittently blocked by the accumulation of charges on said grid-condenser means and causing auxiliary unidirectional potentials to be impressed upon said grid-condenser means in substantial accordance with the amplitude variations in the currents to be amplified.

In testimony whereof, I have hereunto subscribed my name this 4th day of January, 1922.

JOSEPH SLEPIAN.

Certificate of Correction.

It is hereby certified that in Letters Patent No. 1,455,768, granted May 15, 1923, upon the application of Joseph Slepian, of Swissvale, Pennsylvania, for an improvement in "Wireless Receiving Systems," an error appears in the printed specification requiring correction as follows: Page 4, lines 29 and 30, claim 13, for the words "and a symmetrically" read *an asymmetrically*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of June, A. D., 1923.

[SEAL.]

WM. A. KINNAN,
Acting Commissioner of Patents.