April 8, 1941. B. D. H. TELLEGEN 2,237,457

APERIODIC DISTURBANCE SUPPRESSION CIRCUITS

Filed March 11, 1939 2 Sheets-Sheet 1

Fig. 1

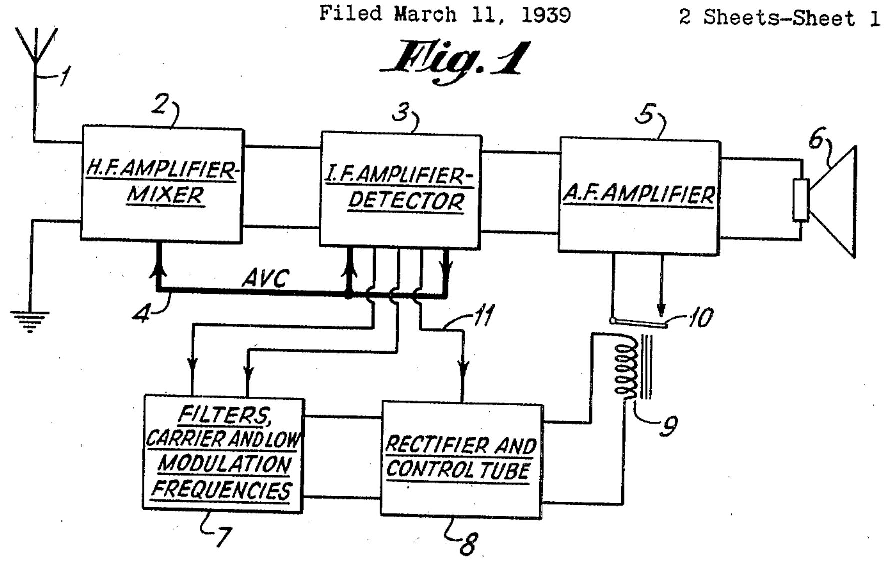
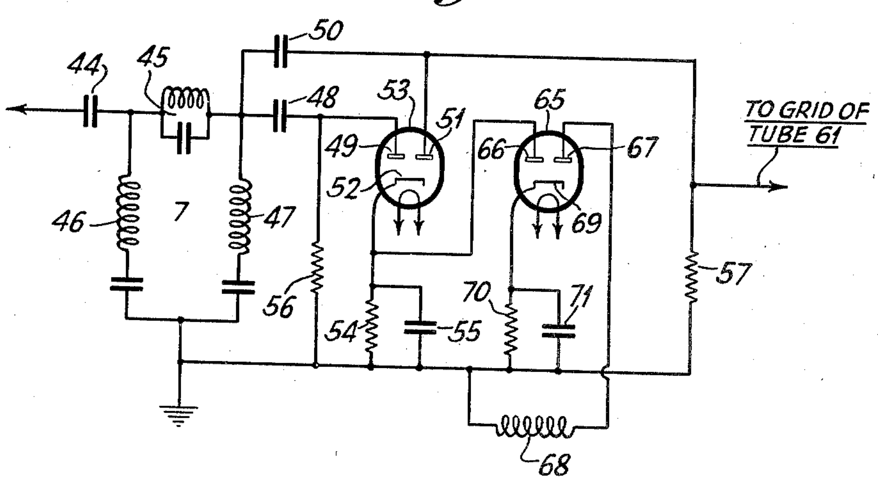


Fig. 3



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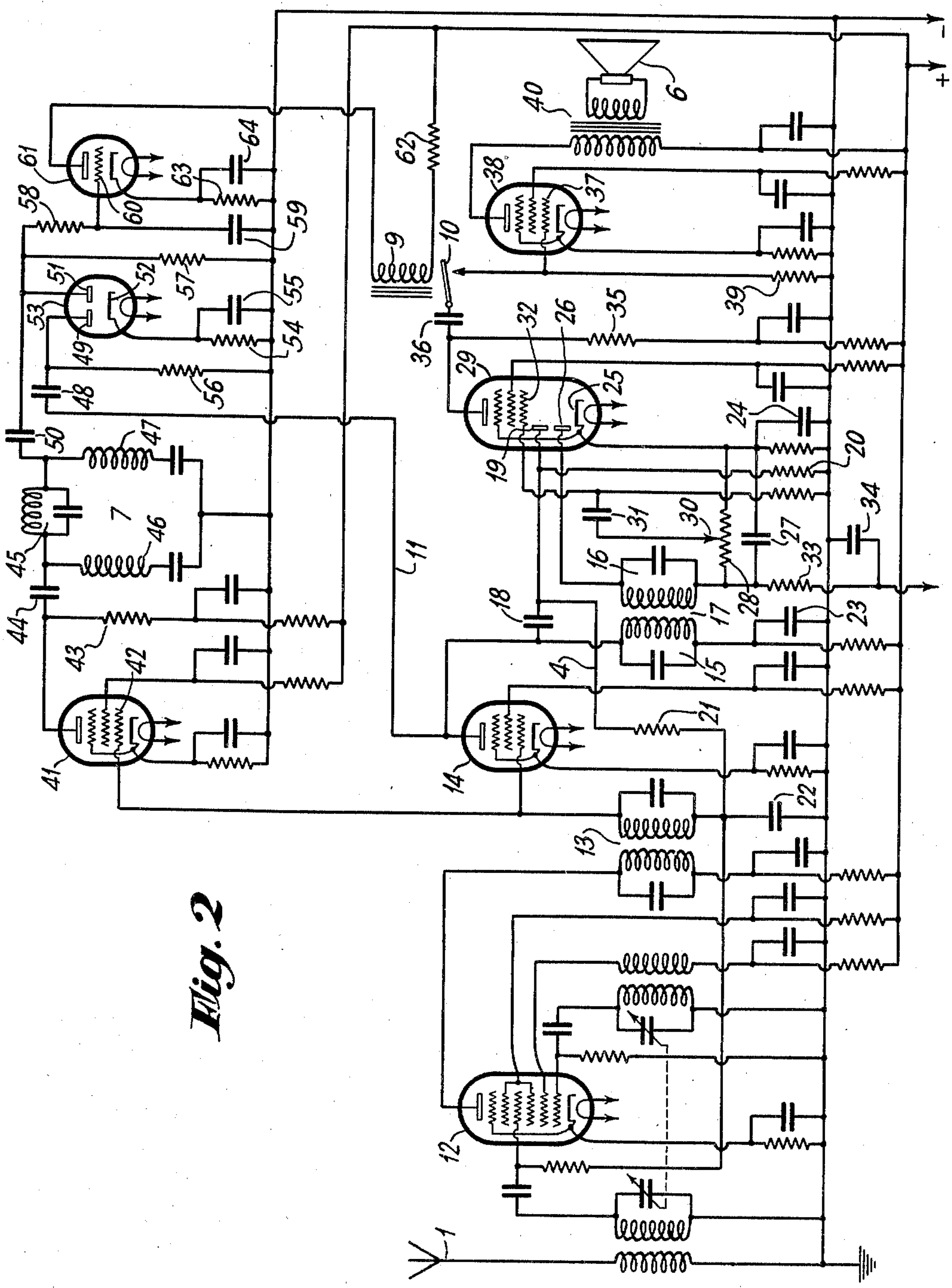

Fig. 2

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2,237,457

UNITED STATES PATENT OFFICE

2,237,457

APERIODIC DISTURBANCE SUPPRESSION CIRCUITS

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Application March 11, 1939, Serial No. 261,257
In the Netherlands June 24, 1938

5 Claims. (Cl. 250—20)

The invention relates to a radio receiver comprising means for suppressing aperiodic disturbances.

It is known to utilize a device which makes the low frequency amplifier inoperative during the duration of a disturbance. Such a device may not be actuated, as a matter of course, by the desired signal, and it has, therefore, been proposed to construct the device in such manner that it only responds to disturbance amplitudes which are larger than double the carrier wave amplitude of the desired signal, for with a modulation depth of 100% the maximal signal amplitude is equal to double the carrier wave amplitude. Only disturbance voltages larger than double the carrier wave amplitude can actuate the said device, and thus block up the low frequency amplifier. In order to be able also to suppress smaller disturbance voltages it has been proposed to have the device for making the low frequency amplifier inoperative actuated by voltages set up within a frequency spectrum which is not occupied by a broadcast transmitter, and which is located as close as possible to the received frequency spectrum. The threshold value over which disturbance elimination takes place may be taken in this case as low as desired. This entails, however, the following drawbacks. Firstly, an unoccupied frequency spectrum can rarely be found, and, when found, it is generally not located close to the desired signal. Throughout the entire frequency spectrum the disturbance voltage does not have, in general, a constant intensity, so that in these circumstances the low frequency amplifier becomes inoperative when it is not necessary, or, inversely, is not made inoperative when it is necessary.

The invention has for its object to provide a device which permits the elimination of at least part of the interfering voltages which are smaller than twice the carrier wave amplitude.

According to the invention, this purpose is attained by supplying the received high, intermediate, or low frequency oscillations to an auxiliary channel which includes a filter which does not pass at least the carrier wave and those sideband frequencies of the high, or intermediate, frequency oscillations which correspond to the lowest modulation frequency, or the lowest modulation frequencies of the low frequency oscillations respectively, while after a determined threshold value has been surpassed the voltages of the remaining frequencies actuate a device for making the low frequency amplifier inoperative. The filter included in the auxiliary channel may, for example, be a band-blocking filter. Also, if the received high, or intermediate, frequency oscillations are supplied to the auxiliary channel, the filter included in this channel may be a low, or a high, pass filter.

The voltages of the remaining frequencies are preferably supplied to a biased rectifier, so that they are not rectified until a determined threshold value has been surpassed, and are supplied as a control direct current voltage to the said device for making the low frequency amplifier inoperative.

According to a further embodiment of the invention, the voltages of the remaining frequencies are rectified and supplied as a control direct current voltage to the device for making the low frequency amplifier inoperative, in such manner that this device starts operating as soon as the said control direct current voltage surpasses a determined threshold value.

It is advisable slowly to control the threshold value in dependence on the intensity of the carrier wave of the received signal, and this in such manner that the threshold values increase with an increasing intensity of the carrier wave.

It is also possible slowly to control the said threshold values in dependence on the value of the voltages of the remaining signal frequencies, and this in such manner that the threshold values increase with an increasing value of the said voltages, in which event means should preferably be provided to prevent the threshold values from exceeding a predetermined value, which maximum threshold value may be determined in this case by the intensity of the carrier wave of the received signal.

The invention affords the possibility of suppressing part of the disturbances which are smaller than double the carrier wave amplitude, since the device for making the low frequency amplifier inoperative can now be actuated by disturbance voltages which are larger than the signal voltages furnished by the high modulation frequencies which are located, for example, over 2500 cycles per second, which signal voltages are considerably smaller than double the carrier wave amplitude. The modulation depth of the frequencies over 2500 cycles per second is under ordinary conditions at the most about 10%. If the auxiliary channel is branched from the high, or intermediate, frequency amplifier, the carrier wave as well as the frequency corresponding to the lowest modulation frequency have to be suppressed in this auxiliary channel. Use may be made for this purpose of a band-blocking filter, but it is also possible to utilize a high, or low pass filter with the aid of which not only the carrier wave and the low modulation frequencies, but also the remainder of one of the side-bands can be suppressed. There is thus obtained the advantage that for the elimination of aperiodic disturbances that side-band may be utilized which is not disturbed by a transmitter adjacent as to frequency. If, namely, one of the side-bands of the received signal comprises frequencies which originate from a transmitter adjacent as to frequency, the voltages, more particularly those of the side-band frequencies corresponding to the high modulation frequencies, have a higher value so that the threshold below which disturbance can no longer be eliminated also comes to lie at a higher level.

The invention will be explained more fully with reference to the accompanying drawings wherein,

Fig. 1 represents diagrammatically, by way of example, one embodiment of a radio receiver having disturbance elimination according to the invention,

Fig. 2 represents a practical example of the circuit arrangement of such a receiver,

Fig. 3 represents a circuit arrangement for limiting the threshold voltage.

Referring to Fig. 1, the high frequency oscillations collected by an aerial 1 are supplied to a high frequency amplifier 2 comprising a mixing tube and, after amplification and frequency transformation, they are passed through to an intermediate frequency amplifier 3 provided with a detector. In the latter the intermediate frequency oscillations are detected, and supplied to a low frequency amplifier 5 whereupon the low frequency oscillations are made audible by a loudspeaker 6. A control voltage for automatic volume control (AVC) is supplied through a conductor 4 to the intermediate frequency amplifier and to the high frequency amplifier. The intermediate frequency amplifier has conected to it a filter 7 which does not pass the carrier wave and the sideband frequencies which correspond to the low modulation frequencies. This filter is followed by a device 8 adapted to operate, with the aid of a relay 9, a switch 10 present in the low frequency amplifier 5. This device can be actuated by voltages which pass through the filter 7 and is connected through a conductor 11 to the intermediate frequency amplifier 3 in order to be able to adjust the threshold value which the disturbing voltages have to exceed in order to allow of their being suppressed.

Fig. 2 shows this device in detail. Similar components are denoted in Fig. 2 by the same numerals as in Fig. 1. The high frequency oscillations received by an aerial 1 are transformed in known manner by a mixing tube 12 into intermediate frequency oscillations and supplied, through an intermediate frequency band-pass filter 13, to an intermediate frequency amplifying tube 14. In the anode circuit of this amplifying tube is included the oscillatory circuit 15 of a second intermediate frequency band-pass filter 17. This circuit is connected, through a condenser 18, to a diode anode 19 arranged in a low frequency amplifying tube 29 and, through condensers 23 and 24, to the cathode 25 of this tube. By rectification there is set up across a resistance 20 a control direct current voltage which is supplied, through a filter formed by a resistance 21 and a condenser 22, to the control grids of the mixing tube 12 and of the amplifying tube 14 and which serves for the automatic volume control.

The oscillatory circuit 16 of the intermediate frequency band-pass filter 17 is connected, on the one hand, to a diode anode 26 which is also incorporated in the amplifying tube 29 and, on the other hand, through the parallel connection of a condenser 27 and a resistance 28, to the cathode of the amplifying tube 29. The low frequency voltages set up, by detection, across the resistance 28 are supplied, through a slide contact 30 and a condenser 31, to the control grid 32 of the amplifying tube 29. A control voltage for a cathode ray indicator which is not shown in the figure is taken from the resistance 28 through a filter formed by a resistance 33 and a condenser 34.

The amplifying tube 29 is connected, through a filter consisting of a resistance 35 and a condenser 36 and through a switch 10, to the control grid 37 of a final amplifying tube 38, which control grid receives, through a resistance 39, a negative bias voltage. A loudspeaker 6 is connected, with the interposition of a transformer 40, in the anode circuit of the final amplifying tube 38.

The switch 10 is operated by a relay 9 and is constructed in such manner that when the current passing through the relay 9 decreases the contact is broken and the low frequency amplifier is made inoperative. The intermediate frequency band-pass filter 13 has furthermore connected to it an amplifying tube 41. This amplifying tube possesses substantially the same characteristic and adjustment as the amplifying tube 14. The output voltage of the amplifying tube 41 is therefore also substantially constant since the control grid 42 of the amplifying tube 41 is connected to the control grid of the amplifying tube 14. A resistance 43 is included in the anode circuit of the amplifying tube 41 while the anode of the tube 41 is connected through a condenser 44 to the filter 7. This filter consists of a parallel resonance circuit 45 which is grounded on either side through series resonance circuits 46 and 47. The circuits 45, 46 and 47 are tuned to the intermediate frequency carrier wave.

The anode of the amplifying tube 14 is connected, through a condenser 48, to a diode anode 49 while the end of the filter 7 is connected through a condenser 50 to a diode anode 51. The two diode anodes 49 and 51 form, together with a cathode 52, a duo-diode 53. The cathode 52 is connected to ground through the parallel connection of a resistance 54 and a condenser 55. The anodes 49 and 51 are grounded through resistances 56 and 57 respectively. The anode 51 is connected, through a filter consisting of a resistance 58 and a condenser 59, to the control grid 60 of an amplifying tube 61 in whose anode circuit is included the relay 9 in series with a resistance 62. A parallel connection of a resistance 63 and a condenser 64 provides for a bias voltage for the control grid 60. The operation of this circuit arrangement is as follows: The high frequency oscillations received by aerial 1 are supplied to the control grid of mixing tube 12 in which the frequency transformation is effected in known manner. The intermediate frequency band-pass filter 13 connected in the anode circuit of the mixing tube 12 supplies the intermediate frequency voltage received from the mixing tube 12 to an intermediate frequency amplifying tube 14 and, moreover, to an auxiliary channel whose input is formed by the amplifying tube 41.

Jointly with the cathode 25, the two diode anodes 19 and 26 present in the low frequency amplifying tube 29 provide, as has been described before, in known manner, for the detection and the automatic volume control. The low frequency alternating voltages set up across the resistance 35 connected in the anode circuit of the amplifying tube 29 are supplied, through a separating condenser 36 and a switch 10 which is closed during normal reception, to the control grid 37 of the final amplifying tube 38 by which they are amplified and then they are reproduced by the loudspeaker 6.

The intermediate frequency oscillations supplied by the band-pass filter 13, which oscillations consist of a carrier wave which, after the first intermediate frequency selection, still has on either side a fairly large side-band, is supplied to the control grid 42 of the amplifying tube 41 which is located at the input of the auxiliary channel. The band blocking filter 7 which is included in the anode circuit of the amplifying tube 41 only passes the intermediate frequency side-band frequencies which correspond to the highest modulation frequencies.

Through a condenser 48 the diode 49—52 present within the duo-diode tube 53 receives intermediate frequency voltage from the anode circuit of the amplifying tube 14. Since the diode 19—25 for the automatic volume control is also connected to this anode circuit this intermediate frequency voltage is substantially constant. The current supplied by the diode 49—52 passes not only through the resistance 56 but also through the resistance 54, the latter having, jointly with the condenser 55, such a time constant that the said current only depends on the intensity of the carrier wave of the received signal. The voltage set up by this current across the resistance 54 consequently constitutes for the diode 51—52 a bias voltage which depends on the carrier wave.

To the latter diode are supplied, through a condenser 50, the intermediate frequency side-band frequencies which correspond to the high modulation frequencies. Since the amplifying tube 41 has substantially the same characteristic as the amplifying tube 14, the ratio between the voltages supplied to the two diodes 49—52 and 51—52 remains substantially independent of the intensity of the desired signal. The values of the resistances 54 and 56 are so chosen that the bias voltage of the diode 51—52 exceeds the normal intermediate frequency side-band frequencies corresponding to the high modulation frequencies. Under normal conditions the diode 51—52 consequently does not rectify, so that the control grid 60 of the tube 61 is at ground potential.

If, however, an aperiodic disturbance whose amplitude exceeds that of the high modulation side-band frequencies is received by the aerial, this disturbance will surpass the threshold voltage across the resistance 54 and be rectified by the diode 51—52 with the result that the diode anode 51 acquires a negative potential and imparts the latter to the control grid 60 of the tube 61. The anode current of tube 61 which flows through the relay winding 9 consequently decreases. This relay is constructed in such manner that with a decreasing current the switch 10 is opened and the low frequency amplifier is made inoperative. If the switch 10 is located at a point in the circuit arrangement where there are only alternating voltages or alternating currents, the opening or closing thereof does not bring about any new disturbance.

If, consequently, there occurs an aperiodic disturbance whose amplitude exceeds that of the side-band frequencies corresponding to the highest modulation frequencies, the operation of the low frequency amplifier is temporarily interrupted. If this takes place in an interval of time which is short enough one would not perceive anything thereof.

Fig. 3 represents a circuit arrangement wherein the threshold value over which disturbance elimination takes place, is dependent on the side-band frequencies which correspond to the high modulation frequencies, and wherein this threshold value is limited by the carrier wave of the desired signal. In this case the threshold value is at any instant not larger than is absolutely necessary and moreover, it cannot exceed a determined limit. In Fig. 3 elements similar to those of Fig. 2 are denoted by the same numerals. The diode anodes 49 and 51 are connected to the band-blocking filter 7 through condensers 48 and 50 respectively. The direct current circuit for the diode 49—52 is formed by series connected resistances 54 and 56. Across the resistance 54 there is set up a direct current voltage which forms a threshold voltage for the diode 51—52. The value of the alternating voltage supplied through the condenser 50 to this diode is adjusted with the aid of this condenser in such manner that in the case of normal reception rectification does not yet occur in the diode 51—52. When a disturbance is received, the latter will be rectified and in the manner above described it causes the control grid 60 of tube 61 to become negative with the result that the low frequency amplifier is made inoperative.

The circuit arrangement of Fig. 3 further comprises a duo-diode 65. The diode anode 66 thereof is connected to the cathode 52 of the first duo-diode 53. The other diode anode 67 is connected to ground through a coil 68. The cathode 69 is grounded through the parallel connection of a resistance 70, which is small relatively to the resistance 54, and of a condenser 71. The duo-diode 65 has for its task to limit the value of the threshold voltage of the first duo-diode 53, for if there occurs a series of successive disturbances, the threshold voltage across the resistance 54 gradually increases with the result that the level above which the disturbances cause the low frequency amplifier to become inoperative, also rises. Owing to the limitation of the threshold value this level is also limited. If the voltage across the resistance 54 exceeds a determined value which is determined by the positive voltage of the cathode 69 of the duo-diode 65 with respect to ground, the diode 66—69 becomes conductive with the result that the resistance 70 in series with the diode 66—69 is connected in parallel with the resistance 54. This parallel connection causes in series with the resistance 56 such a division of the direct current voltage existing across the diode 49—52 that the amplitude of the disturbing voltages which give rise to the initial rise of the threshold is larger than the partial voltage across the parallel connection of the resistances 56 and 70, so that these interfering voltages are suppressed.

The positive voltage which the cathode 69 of the duo-diode 65 has with respect to ground is determined by the value of the alternating voltage existing between the diode anode 67 and ground, which alternating voltage may inductively be taken, for example with the aid of an inductance coil 68, from the oscillatory circuit 15 which is included in the anode circuit of the amplifying tube 14.

What is claimed is:

1. In a side band modulated carrier receiving system of the type provided with a carrier demodulator and a demodulation voltage utilization network, the improvement which comprises a network for deriving from the carrier voltage prior to demodulation voltage of side band component frequencies corresponding to higher modulation frequencies, means for rectifying the derived voltage, means responsive to the carrier amplitude for controlling the operation of said rectifying means, and means responsive to the rectified voltage for controlling the said utilization network.

2. In a side band modulated carrier receiving system of the type provided with a carrier demodulator and a demodulation voltage utilization network, the improvement which comprises a network for deriving from the carrier voltage prior to demodulation voltage of side band component frequencies corresponding to higher modulation frequencies, means for rectifying the derived voltage, means responsive to said derived voltage for determining the amplitude level at which said rectifying means is operative, and means responsive to the rectified voltage for controlling the said utilization network.

3. In a radio receiving system having a modulated carrier amplifier, a detector and audio amplifier, means for suppressing the reproduction of disturbances without substantially interfering with reproduction of modulation frequencies, said means comprising a modulated carrier voltage path, said path including a filter network for passing voltages solely of side band frequencies, corresponding to the high modulation frequencies, a rectifier coupled to said filter network for deriving a control voltage from said passed voltages, means responsive to carrier amplitude variation for controlling said rectifier, and means responsive to the control voltage for controlling the transmission of modulation voltage between the detector and audio amplifier.

4. A method of receiving side band modulated carrier waves without interference from disturbing electrical impulses which includes collecting modulated carrier waves and disturbance impulses, demodulating the collected waves and impulses, amplifying and reproducing the demodulated waves and impulses, deriving from the collected waves prior to demodulation thereof voltages of side band frequency components corresponding to the high modulation frequencies, deriving a uni-directional control voltage from the derived voltages, controlling the amplification of said demodulated waves in response to said control voltage, and simultaneously regulating the derivation of said control voltage in response to collected waves.

5. A method of receiving side band modulated carrier waves without interference from disturbing electrical impulses which includes collecting modulated carrier waves and disturbance impulses, demodulating the collected waves and impulses, amplifying and reproducing the demodulated waves and impulses, deriving from the collected waves prior to demodulation thereof voltages of side band frequency components corresponding to the high modulation frequencies, deriving a uni-directional control voltage from the derived voltages, controlling the amplification of said demodulated waves in response to said control voltage, and simultaneously controlling the derivation of said control voltage in response to the amplitude of said first named derived voltages.

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