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MODULATED CARRIER WAVE RECEIVING SYSTEM

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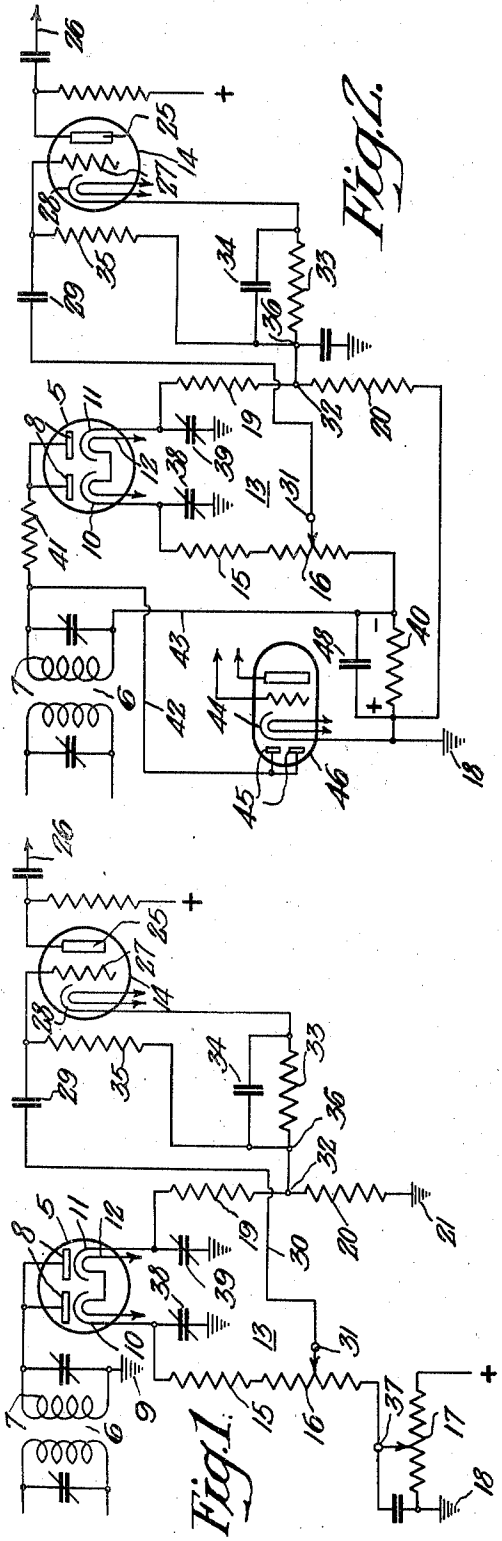


Fig. 1.

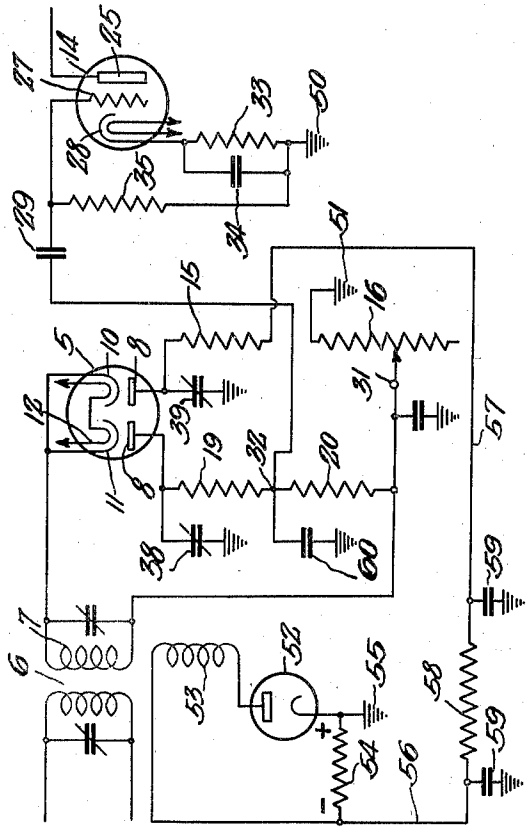


Fig. 2.

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MODULATED CARRIER WAVE RECEIVING SYSTEM

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8 Claims. (Cl. 250—20)

The present invention relates to a modulated carrier wave receiving system, and has for its primary object to provide a detector and amplifier network in a system of the character referred to, wherein the reduction of static noises and interference from undesired signals may be prevented or materially reduced for modulated carrier wave reception.

This invention is related to a system of the type shown and described in my U. S. Patent No. 1,929,086, for Radio telegraph and telephone reception, wherein a static limiter circuit is shown, described and claimed, which comprises a balanced detector.

In the system referred to, the balanced detector is arranged to make use of the principle of a heterodyne straight line detector wherein the output beat frequency of two input voltages of different frequencies has an amplitude dependent only upon the amplitude of the smaller of the input voltages and is independent of the larger voltage. The circuit operates as a signal limiter when the smaller voltage is supplied by a local oscillator and the larger voltage is provided by disturbing effects such as static or an interfering radio signal wave.

It is a further object of the present invention to provide a simplified circuit embodying a balanced detector such as employed in the system referred to in the patent, wherein the local oscillator coupled to the detector circuit may be eliminated for the reception of modulated signals or a modulated carrier wave.

In carrying out the invention, a balanced diode detector circuit is employed and a controllable D. C. bias is provided on one of the diode detectors, which operates to provide signal amplitude limitation effectively in the reception of modulated carrier wave signals without the use of an oscillator. In the balanced output impedance network for the balanced diode detector, means are provided for introducing a biasing potential into one leg of the network, and further means are provided for deriving an output signal from said network and applying the same to an amplifier through a connection with the cathode and control grid of the amplifier. The network may be balanced with respect to static and undesired signal waves having an amplitude above a predetermined normal value, such, for example, as amplitudes above 100% modulation of a desired received signal.

This simplification is of importance in the reception of broadcast signals, for example, and in the production of broadcast receiving apparatus, for the reason that the oscillator and means for maintaining a suitable oscillator amplitude may be eliminated, and in lieu thereof, there may be substituted a simple diode rectifier circuit in connection with a balanced output network for the detector, which is entirely stable in operation.

It is a further object of the present invention to provide an improved detector circuit for modulated carrier wave reception which operates automatically in response to variations in carrier wave or signal strength to provide a predetermined static and interference reduction without manual adjustment.

It is another object of the present invention to provide, in a system of the character referred to, an improved output coupling network between the balanced detector and the following amplifier, wherein an audio frequency coupling transformer may be eliminated and an improved control of the output from the detector may be obtained.

The invention will, however, be better understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Figure 1 is a schematic circuit diagram of a signal demodulator or detector and amplifier circuit for a modulated carrier wave receiving system embodying the invention;

Figure 2 is a similar schematic circuit diagram of the system shown in Fig. 1 and provided with automatic control means responsive to signal amplitude variations or carrier wave strength in accordance with the invention; and

Figure 3 is a further schematic circuit diagram showing a modification of the circuit of Fig. 2 and also embodying the invention.

Referring to Fig. 1, a double diode rectifier device 5 is provided as a modulated signal detector or demodulator, and in the present example is shown in connection with an intermediate frequency amplifier output transformer 6. The tuned secondary 7 of the transformer 6 is connected at its high potential side to the diode anodes 8 in parallel, and on its low potential side to ground or chassis as indicated at 9.

The rectifier is of the double diode type having two cathodes 10 and 11, which are indirectly heated by a heater element 12. The cathodes are connected into separate circuits forming part of a balanced output impedance network 13, by which the operation of the rectifier as a limiter is controlled, and through which it is coupled as a detector to a following amplifier tube 14 for the modulation of the audio frequency component of the receiver modulated signal.

In accordance with the invention, the cathodes 10 and 11 are each connected through a phase controlling resistor and capacitor branch of a resistance bridge arrangement to ground or a return circuit to the common tuned input circuit provided by the secondary 7. The cathode 10 is connected through one branch of the balanced output impedance network, comprising a resistor

section 15, a resistor section 16, and a potentiometer resistor 17, to ground 18, while the cathode 11 is connected through the other branch of the network comprising a resistor section 19 and a second resistor section 20 to ground 21.

The amplifier device 14 is provided with an output anode 25 having an audio frequency output circuit 26 in connection therewith, a control grid 27, and a cathode 28. The control grid 27 is coupled through a coupling capacitor 29 and a lead 30 with an adjustable contact 31 on the output resistor leg 15—16 for the cathode 10, and the cathode 28 is connected to a fixed tap point 32 on the resistor leg 19—20 for the cathode 11, which in the present example is between the resistor sections 19 and 20.

The cathode connection for the amplifier 14 includes a self-bias resistor 33 shunted by a suitable bypass capacitor 34, and the grid 27 is provided with a bias supply connection through a grid resistor 35 to the negative terminal 36 of the resistor 33.

In the present connection, the capacitor or ground connection may be considered as the negative anode potential supply connection, and accordingly, it will be seen that the anode current for the amplifier 14 flows through the resstor 33 and the resistor section 20 to ground 21, placing the usual fixed self-bias on the grid 27 with respect to the cathode 28.

The resistor 17 is provided with an adjustable contact 37 whereby it functions as a potential supply source which may be adjusted to include a variable portion of the resistor 17 in circuit with the resistor leg 15—16 and the corresponding potential drop in the resistor 17, the polarity of the supply source being such that as the contact 37 is moved to the right, as viewed in the drawing, an increasing positive potential is applied to the cathode 10 with respect to the corresponding anode 8.

The resistance elements in the two branches of the output impedance network are arranged to provide substantially equal impedance to the flow of current from the two cathodes 10 and 11 from the common input circuit provided by the secondary of the intermediate frequency transformer 6, whereby the output circuit from the detector 5 may be balanced for the flow of signal currents, and the output network is further balanced by means of shunt capactors indicated at 38 and 39, connected respectively between the cathodes 10 and 11 and ground, across the respective branches of the network.

In response to a received carrier wave or intermediate frequency signal, it will be seen that the signal wave is applied to both diode anodes 8 in parallel, and the rectified current from each cathode flows through the branches of the balanced output network 15—16 and 19—20. The resistance elements of the two branches are such that substantially equal current flows through the two branches to the ground connections 21 and 18, and returns to the ground 9.

In any case, the alternating current and direct current components of the rectified signal wave are such that the output contact 31 in one branch of the network may be moved to a point of balance or equal potential to that at the output terminal 32 in the other branch of the network. With a strong signal on the detector 5, the contact 31 is adjusted to provide a zero output with respect to the terminal 32, that is, both the contact 31 and the terminal 32 are at equal potential points on the two branches of the network. The capacitors 38 and 39 are also adjusted for maintaining the phase relation and wave form of energy the same in the two branches, thereby further to balance the two branches of the network and further to reduce the output potential existing between the terminals 31 and 32.

The adjustable bias voltage provided by the potentiometer 17 is reduced to zero by moving the contact 37 to the ground end of the resistor, and under such conditions it will be seen that the rectified currents passing through the resistor section 20 will produce a voltage which is applied to the cathode of the amplifier tube 14, and the rectified currents passing through the resistor section 16 will produce a like potential on the grid of the amplifier 14. Thus the potential difference between the grid and the cathode of the amplifier 14 may be made substantially zero and the circuit is balanced.

If a D. C. bias potential equal to approximately twice the signal carrier voltage is applied to the cathode 10 with respect to ground and the corresponding anode 8, the branch circuit of the output network, including the cathode 10 and the resistor sections 15 and 16, will not function on the signal, and accordingly, the signal voltage across the resistor section 20 will be applied to the amplifier 14 and transmitted to the output circuit 26, which may lead to other audio frequency amplifiers and a suitable output device (not shown), as is well understood.

Peak voltages from static and other undesired signal waves which rise above the bias voltage will produce rectified currents through the resistor section 16 as well as the resistor section 20, and will be balanced out of the circuit. By adjusting the contact 31 and the capacitors 38 and 39 for zero output from the balanced output network, and by placing a desired positive biasing potential on the cathode 10, it will be seen that the network may transmit signals having a peak value below the value of the biasing potential, and will cut off signals having a peak value higher than the adjusted biasing potential. In order to permit the full reception of signals having 100% modulation, the biasing potential on the anode 10 should be approximately twice the signal carrier voltage.

From the foregoing description, it will be seen that the detector comprises a double diode rectifier having separate cathodes connected each to one branch of a symmetrical balanced output circuit having resistance and capacity such that the phase relation and wave form of energy passing through the output circuits may be the same in each branch. This includes a balanced output impedance network having means for introducing a biasing potential into one branch of the network and a balanced output connection at equal potential points on each branch for deriving an output signal from the network when the signal peak voltage is equal to or less than the value of the biasing potential.

With a receiver having a comparatively flat A. V. C. characteristic, no further adjustment of the balance or bias voltage is necessary in operation. However, if the signal level on the detector 5 varies appreciably, the adjustable bias voltage in circuit with the cathode 10 and its corresponding anode must be adjusted for optimum results.

Because of the fact that it is generally difficult to obtain a substantially flat A. V. C. characteristic, it has been found desirable to provide

an improved arrangement for the biasing potential source 17 whereby it requires no manual adjustment when the signal level at the detector varies over a relatively wide range, while at the same time maintaining the static and undesired signal reduction at an optimum value. For this purpose the circuit of Fig. 2 is provided, and attention is now directed to this figure, wherein the same circuits and elements as in Fig. 1 are employed and designated by the same reference numerals except for the bias control arrangement which will be described in connection with Fig. 2.

Referring to Fig. 2, a bias potential supply source 40 is included in circuit between ground 18 and the resistor sections 15 and 16 in the output branch connected with the anode 10, as in Fig. 1. However, in this case the input circuit provided by the tuned secondary 7 is connected through a series resistor 41 with the parallel connected anodes 8 of the rectifier 5, and the input circuit is further shunted by a rectifier circuit 42—43 including a diode rectifier having a cathode 44 and a pair of parallel connected anodes 45 included in an amplifier device 46 used in other portions of the receiver. The lead 42 is connected with the anodes 45, and the lead 43 is connected through the potential source or resistor 40 to the cathode 44, whereby signals received on the tuned secondary 7 are rectified and appear as a D. C biasing potential across the resistor 40.

With this arrangement, the biasing potential on the cathode 11 is obtained by rectifying the signal carrier by means of the diode portion of the tube 46. This produces a D. C. voltage across the resistor 40 proportional to the carrier amplitude. The modulation of the carrier is removed from the resistor 40 by a large bypass capacitor indicated at 48 connected in shunt therewith. The cathode 11 is then biased with respect to its corresponding anode by an amount proportional to the carrier amplitude when a modulated signal or carrier wave is received through the intermediate frequency amplifier output transformer 6.

As the bias potential delivered by the source 40 and also by the source 17 in the circuit of Figure 1, preferably is substantially twice the value of the carrier voltage on the detector so that 100% modulated signal may be received without distortion, means are provided to reduce the carrier voltage on the detector by a required amount. In the present example, this is provided by the resistor 41 in series with the diode anodes of the detector 5, although it may be obtained by other suitable means.

The circuit shown in Fig. 2 has been found to be effective in ultra high frequency receivers for police work in a band between 30 and 40 megacycles wherein the receiver is subject to considerable interference from noise disturbances about city streets and in particular from passing automobiles and trucks.

In operation, the circuit is the same as that of Fig. 1 except for the automatic bias control for one branch of the diode output circuit whereby the positive potential on the cathode 11 increases with signal strength to maintain an optimum voltage for static reduction and interference prevention from undesired signals.

Referring now to Fig. 3 and the modification of the circuit of Fig. 2, the diode rectifier or detector 5 is connected to the intermediate frequency output transformer 6 and the tuned secondary 7 thereof, with the cathodes 10 and 11 connected in parallel to the high potential side of the circuit, while the anodes 8 are connected through the separate branch resistors of the output circuit as indicated at 15 and 16 and 19 and 20. In the present example, the resistor 16 is made variable in value and is grounded at one end to the cathode self-bias resistor 33 as indicated at 50 and 51. The terminal 32 between the resistor sections 19 and 20 is connected to the grid 27 of the amplifier tube 14 of the cathode. However, the output operation is the same as in the circuit of Figs. 1 and 2. The circuit is balanced by adjusting the contact 31 on the resistor 16 as in the previous circuits.

In the present circuit, the biasing potential which is varied in accordance with the variations in signal strength or carrier wave amplitude, is provided by a rectifier device 52 coupled to the transformer 6 through a coupling winding 53 and having an output resistor 54 grounded at its positive end as indicated at 55 and having the opposite end connected to a lead 56—57 with the resistor 15. In this manner, the resistor 54 is included in circuit between the resistor 15 and the resistor 16 as a variable potential source or biasing voltage for the cathode 10 with respect to the corresponding anode 8.

A suitable intermediate frequency and audio frequency filter is provided between the leads 56 and 57 comprising a series resistor 58 and suitable bypass capacitors 59. A corresponding bypass capacitor 60 is also provided between the terminal 32 and ground for assisting in balancing the output circuit.

The operation of the circuit of Fig. 3 is as follows: Signals received through the intermediate frequency output transformer 6 are rectified by the detector 5 and the rectified modulated signal appears across the output branches of the balanced output impedance network comprising the resistor sections 19—20 and 15—16. The cathode of the amplifier device 14 is connected to ground which in effect is a connection at a tap point between the resistors 15 and 16 and the grid 27 is connected with the tap point 32 between the resistor sections 19 and 20. By adjusting the contact 31 the cathode and control grid may be effectively connected to equal potential points on the two branches of the output network whereby a zero signal output is obtained from the balanced network.

However, the carrier wave is rectified by the rectifier 52 and the D. C. bias resulting therefrom is applied between the cathode 10 and the corresponding anode 8 in a direction to cause the cathode 10 to become more positive with increased carrier wave strength, thereby to maintain the noise suppression at a predetermined optimum value, preferably for 100% modulation, by preventing rectification up to and including such modulation. By providing a transformer winding to supply the diode bias circuit, the voltage may be stepped up as is desirable for providing a biasing potential substantially equal to twice the signal carrier voltage.

The rectifier circuit including the cathode 10 does not function on the signal, and the signaling voltage across the resistor 20 is then applied to the amplifier 14. Peak voltages resulting from static and undesired signals which rise above this value produce rectified currents through the resistor 16 corresponding to those through the resistor 20, and is thus balanced so that no output voltage is applied to the amplifier 14.

I claim as my invention:

1. In a modulated carrier wave receiving system, a modulated carrier wave signal circuit, a diode rectifier device connected with said circuit and having two output electrodes, means providing two balanced output impedance circuits for said rectifier device each comprising an output electrode of said rectifier, means providing an output tap connection on said output impedance circuits at substantially equal potential points thereon whereby the output from said circuits through said tap connections may be balanced, and means responsive to variations in the amplitude of a received carrier wave for applying a biasing potential to said rectifier device through one of said output impedance circuits.

2. In a modulated carrier wave receiving system, the combination of a signal rectifier comprising a double diode rectifier device, means providing an output circuit for said rectifier device having two branches of substantially equal impedance to the flow of rectified signal currents, means providing a balanced signal output connection on said branches at substantially equal potential points thereon, means providing a source of biasing potential for said rectifier device in one of said branches, and means for causing the potential of said source to vary in proportion to the carrier wave amplitude.

3. A modulated carrier wave receiving system including, in combination, a modulated signal detector circuit, double diode rectifier means in said circuit having separate cathodes, means providing a symmetrical balanced output circuit for said rectifier means having separate branches connected one in circuit with each of said cathodes, said output circuit including resistance and capacity means such that the phase relation and wave form of energy passing through the output circuit may be substantially the same in both branches, means for introducing a biasing potential into one branch of the output circuit, and means providing a balanced output connection at equal potential points on said branch whereby the modulation component of a received signal may be derived from the output circuit when the signal peak voltage is equal to or less than the value of said biasing potential.

4. A modulated carrier wave receiving system including, in combination, a modulated signal detector circuit, double diode rectifier means in said circuit having separate cathodes, means providing a symmetrical balanced output circuit for said receifier means having separate branches connected one in circuit with each of said cathodes, said output circuit including resistance and capacity means such that the phase relation and wave form of energy passing through the output circuit may be substantially the same in both branches, means for introducing a biasing potential into one branch of the output circuit, means providing a balanced output connection at equal potential points on said branch whereby the modulation component of a received signal may be derived from the output circuit when the signal peak voltage is equal to or less than the value of said biasing potential, and means including a second signal rectifier responsive to variations in the amplitude of a received carrier wave for supplying said biasing potential.

5. In a modulated carrier wave receiving system, the combination of a signal rectifier comprising a double diode rectifier device, means providing a common tuned input circuit for said device, means providing an output circuit for said device having two impedance branches comprising phase controlling resistor and capacitor elements, an amplifier having a cathode connected with one of said branches and a control grid connected with the other of said branches, means for adjusting said last-named connections to provide substantially equal signal potentials on said grid and cathode, a signal rectifier having an output impedance, and means for variably including said output impedance in one of said impedance branches.

6. In a superheterodyne receiver, an intermediate frequency amplifier having an output transformer, a diode rectifier circuit connected to said output transformer to receive modulated signals therefrom and including two diode signal rectifiers, means providing an output circuit for said rectifiers having two substantially equal impedance branches and a common return connection to both rectifiers, an output resistor in each of said branches, means providing a signal output connection on each of said resistors at equal potential points thereon, and means providing a variable potential source in one of said branches for preventing rectification and signal output therethrough below a predetermined signal level, said last named means comprising a carrier wave rectifier having an output resistor connected serially in circuit with the resistor in said branch.

7. In a superheterodyne receiver, an intermediate frequency amplifier having an output transformer, a diode rectifier circuit connected to said output transformer to receive modulated signals therefrom and including double diode signal rectifier means, means providing an output circuit for said rectifier means having two substantially equal impedance branches, means providing a signal output connection on each of said branches at equal potential points thereon, and a variable potential source in one of said branches for preventing rectification and signal output therethrough below a predetermined signal level, said variable potential source comprising a diode rectifier output resistor, a diode rectifier connected therewith, and means for coupling said rectifier to said intermediate frequency amplifier to apply signals to said rectifier.

8. In a modulated carrier wave receiving system, an amplifier having an output circuit, a modulated signal detector coupled to said output circuit and comprising a tuned input circuit and double diode rectifier means connected in parallel to said input circuit, means providing parallel branch output circuits for said rectifier means, means for selecting the modulation output from said rectifier means comprising a circuit connected to substantially equal potential points on said branch output circuits, means for adjusting said last-named connection for balancing the output including a potentiometer resistor and variable capacity means connected in parallel with each branch output circuit, and means responsive to variations in the amplitude of a received carrier wave for applying a biasing potential to said rectifier means through one of said branch output circuits, said last-named means being adjustable for balancing the output from said rectifier means in response to signals having amplitude peaks above a predetermined lever.

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