

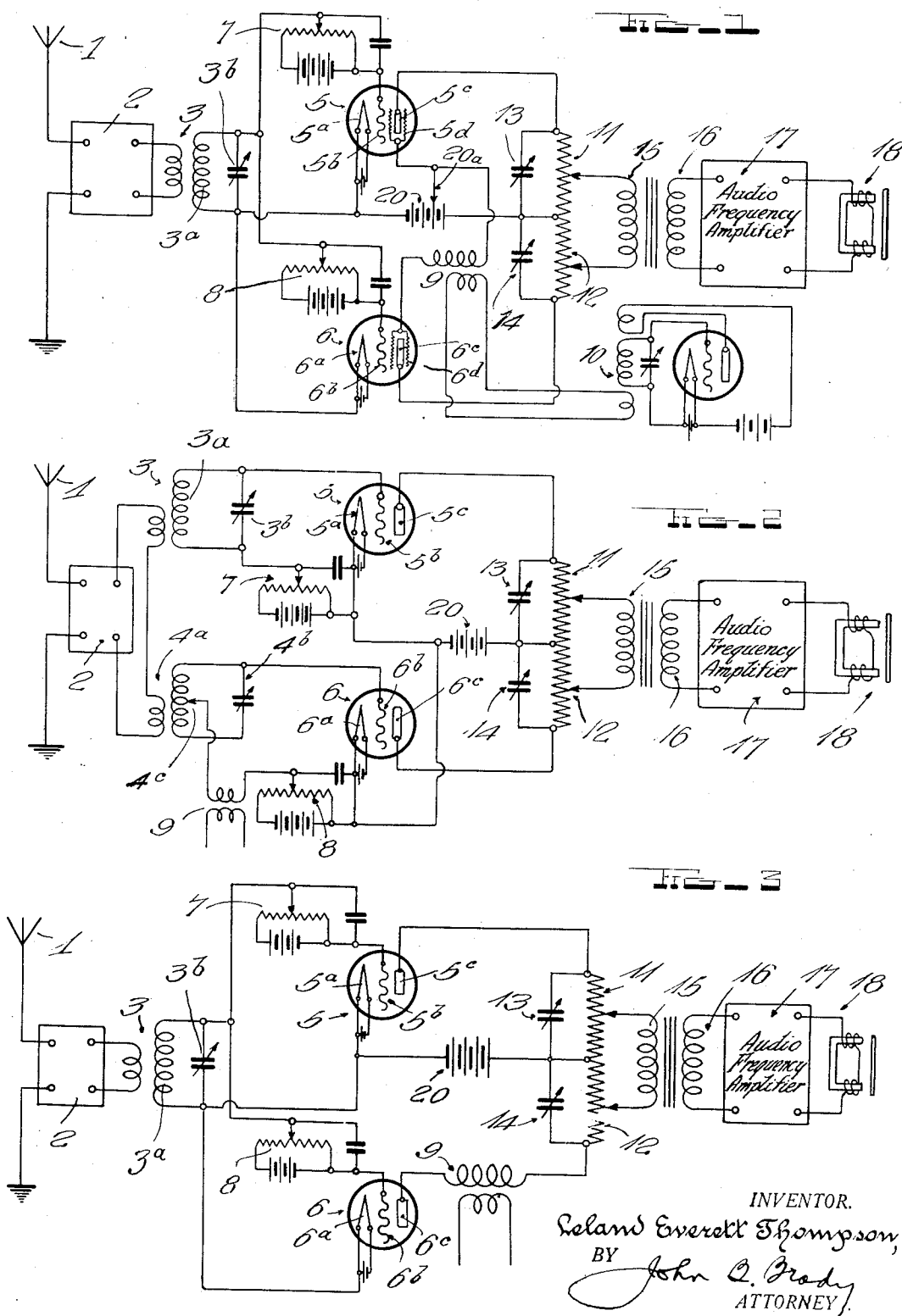
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RADIO TELEGRAPH AND TELEPHONE RECEPTION

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RADIO TELEGRAPH AND TELEPHONE
RECEPTION

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The invention relates to arrangements for eliminating disturbing effects when receiving messages from radio telegraph and telephone stations. The arrangements allow the reception of all electromagnetic waves which can produce beat currents of audio frequency with a local oscillator. Waves which do not produce beat currents of audio frequency with the local oscillator have no effect on the head telephones or other indicator. Atmospheric disturbances and all other effects producing, in the receiver, oscillations of an aperiodic or highly damped nature do not produce audio beat currents with the oscillator effectively and thus do not interfere with the reception of desired signals. According to the invention, radio waves which are aperiodic, or highly damped, are received in two circuits which are in opposition and are therefore not passed on to the indicating instrument. The local oscillator is used to produce beat currents in only one of these opposing circuits, consequently the beat currents are not opposed and are passed on to the indicating instrument.

The invention is shown by way of example in the accompanying drawing, in which Figure 1 shows the application of two four-element tubes for the detector circuit and Figures 2 and 3 the application of two three-element tubes.

In Figure 1, the antenna 1 and radio frequency amplifier 2 may be of any type. The tuned circuit 3 is connected to the grids of the two tubes 5 and 6. Tube 5 is provided with a cathode 5a, a control grid 5b, an anode 5c and a screen grid 5d. The electron tube 6 is provided with a cathode 6a, a control grid 6b, an anode 6c and a screen grid 6d. Arrangements 7 and 8 are provided for securing individual bias voltages on the control grids of the two tubes. Through the coupling coils 9, the oscillator 10 superimposes an oscillating voltage on the second grid 6d of the tube 6. This oscillating voltage produces a corresponding oscillating current in the plate circuit of the tube. Thus in the plate circuit of tube 6 there is produced a beat current between the desired signal frequency and the oscillator frequency. The local oscillator may be adjusted to a frequency differing from the signal by any desired amount. This beat frequency current in the plate circuit of tube 6 is rectified if either component or both component currents are rectified. That is, the grids connected to the signal frequency circuits may be operating on the straight portion of their grid voltage-plate current characteristic curves, while the grid connected to the local oscillator circuit is operating on a curved portion of its voltage-

plate current characteristic curve. This local oscillator voltage is then rectified in the plate circuit of tube 6 and consequently the combination or beat frequency voltage between the signal and the local oscillator is rectified in the plate circuit of the tube 6. In this condition the tube 5 is used to balance out any aperiodic oscillations which are rectified slightly due to a small curvature of the straight portion of the grid voltage-plate current characteristic curve of tube 6.

The bias voltages 7 and 8 are adjusted so that the tubes 5 and 6 operate on the same portion of their grid voltage-plate current characteristic curves. The source of potential 20 is employed for energizing the anodes 5c and 6c of tubes 5 and 6. A tap 20a is taken from the source of potential 20 to the screen grids 5d and 6d for applying the required screen grid potential to the tubes 5 and 6. Detection causes audio frequency currents to flow through the resistances 11 and 12 in the output circuits of the two tubes 5 and 6. The resistances 11 and 12 are arranged in a form of bridge circuit. When the proper adjustment is made, the currents flowing through 11 and 12 caused by a detector or rectifier action in the two tubes 5 and 6 will not cause a corresponding current to flow through circuits 15 and 16. That is, received disturbing effects are impressed on the grid circuit of both tubes 5 and 6 in the same manner. Through the resistances 11 and 12 therefore flow currents of the same frequency. Circuit 15 is therefore connected to two points on the resistances 11 and 12 which are always at the same potential with respect to each other and consequently the disturbing currents do not flow through the circuit 15. If however, an additional current flows through only one of the resistances, this current produces a potential difference across circuit 15 and a corresponding current therefore flows through the said circuit. The oscillator 10 is coupled through 9 to the second grid 6d of tube 6, and adjusted to such a frequency that beat currents of audio frequency are produced with the received currents. These beat currents flow through the resistance 12 and the circuits 15 and 16 and may be amplified and used to operate some form of indicator. In Figures 1, 2, and 3, 17 represents an audio frequency amplifier and 18 represents an indicator. Thus no audio frequency currents flow through circuits 15 and 16 except the beat currents produced by the local oscillator. The bias voltages 7 and 8 may be adjusted so that radio frequency currents in the grid circuits of the two tubes are not rectified. In this case the local oscillator

current must be rectified before being applied to the second grid of tube 6, or, this second grid must be worked on the proper point of its voltage, plate current characteristic curve in order that the resultant beat current shall be rectified. Thus the beat currents are rectified although the incoming signals alone are not.

An important feature of the invention is the use of the resistances 11 and 12. The phase relations of the currents and voltages in the output circuits of tubes 5 and 6 must be the same. Condensers 13 and 14 serve to by-pass any radio frequency currents present but are so small that they do not materially change the current-voltage phase relations of the circuit. They can, however, be made variable. Inductance coils may be used for 11 and 12 if the inductance and resistance is of such a value that the phase relation between current and voltage is substantially the same in each circuit.

The use of inductance coils or transformers for resistances 11 and 12 offers practical difficulties due to the distributed capacity and capacity to ground of the windings. These capacities are difficult to match in the two circuits, and the effectiveness of the system is greatly reduced. The resistances 11 and 12 also offer a very convenient means of adjusting the amplitude of the two voltages which are to be balanced, by the use of the sliding contacts on the resistances 11 and 12. This amplitude must be exactly the same in the opposing circuits when a signal is being received through interference which has an amplitude many times that of the signal. So slight an unbalance as one percent, that is, if one voltage had an amplitude one percent lower than the other, would cause the signal to be unreadable, in some cases. An important feature of the invention is that the use of the sliding contacts on the resistance arrangement 11 and 12 permits the amplitude of the voltages which are to be balanced to be adjusted without materially affecting the output plate circuit impedances of tubes 5 and 6. This is important since the changing of the plate circuit impedance would change the grid voltage-plate current operating characteristic and a complete balance of the undesired effects would be impossible.

In Figure 2, two three-element tubes are used for 5 and 6. In this arrangement, the two grid circuits are isolated by the use of a tuned circuit in each grid circuit. These two circuits 3 and 4 are tuned to the same frequency. Tuned circuit 3 comprises inductance 3a and tuning condenser 3b connected across cathode 5a and control grid 5b. The tuned circuit 4 comprises inductance 4a and tuning condenser 4b. The connection to the electrodes of electron tube 6 differs from the arrangement employed for tuned circuit 3 and electron tube 5. One end of the tuned circuit 4 connects to control grid 6b. However, the connection from cathode 6a extends through the secondary winding of transformer 9 to a mid-tap 4c on inductance 4a by which oscillations are introduced into the input system of tube 6. The oscillator superimposes a frequency through 9 to the grid circuit of tube 6, this frequency having such a value as to produce beat currents of audio frequency in circuits 12, 15 and 16. The bridge arrangement used for superimposing the oscillator frequency voltage on the grid of tube 6 prevents this frequency from being induced in circuit 3 and consequently little or no beat currents flow through circuit 11. This is necessary in order to allow the beat currents

in circuit 12 to flow on to circuits 15 and 16. Other means of superimposing the local oscillator on the grid of only one tube may be used. There are two requirements: First, the current induced in circuit 4 from the local oscillator must have a higher amplitude than that induced in circuit 3 from the local oscillator. This is obvious since otherwise the beat currents would be of the same amplitude in circuits 11 and 12 and would therefore be opposed. Second, the current induced in circuit 3 from the local oscillator must have a lower amplitude than that of the signal current in circuit 3. This is necessary in order that the amplitude of the beat frequency currents will be more nearly determined by the amplitude of the local oscillator current and consequently the amplitude of the beat frequency in circuit 4 will be greater than the amplitude of the beat frequency in circuit 3 and the two beat currents will not be entirely opposed and will pass to the indicating instrument.

The oscillator voltage may be superimposed on the plate circuit of only one tube, thus producing the beat currents directly in the plate circuit as shown by the arrangement in Figure 3. In this arrangement, the cathodes 5a and 6a connect to one end of the tuned circuit 3 while the control grids 5b and 6b connect to the opposite ends of the tuned circuit 3 through the bias control circuits 7 and 8. The course of potential shown at 20 serves to supply anode potential for anodes 5c and 6c of both tubes 5 and 6 as shown.

Arrangements for eliminating disturbing effects in radio telegraphy and telephony are known in which two receiving systems or circuits are used that are tuned to the same frequency and the energies that would produce disturbing effects are neutralized, while the useful energy that produces the signals is unequally distributed in the two receiving systems and is therefore not neutralized.

In the arrangement according to this invention, only one receiving system is used. An important factor in the successful operation of the system is high radio frequency amplification before detection. When two radio frequency currents of approximately the same amplitude are made to beat in the grid circuit of a vacuum tube, the output rectified beat current is approximately proportional to the product of the component currents. In the present system the signal frequency may be amplified to a comparatively high value, and the amplitude of the beat frequency may be made to be nearly dependent on the amplitude of the locally generated oscillations alone. Consequently the beat currents produced with the desired signal and those produced with the disturbing effects approach the same amplitude, if the amplitude of the impressed oscillator voltage is kept low with respect to the signal, although the disturbing effects may originally be very much stronger than the signals. Due to the aperiodic or highly damped nature of the disturbing effects, the beat currents formed between the said disturbing effects and the locally produced oscillations appear to be of a much lower intensity to the human ear than the beat currents produced with the desired signals. While the amplitude of the beat current between the disturbing effects and the locally produced oscillations may have approximately the same maximum value as the beat currents between the desired signal and the locally produced oscillations, the energy of the former beat currents

is much smaller than that of the latter beat currents:

There is a high loss or attenuation in the detector tubes 5 and 6 and it is necessary to use high audio frequency amplification after circuit 16 in order to produce a useful effect. Two detector or amplifier circuits are used in opposition and so adjusted that the opposition is practically complete. If a separate radio frequency amplifier is used to feed each detector circuit, the system is not effective because of the practical difficulty of working each vacuum tube in the one amplifier on the same portion of its grid voltage-plate current characteristic curve as the corresponding vacuum tube in the other amplifier. This causes the "linear distortion" of the interfering aperiodic or highly damped oscillations to be different in the two amplifiers, and a correct balance cannot be obtained in the plate circuits of the two detector tubes 5 and 6. For example, suppose with a weak interfering signal, one amplifier gave an amplification factor of 10, and the other an amplification factor of 9.5. For this particular signal level a balance could be obtained on the resistance bridge arrangement in the plate circuits of tubes 5 and 6. But now suppose a strong aperiodic or highly damped oscillation enters the two amplifiers. One amplifier might give an amplification factor of 9 and the other one an amplification factor of 8. There-
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When an indicator is used that produces sound waves, due to the characteristics of the human ear, strong disturbing currents must be reduced to a very small fraction of their original amplitude and this can be done only by adjusting the opposing circuits to have the same phase relation between current and voltage, and to have currents of substantially the same wave form in the said opposing circuits. This wave form is made the same in each opposed circuit by using vacuum tubes having similar grid voltage-plate current characteristic curves and operating on the same portions of the said curves. The currents must in addition have the same amplitude and frequency.

The desired signals are transformed into audio frequency currents by the production of beats with a local oscillator, these beat currents of audio frequency being rectified, amplified and used to operate some type of indicator.

I claim:

1. The method of receiving signals and eliminating disturbing effects in radio receiving systems which consists in amplifying to a high degree the received energy, detecting the amplified received energy in two circuits opposed to each other, maintaining the energy in each of said opposed circuits of the same wave form and maintaining the same phase relation between current and voltage, transforming the received energy in only one of the circuits by combining with locally produced oscillations, maintaining the amplitude of said locally produced oscillations appreciably smaller than the amplitude of the amplified received energy, amplifying the resultant of the opposed circuits and transforming into a useful effect.

2. The method of receiving signals and eliminating disturbing effects in radio receiving systems which consists in amplifying to a high degree the received energy, detecting the amplified received energy in two circuits opposed to each other, transforming the received energy in only

one of the circuits by combining with locally produced oscillations, maintaining the amplitude of said locally produced oscillations smaller than the amplitude of the amplified received energy to the extent that the amplitude of the resultant current of beat frequency is substantially dependent on the amplitude of the locally produced oscillations alone, amplifying the resultant of the opposed circuits and transforming into a useful effect.

3. A radio receiver for eliminating disturbing effects comprising a radio frequency amplifier, the output coupled to two tuned circuits, one in each grid circuit of two opposed detectors, an oscillator superimposing a voltage on only one of the said tuned circuits, means for adjusting the said opposed detectors for complete neutralization of the amplified received energy which does not combine with the locally generated oscillations, said means comprising separately adjustable grid bias voltages, a resistance in the plate circuit of each of the said opposed detectors with an adjustable condenser connected across each of the said resistances, an output circuit connected between a tap on one of said resistances and another tap on the other of the said resistances, and means for amplifying the energy which combines with the locally generated oscillations to produce a current of beat frequency to be used in operating an indicator.

4. In a radio receiver for eliminating disturbing effects comprising a radio frequency amplifier, two opposed detector circuits, an oscillator superimposing a voltage on only one of the said opposed detector circuits, means for adjusting the said detector circuits for producing rectified energy having the same wave form and the same phase relation between current and voltage, said means consisting of separately adjustable grid bias voltages and a resistance in the plate circuit of each of the said opposed detectors with an adjustable condenser connected across each of the said resistances and means for amplifying the energy which combines with the locally generated oscillations to produce a current of beat frequency to be used in operating an indicator.

5. In a radio receiver for eliminating disturbing effects comprising a radio frequency amplifier, two opposed detector circuits, an oscillator superimposing a voltage on only one of the said opposed detector circuits, means for adjusting the amplitude of the two opposing voltages due to the disturbing effects, which do not combine effectively with the local oscillator to the same value without materially changing the plate circuit impedance of either of the two said opposed detectors, said means comprising a resistance in the plate circuit of each of the said opposed detectors with an adjustable condenser connected across each of the said resistances, an output circuit connected to two adjustable contacts, one on each of the said resistances and means for amplifying the energy which combines with the locally generated oscillations to produce a current of beat frequency to be used in operating an indicator.

6. A radio receiver for eliminating disturbing effects comprising a radio frequency amplifier, a single tuned circuit connected to two amplifiers opposed to each other, an oscillator superimposing a rectified voltage and producing audio beat currents with the amplified received energy in only one of the two amplifiers, means for opposing any rectified energy due to strong disturbing currents, which do not combine effectively with

- the local oscillator current, in one of the amplifiers by the other amplifier adjusted to produce the same wave form of rectified currents and having in its output circuit the same phase relation between current and voltage, said means consisting of separately adjustable grid bias voltages and a resistance bridge arrangement with adjustable condensers arranged to permit adjustment of the opposing voltages without materially changing the impedance in the plate circuit of said opposed amplifiers, and means for amplifying the beat currents to be used in operating an indicator.
7. In a signal receiving system, a tuned circuit, a pair of electron tubes each having input and output circuits, connections between the input circuit of each of said electron tubes and said tuned circuit, a source of potential common to the output circuits of each of said electron tubes, an output system, means symmetrically connecting the output circuits of said electron tubes with said output system, a source of local oscillations, and means for coupling said source of oscillations with the circuits of one of said electron tubes.
8. In a signal receiving system, a signal receiving circuit, a pair of balanced electron tubes having their input circuits connected in parallel, means for coupling said parallel connected input circuits to said signal receiving circuit, an output circuit connected with each of said tubes, an output system, means for symmetrically connecting the output circuits of said balanced electron tubes with said output system, a local source of oscillations, and means coupling said local source of oscillations with one of the output circuits of said symmetrically connected balanced electron tubes.
9. In a signal receiving system, a pair of electron tubes connected in balanced relationship, each of said electron tubes including a cathode, a control grid, a screen grid and an anode, an input system connected with said cathodes and said control grids, an output system connected with said anodes and said cathodes, a source of high frequency oscillations, and a connection between said source of high frequency oscillations and the screen grid in one of said tubes.
10. In a signal receiving system, a pair of electron tubes each having input and output circuits, a tuned input system, connections between the input circuits of each of said electron tubes and said tuned input system, a phase controlling path in each of said output circuits, a source of potential common to each of said output circuits, means for superimposing local oscillations upon one of said output circuits, and an output system symmetrically coupled to the phase controlling paths in said output circuits.
11. In a signal receiving system, a pair of electron tubes each having input and output circuits, a tuned circuit comprising an inductance shunted by a capacity individual to the input circuits of each of said electron tubes, a phase adjusting path in the output circuit of each of said electron tubes, a source of potential common to each of said output circuits, an output system symmetrically coupled with the phase adjusting paths in said output circuits, a source of local oscillations, and means for introducing said local oscillations in the input circuit of one of said electron tubes.
12. In a signal receiving system, a pair of electron tubes each having input and output circuits, a tuned circuit comprising an inductance shunted by a capacity individual to the input circuits of each of said electron tubes, a phase adjusting path in the output circuit of each of said electron tubes, a source of potential common to each of said output circuits, an output system symmetrically coupled with the phase adjusting paths in said output circuits, a source of local oscillations, a circuit extending between the cathode of one of said electron tubes and the midpoint of the inductance in one of said tuned input circuits, and means coupling said local oscillator with said circuit for introducing oscillations in the input circuit of the said electron tube.
13. In a signal receiving system including a pair of electrically balanced electron tube circuits connected to the same tuned input system and having symmetrically related output circuits, the method of maintaining the same phase relation between current and voltage in the output circuits and maintaining the wave form of energy delivered by the electron tube circuits the same in the output circuits of two electron tube circuits, which consists in applying oscillations to the electron tube circuits in an out of phase relation to the phase relation of the balanced electron tube circuits and adjusting the output circuits of the electron tube circuits for deriving a constant and substantially identical phase relation between current and voltage in the output circuits of the balanced electron tube circuits.
14. In a signal receiving system, a pair of electron tubes each having input and output circuits symmetrically connected in balanced arrangement, a tuned input system, connections between the input circuits of both of said electron tubes and said tuned input system, a source of potential common to the output circuits of said electron tubes, each of said output circuits including a phase controlling resistance element shunted by a condenser, a source of oscillations coupled to one of said output circuits, an output system, a coupling device connected with said output system and a tap on each of said resistance elements connected to points of opposite potential on said coupling device.
15. In a signal receiving system, a pair of balanced electron tubes each having input and output circuits connected in balanced symmetrical relation, a radio frequency tuned input system, connections between said input circuits and said radio frequency tuned input system, a source of potential common to said output circuits, a resistance element having its center point connected with the positive side of said source of potential and having one end thereof connected with the anode of one of said electron tubes and the other end thereof connected with the anode of the other electron tube, a radio frequency bypass condenser connected across the central point and the end of said resistance element in each of said output circuits, a source of oscillations coupled to one of said output circuits, an output system, a coupling device connected with said output system, and connections intermediate the central point of said resistance element and the opposite ends thereof extending to points of opposite potential on said coupling device.

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