

May 10, 1938.

D. A. WILBUR

2,116,814

DISTORTION BALANCED DEMODULATOR

Filed June 18, 1935

2 Sheets-Sheet 1

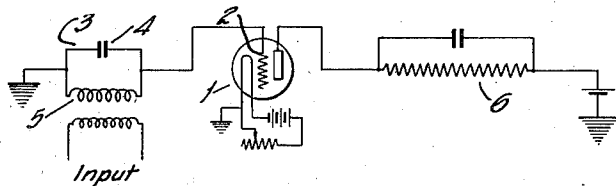


FIG. 1

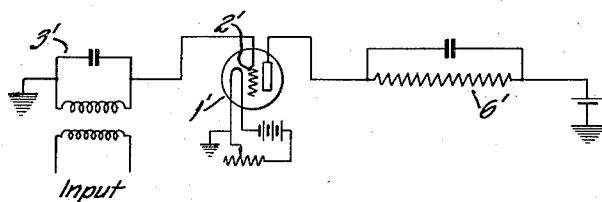


FIG. 2

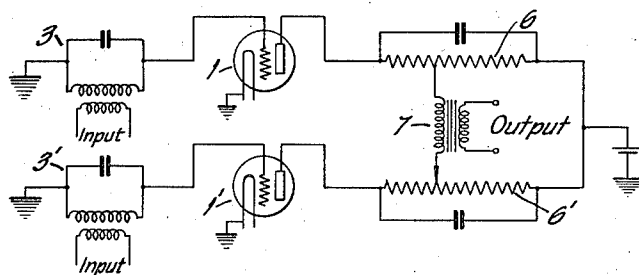


FIG. 3

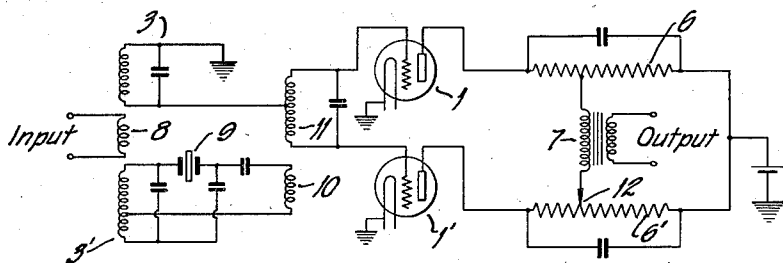


FIG. 4

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2 Sheets-Sheet 2

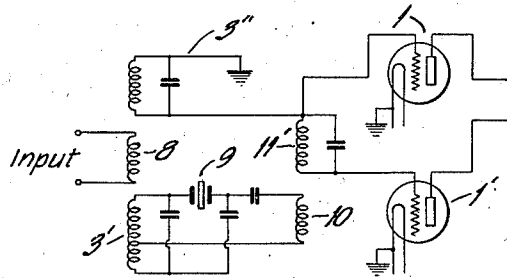


FIG. 5

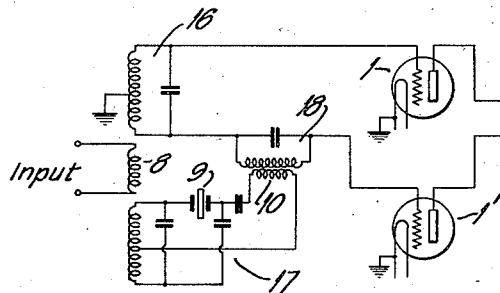


FIG. 6

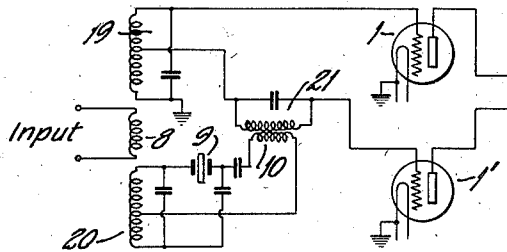


FIG. 7

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DISTORTION BALANCED DEMODULATOR

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Application June 18, 1935, Serial No. 27,159

11 Claims. (Cl. 250—20)

My invention relates to demodulators and more particularly to means and methods of reducing or eliminating distortion and interference in the reception of radio signals.

Interference with and distortion of detected radio signals result from various causes, and the principal object of my invention is to provide a radio signal receiving device, including a demodulator, in which difference frequencies resulting between components of the signal, other than those due to a difference frequency between any component and the carrier, are effectively canceled, with the result that the detected signal consists only of difference frequencies between the side band components and the carrier component. In other words, the principal object of my invention is to provide a method and means whereby demodulation components due to reactions between side components of the signal are reduced or entirely eliminated in the output circuit.

Broadly, this result is attained by dividing the radio signal, as received, into two separate signals having corresponding carrier and side components but in which the relative relations between the carrier and corresponding side components differ. These separate signals are separately demodulated and the demodulation components are introduced into a common output circuit in such a way that demodulation components other than those demodulation components resulting from reactions between the carrier components of said signals with their respective side components are effectively canceled. The difference in the relative relation between the carrier and side components in one signal and the relative relation between the carrier and the corresponding side components in the other signal may be one of phase, or of amplitude or of both, and to attain this result either the carrier component or the side components or both of one or both of the signals may be varied. This will result in a difference either in phase, or in amplitude, or in both phase and amplitude, of those demodulation components of the respective signals but will leave unaltered the characteristics of those demodulation components resulting from reactions between the side components of the respective signals and thus, since, in the common output circuit we may effect a cancelation of all demodulation components other than those altered in phase or amplitude or both we may effect a cancelation of all demodulation components other than those resulting from reactions between the carrier and the side components of the signals.

The phase of a side component relative to the carrier may be defined as the instantaneous value of the angle of the side component for any arbitrarily chosen value of angle for the carrier. Thus a difference in the relative phase relations of corresponding side components in two corresponding separate signals with respect to their respective carriers would mean that the instantaneous values of the angles for the corresponding side components, with respect to the same value of angle of their respective carriers, differ.

In order that my invention may be clearly understood the following description should be considered in connection with the accompanying drawings in which—

Fig. 1 shows a fragmentary portion of a radio signal receiving circuit;

Fig. 2 is a fragmentary portion of a second circuit similar to Fig. 1;

Fig. 3 is a combination of the circuits shown in Figs. 1 and 2 in which the outputs of the demodulators are combined;

Fig. 4 illustrates my complete circuit;

Fig. 5 shows a modification of the circuit on the input side of the demodulators;

Fig. 6 shows another modification of the circuit on the input side of the demodulators; and

Fig. 7 shows a further modification of the circuit on the input side of the demodulators.

For the purpose of describing my method of procedure and the operation of my circuit it will be assumed that a carrier $E_0 \sin wt$ where f_w , the carrier frequency, equals $w/2\pi$ is modulated by a signal $E \sin pt$ where f_p , the modulating frequency, equals $p/2\pi$. The resulting modulated signal e_1 may be expressed

$$e_1 = E_2 \cos(w-p)t + E_1 \sin wt - E_2 \cos(w+p)t$$

The term $E_1 \sin wt$ will be referred to as the carrier component, and any term involving a frequency other than that of the desired carrier, regardless of its source, will be referred to as a side band component or a side component. In this case then, the terms $E_2 \cos(w-p)t$ and $E_2 \cos(w+p)t$ are side components.

In practice, the signal e_1 is the signal applied to the demodulator in question whether it be the signal as received from the station or as applied to the demodulator after intermediary processes such as occur in a superheterodyne in which the entire frequency range is shifted.

For purposes of illustration, we will use square law detection and consider the distortion or detection terms only, although it is to be understood

that my invention is in no sense limited to detectors which operate according to this principle.

Now let this modulated signal e_1 be applied to the grid 2 of demodulator 1 through circuit 3 including condenser 4 and coil 5. Then in the impedance 6 of the output circuit of demodulator 1 we will have developed the demodulated frequencies or components.

Considering the action of this detector or demodulator, in Fig. 1, we find that we have for the demodulation components in terms of current:

$$\begin{aligned} i_1 &= c_0 \{ E_2 \cos (w-p)t + E_1 \sin wt - E_2 \cos (w+p)t \}^2 \\ &= c_0 \{ 2E_1 \sin wt E_2 \cos (w-p)t - \\ &\quad 2E_2 \cos (w+p)t E_1 \sin wt - \\ &\quad 2E_2 \cos (w-p)t E_2 \cos (w+p)t \} \end{aligned}$$

and again omitting radio frequency terms

$$\begin{aligned} i_1 &= c_0 (E_1 E_2 \sin pt + E_1 E_2 \sin pt - E_2^2 \cos 2pt) \\ i_1 &= c_0 (2E_1 E_2 \sin pt - E_2^2 \cos 2pt) \end{aligned}$$

Hence, through the impedance 6, we have not only currents which correspond in form to the original modulating component, $E \sin pt$, (due to the reaction between the carrier component $E_1 \sin wt$ and the side components $E_2 \cos (w-p)t$ and $E_2 \cos (w+p)t$, but also other components; in this case the term $-c_0 E_2^2 \cos 2pt$, which was not present in the original modulating signal $E \sin pt$ and which is due to a reaction between the side band components $E_2 \cos (w-p)t$ and

$$E_2 \cos (w+p)t$$

It should also be noticed that any reaction between these side band components is independent of the carrier component $E_1 \sin wt$, and that the reaction producing the desired term,

$$2c_0 E_1 E_2 \sin pt$$

is dependent upon the carrier component

$$E_1 \sin wt$$

Now, since it is evident that the terms in the output which are desired, (those corresponding in form to the original modulating components), are not independent of the carrier component, and that the distortion terms which are not desired (those components for which there are no corresponding components in the original modulating signal), are independent of the carrier, it is possible by varying the characteristics of the carrier in its relation to the side band components, to vary the characteristics of the desired terms in their relation to the undesired terms.

It is also well to note that since this variation of the carrier in its relation to the side band components is relative, the same result may be achieved by varying the side band components in phase, in amplitude, or in both, with respect to the carrier. If this variation of the side band components affects each such component to the same degree, there will be no variation of the relations existing between these side components and consequently no variation other than in amplitude of the undesirable terms in the output of the demodulator (those dependent upon reactions between these side components). This variation in amplitude may be compensated for in the output of the demodulator and will occur only for the case where a variation of the amplitude of the side band components is produced.

Thus, a variation of the desired demodulation components with respect to the undesired components may be effected by varying the relative

relation of the carrier component to the side components, as, for example, by—

a. Varying the amplitude of the carrier with respect to the side components.

b. Varying the phase of the carrier with respect to the side components.

c. Varying uniformly the amplitude of the side components with respect to the carrier.

d. Varying uniformly the phase of the side components with respect to the carrier.

e. A combination of any or all of the above.

For purposes of simplicity and clarity in explanation of my method, I will assume a case where the amplitude only of the carrier is varied, but it is to be understood that the same result can be attained in any of the ways above mentioned.

Now referring to Fig. 2, suppose that, to a demodulator or detector 1' similar to demodulator 1, there is applied a signal e_2 in which the amplitude only of the carrier is varied, leaving the side bands identical with those which were applied to demodulator 1. Let this carrier be represented by $E_3 \sin wt$.

The signal as applied to grid 2' of demodulator 1' is then:

$$e_2 = E_2 \cos (w-p)t + E_3 \sin wt - E_2 \cos (w+p)t$$

Hence, through impedance 6' of demodulator 1' we have currents corresponding to the reaction between the carrier and the side band components, but we have altered the carrier from $E_1 \sin wt$ to $E_3 \sin wt$ and thus the desired demodulated components or terms will now be $2c_0 E_3 E_2 \sin pt$. However, we have not altered, in any way, the relations existing between the side band components and thus the undesired terms due to the reaction between side band components are the same as in Case 1, and we have for these $-c_0 E_2^2 \cos 2pt$.

Thus in the outputs of these two demodulators or detectors we have, in terms of current for—

$$\begin{aligned} (1) \quad i_1 &= 2c_0 E_1 E_2 \sin pt - c_0 E_2^2 \cos 2pt \\ (2) \quad i_2 &= 2c_0 E_3 E_2 \sin pt - c_0 E_2^2 \cos 2pt \end{aligned}$$

And, if we then take the difference between these, say by inserting a transformer 7, as shown in Fig. 3, where i_T , the current through the transformer, $= c_2 (i_1 - i_2)$, then $i_T = c_3 (E_1 - E_3) E_2 \sin pt$ and thus it is evident that the undesired terms due to reactions between side band components will be absent in the output circuit of this transformer.

An exactly similar result is achieved if we proceed as set forth in b, c, d, or e above.

Consider now the action of a signal from an interfering station. Let this signal be of the form

$$E_4 \cos (b-a)t + E_5 \sin bt - E_4 \cos (b+a)t$$

where b may be greater or less in value than w and where f_b , the carrier frequency of the interfering station equals $b/2\pi$ and f_a the modulating frequency of the interfering station equals $a/2\pi$. In this case assume for the time that b is less than w (the action will be the same for b greater than w) and consider only the carrier component $E_1 \sin wt$ of the desired station since we have already shown the result when the side band components of the desired station are present. We have then for the signal e_1 applied to grid 2 of demodulator 1—

$$\begin{aligned} e_1 &= E_4 \cos (b-a)t + E_5 \sin bt - \\ &\quad E_4 \cos (b+a)t + E_1 \sin wt \end{aligned}$$

Following the same method as in the previous development, we have for the demodulation current produced in impedance 6 by the interfering station—

$$i_1 = c_0 \{ 2E_4 E_5 \sin at - E_4^2 \cos 2at + E_1 E_4 \sin (w-b+a)t + E_1 E_5 \sin (w-b)t - E_1 E_4 \sin (w-b-a)t \}$$

where $2E_4 E_5 \sin at$ corresponds in form to the original modulating signal of the interfering station. This we shall call intelligible interference. It is evident that since this component is independent of the carrier of the desired station it will not be affected by a variation of the relations existing between that carrier and the side band components or, that the same conditions hold for this case as did in the previous one.

Then modifying the carrier of the desired station as before for demodulator, 1', we have for

$$e_2 = E_4 \cos (b-a)t + E_5 \sin bt - E_4 \cos (b+a)t + E_3 \sin wt$$

We have then for the demodulation current components produced in impedance 6' by the interfering station

$$i_2 = c_0 \{ 2E_4 E_5 \sin at - E_4^2 \cos 2at + E_3 E_4 \sin (w-b+a)t + E_3 E_5 \sin (w-b)t - E_3 E_4 \sin (w-b-a)t \}$$

Thus, since

$$i_T = c_2 (i_1 - i_2)$$

we have

$$i_T = c_3 \{ (E_1 - E_3) E_4 \sin (w-b+a)t + (E_1 - E_3) E_5 \sin (w-b)t - (E_1 - E_3) E_4 \sin (w-b-a)t \}$$

and it is evident that not only has the term $2E_4 E_5 \sin at$, the intelligible interference, been eliminated but also the components corresponding to $E_4^2 \cos 2at$.

An exactly similar result will be achieved if we proceed as set forth in *b, c, d* or *e* above.

This same elimination will also take place for any demodulation components due to a reaction between the side band components of the two stations and, generalizing, will include the elimination of any demodulation components due to a reaction between any side components regardless of their source, whether they be from a desired station, an interfering station, static, noise, shot effect or thermal agitation in the preceding amplifiers or detectors, or from other sources.

Thus in general we may say that, no demodulation components which result from reactions between the components of side bands will appear in the output of transformer 7; but that only those demodulation components which result from a reaction between the components of side bands and the desired carrier will appear. It should also be noticed that unless the carrier of the desired signal is present no demodulation components will appear in the output of transformer 7 of the demodulator and thus there results a complete suppression of output signal except when the carrier of the desired signal is applied.

To vary the amplitude only of the carrier relative to the side bands as applied to the input of the two demodulators, we proceed as follows:

Referring to Fig. 4, let the modulated signal from the intermediate amplifier of a superheterodyne receiver be coupled to circuits 3 and 3' through coil 8. Then to demodulators 1 and

1', we apply through circuit 3, the carrier and side bands. The same signal is coupled into circuit 3', through 8, but by means of a selective filter 9 which passes only a very narrow frequency range and to which is tuned the carrier, we couple through coil 10 into circuit 11 essentially only the carrier. Thus, since the carrier from circuit 3 must pass through circuit 11, to modulators 1 and 1' in opposite directions, so to speak, any modification of the carrier as applied to modulators 1 and 1', due to its presence in circuit 11 will be in opposite directions. Thus, if in circuit 11 the carrier is present in such a way as to add to that from circuit 3 when applied to modulator 1, it will, at the same time, subtract from that applied to modulator 1' from circuit 3. And, since only the carrier from circuit 3' is present in coil 10, this action will take place only upon the carrier and will leave the side components unaffected. Thus, we modify the carrier as applied to the two detectors or demodulators in different ways and achieve the desired results.

Consider now the requirements to be met by the selective filter 9. This filter, in order that the action of the detector may be effective, must pass as narrow a frequency range as possible, preferably a range narrower than that existing between the two opposite side components nearest the carrier in frequency, or, those two side components due to the lowest modulating frequency to be used. This means that the ordinary resonant circuit consisting of a coil and condenser will not be effective and hence use must be made of such a narrow pass band as is provided by the piezo electric crystal filter. That a selective filter of this type is very important to the proper action of the detector is evident since the action is dependent upon producing a change in the relative relations existing between the carrier and side components by the reintroduction of the carrier alone, and hence, if there is simultaneously a reintroduction of side components due to the fact that they have not been rejected by the filter, the relative relations existing between these components and the carrier will be such that the action will be ineffective.

By slight modifications of the circuits shown in Fig. 4, we can achieve the same results utilizing methods *b, c, d* or *e* above.

Referring to the fragmentary circuit in Fig. 5, it is apparent that the side band components and carrier component are coupled into circuit 3'' by means of coil 8 and applied to demodulator 1 directly and to demodulator 1' through circuit 11'. If now, as before, we couple only the carrier component into circuit 11' by means of coil 10 and adjust the constants of the circuits so that the carrier component introduced into circuit 11' is equal to $-2E_1 \sin wt$, where $E_1 \sin wt$ is the carrier component present in circuit 3'', then the carrier component applied to demodulator 1 is $E_1 \sin wt$ while the carrier component applied to demodulator 1' is $E_1 \sin wt - 2E_1 \sin wt$ which gives $E_1 \sin (wt + \pi)$. Since only the carrier is present in coil 10 only the carrier as applied to demodulator 1' is altered and we thus have carriers which differ in phase applied to the two demodulators while the side band components applied are identical. This combination will produce the action previously described. It is also evident that since the characteristics of the carrier introduced into circuit 11' depend upon the constants of circuits 3', 9, 10 and 11',

that, by varying these constants, we may vary the characteristics of the carrier introduced and consequently the characteristics of the carrier as applied to demodulator 1' in any manner we desire.

Referring to the fragmentary circuit in Fig. 5, it is apparent that the side band components and carrier component are coupled into circuit 3'' by means of coil 8 and applied to demodulator 1 directly and to demodulator 1' through circuit 11'. If now, as before, we couple only the carrier component into circuit 11' by means of coil 10 and adjust the constants of the circuits so that the carrier component introduced into circuit 11' is equal to say $E_2 \sin (wt + a_1)$, where $E_1 \sin wt$ is the carrier component present in circuit 3'', then the carrier component applied to demodulator 1 is $E_1 \sin wt$ while the carrier component applied to demodulator 1' is $E_1 \sin wt + E_2 \sin (wt + a_1)$ which gives as a resultant $E_3 \sin (wt + a_2)$ for the carrier component applied to demodulator 1'. Thus since the side components remain unaltered and since we have changed the carrier component as applied to demodulator 1' both in phase and in amplitude this means that both the relative phase and the relative amplitude relations existing between the side components and carrier component of the respective signals applied to demodulators 1 and 1' differ, and thus the desired result is produced.

Referring to the fragmentary circuit shown in Fig. 6 it is evident that the carrier and side band components are introduced into circuit 16 by means of coil 8, and, where these are represented by

$$E_1 \cos (w-p)t + E_2 \sin wt - E_1 \cos (w+p)t$$

it is obvious that the signal applied to demodulator 1 is

$$\frac{1}{2} \{ E_1 \cos (w-p)t + E_2 \sin wt - E_1 \cos (w+p)t \}$$

Then the signal applied to demodulator 1' through circuit 16 is

$$\frac{1}{2} \{ E_1 \cos [(w-p)t + \pi] + E_2 \sin (wt + \pi) - E_1 \cos [(w+p)t + \pi] \}$$

Now introducing as before only the carrier component into circuit 18 by means of coil 10 and by an amount $E_2 \sin wt$ we find that the resultant signal applied to demodulator 1' is

$$\frac{1}{2} \{ E_1 \cos [(w-p)t + \pi] + E_2 \sin wt - E_1 \cos [(w+p)t + \pi] \}$$

and consequently the side bands as applied to the two demodulators have been shifted in phase while the characteristics of the carrier remain the same. The resultant action of this circuit is the same as for the one given in Fig. 4.

Referring to the fragmentary circuit given in Fig. 7 it is evident that the carrier and side band components are induced into circuit 19 by means of coil 8 and where these are represented by

$$E_1 \cos (w-p)t + E_2 \sin wt - E_1 \cos (w+p)t$$

it is obvious that the signal applied to demodulator 1 is

$$E_1 \cos (w-p)t + E_2 \sin wt - E_1 \cos (w+p)t$$

The signal applied to demodulator 1' is but a fractional part of that present in circuit 19 however and may, then, be represented by

$$E_3 \cos (w-p)t + E_4 \sin wt - E_3 \cos (w+p)t$$

where E_3 is less in value than E_1 and where E_4 is less in value than E_2 . Now, as before, introducing only the carrier into circuit 21 by means

of coil 10 and by an amount $(E_2 - E_4) \sin wt$ the signal as applied to demodulator 1' becomes

$$E_3 \cos (w-p)t + E_2 \sin wt - E_3 \cos (w+p)t$$

and thus the amplitude of the side band components as applied to the two demodulators is modified while the characteristics of the carrier applied to the two demodulators remain the same. The resultant action of this circuit is the same as that given in Fig. 4.

From the foregoing it will be apparent that the difference frequencies between the side band components of the signal have not been affected and are thus balanced out in the transformer 7. However, this balance is not attained for the difference frequencies between the carrier and the side band components, and hence these difference frequencies appear in the output or secondary of transformer 7.

By my method of detection, distortion, due to a lowering of the level of the carrier and a consequent relative increase in amplitude of the difference frequency terms due to reaction between side band components, as compared with that of those between carrier and side band components cannot occur, due to the elimination of the distortion terms. Such distortion is ordinarily noticeable when interference occurs between the ground and sky waves or between the signals from synchronized stations.

Any difference frequencies due to interfering signals, such as static, noise, shot effect, thermal agitation, etc. which are received with the signal, or which occur in the previous amplifiers and detectors, except those difference frequencies which occur between these signals and the carrier of the desired signal, will be suppressed. Hence, my device and method of procedure will provide automatic noise and interference suppression with no loss of sensitivity when the carrier component of the desired station is being applied.

There can be no intelligible interference from adjacent signals since all such components are canceled in the output circuit and furthermore, the strength of those demodulation components due to the signals from the interfering station will be reduced because their amplitude depends upon the amplitude of the desired carrier. Thus for low amplitude of the desired carrier, the noise level will also be low.

Another desirable feature of my device and method of procedure is its extremely sharp tuning since there is no output from the demodulators except when the carrier is tuned to the resonant frequency of the filter. Hence, my device and method of procedure will provide automatic, interstation noise suppression with no loss of sensitivity.

While the condensers illustrated in the drawings are shown as fixed condensers it is to be understood that, in the first instance, in order to secure proper tuning, these condensers will be adjustable. But once the circuits are properly tuned the condensers may be permanently set and it will not be necessary thereafter to adjust them. Likewise in order to secure an accurate balance between the demodulators it is desirable that one of the impedances, say 6' in the output circuit, be made initially adjustable as shown at 12.

While I have described my invention in its preferred embodiment, it is to be understood that the drawings are merely illustrative; that the words which I have used in describing my invention are words of description rather than of

limitation; and that changes within the purview of the appended claims may be made without departing from the true scope and spirit of my invention in its broader aspects.

5 What I claim is:

1. In a device for receiving a modulated radio signal comprising carrier and side components, means for producing from said signal two separate signals having corresponding carrier and side components but in which the relative phase relations between said carrier and said side components differ, and means for separately demodulating said signals.

15 2. In a device for receiving a modulated radio signal comprising carrier and side components, means for producing from said signal two separate signals having corresponding carrier and side components but in which the relative phase and amplitude relations between said carrier and said side components differ, and means for separately demodulating said signals.

20 3. The method of reducing distortion and interference in the reception of a modulated radio signal including carrier and side components which comprises, dividing said signal into two separate signals having corresponding carrier and side components, effecting different modifications of the relative relations between the carrier and side components in said separate signals, effecting separate, simultaneous demodulations of said signals, and combining the demodulation components in a manner to effect an elimination of those demodulation components due to reactions between side components of said signals.

35 4. The method of reducing distortion and interference in the reception of a modulated radio signal including carrier and side components which comprises, forming from said signal two separate signals having corresponding carrier and side components but in which the relative phase relations between the carrier and corresponding side components differ, effecting separate, simultaneous demodulations of said signals, and combining the demodulation components in such a relation as to effect an elimination of those demodulation components due to reactions between side components of said signals.

40 5. The method of reducing distortion and interference in the reception of a modulated radio signal including carrier and side components which comprises, forming from said signal two separate signals having corresponding carrier and side components but in which the relative phase and amplitude relations between the carrier and corresponding side components differ, effecting separate, simultaneous demodulations of said signals, and combining the demodulation components in such a relation as to effect an elimination of those demodulation components due to reactions between side components of said signals.

45 6. In a device for receiving a modulated radio signal comprising carrier and side components, means for producing from said signal two separate signals having corresponding carrier and side components but in which the relative phase relations between said carrier and said side components differ, means for separately demodulating said signals, and means, including a common output circuit, for combining the demodulation components to effect a cancellation in said circuit of demodulation components other than those

resulting from reactions between the carriers and their respective side components.

7. In a device for receiving a modulated radio signal comprising carrier and side components, means for producing from said signal two separate signals having corresponding carrier and side components but in which the relative phase and amplitude relations between said carrier and said side components differ, means for separately demodulating said signals, and means, including a common output circuit, for combining the demodulation components to effect a cancellation in said circuit of demodulation components other than those resulting from reactions between the carriers and their respective side components.

8. In a device of the character described, the combination with means for dividing a modulated radio signal, including carrier and side components, into two modulated signals having corresponding carrier and side components but in which the relative phase relations between the carrier and corresponding side components differ, of two demodulators for separately demodulating said last mentioned signals, and a common output circuit for said demodulators; whereby in said output circuit the demodulated components from said demodulators which are due to reactions between the side components of said signals are in opposed relation and the demodulated components from said demodulator which are due to reactions between the carrier component and the side components are in additive relation.

9. In a device of the character described, the combination with means for dividing a modulated radio signal, including carrier and side components, into two modulated signals having corresponding carrier and side components but in which the relative phase and amplitude relations between the carrier and corresponding side components differ, of two demodulators for separately demodulating said last mentioned signals, and a common output circuit for said demodulators; whereby in said output circuit the demodulated components from said demodulators which are due to reactions between the side components of said signals are in opposed relation and the demodulated components from said demodulator which are due to reactions between the carrier component and the side components are in additive relation.

10. The method of reducing distortion and interference in the reception of a modulated radio signal including carrier and side components which comprises, forming from said signal two separate signals having corresponding carrier and side components, effecting a substantially complete separation of the carrier component from the side components of said modulated signal, combining said separated carrier component with at least one of said separated signals in a manner to establish different carrier-side component relations in said separated signals, respectively, effecting separate, simultaneous demodulations of said signals, and combining the demodulation components in such a relation as to effect an elimination of those demodulation components due to reactions between the side components of said signals.

11. The method of reducing distortion and interference in the reception of a modulated radio signal including carrier and side components which comprises, forming from said signal two separate signals having corresponding carrier

and side components, effecting a substantially complete separation of the carrier component from the side components of said modulated signal, combining said separated carrier component with at least one of said separated signals in a manner to establish different relative amplitude relations between the carrier and side components in said separated signals, respectively, effecting separate, simultaneous demodulations of said signals, and combining the demodulation components in such a relation as to effect an elimination of those demodulation components due to reactions between the side components of said signals. 5

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