July 7, 1936. R. A. BRADEN 2,046,765

RECEIVING SYSTEM

Filed Jan. 9, 1932 2 Sheets-Sheet 1

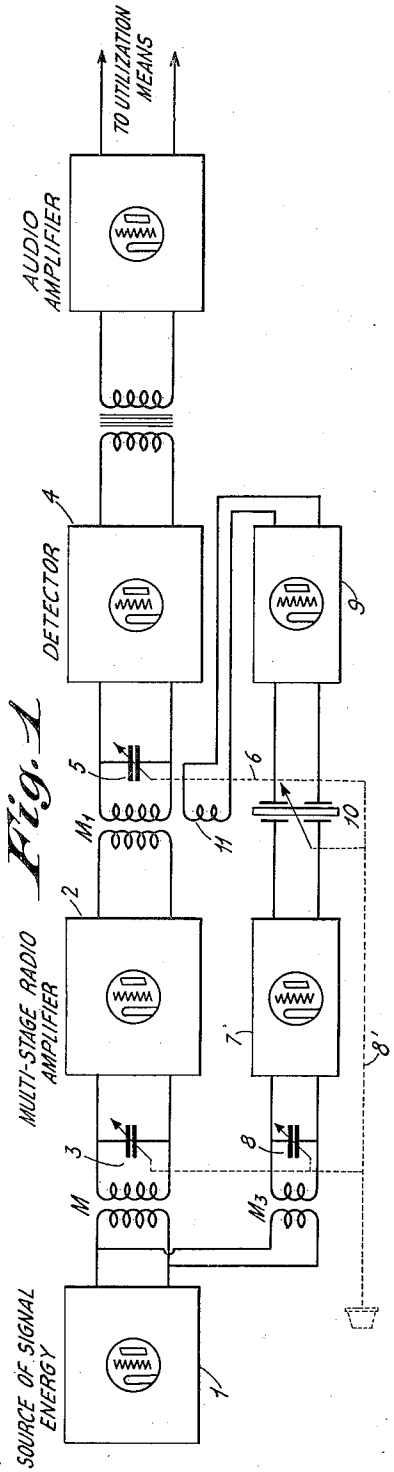


Fig. 1

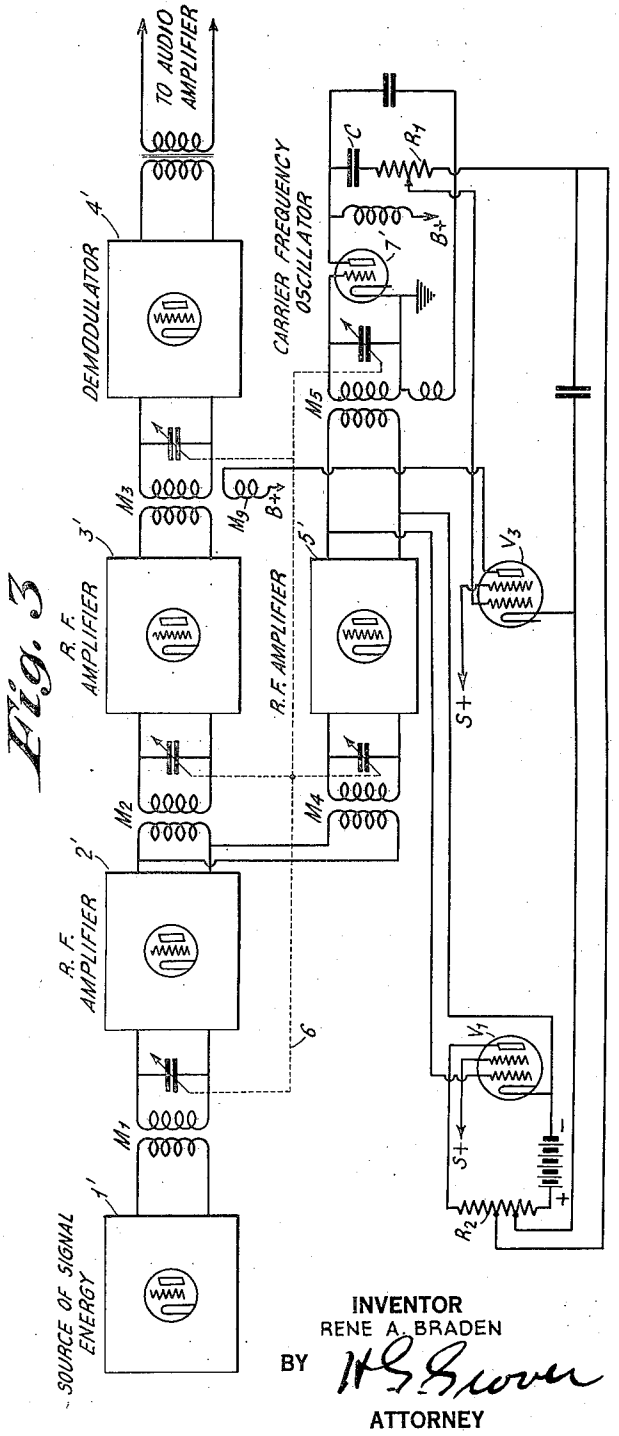


Fig. 3

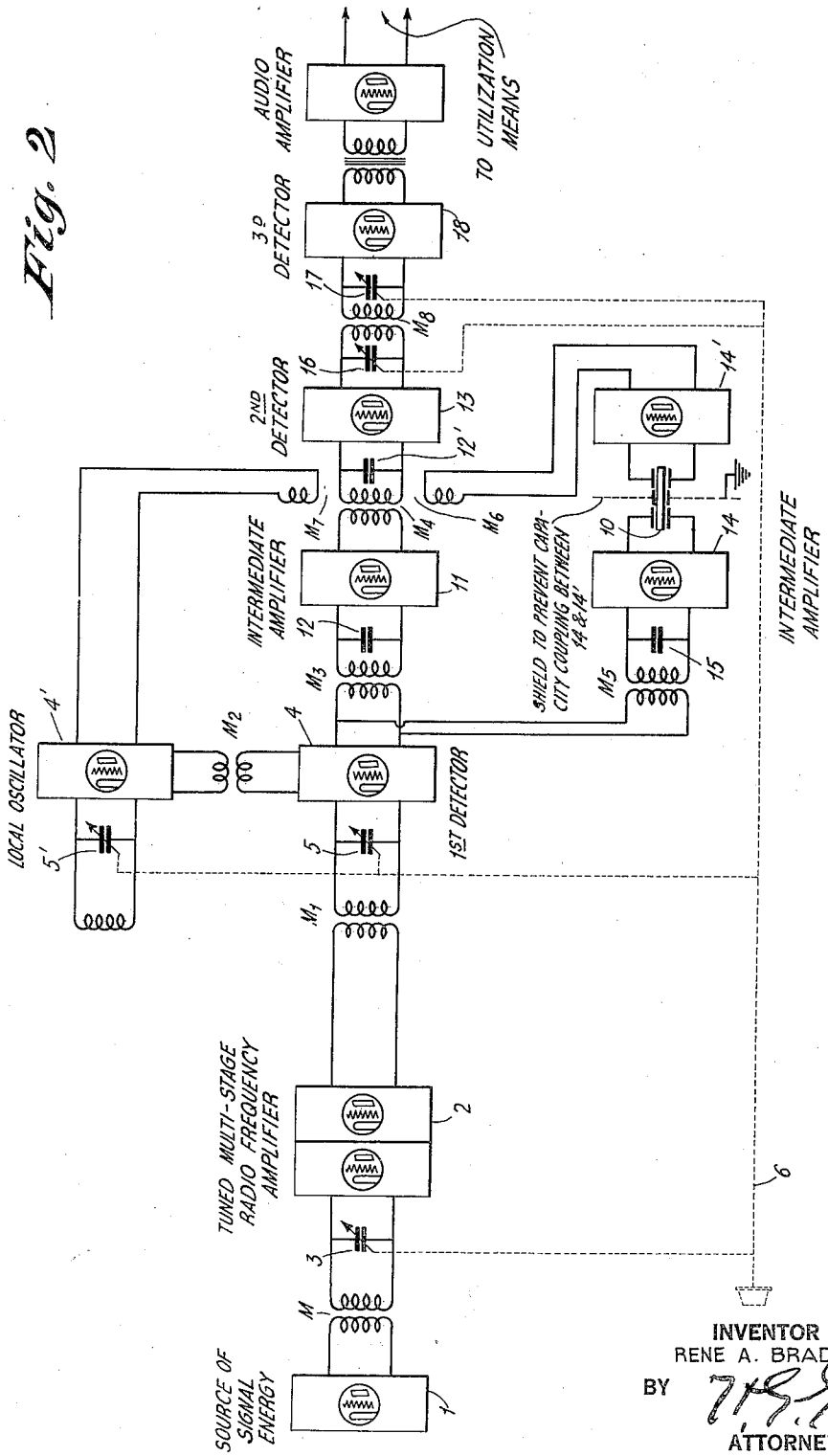
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Filed Jan. 9, 1932 2 Sheets-Sheet 2

Fig. 2



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RECEIVING SYSTEM

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Application January 9, 1932, Serial No. 585,646

11 Claims. (Cl. 250—20)

My present invention relates to electrical wave receiving systems, and more particularly to novel methods of, and means for, amplifying the amplitude of the carrier wave of intelligence modulated carrier energy with respect to the side bands of such carrier energy.

In the reception of modulated carrier energy there exist various situations where it is extremely desirable to effect amplification of the carrier amplitude with respect to side band amplitude after the modulated carrier energy has been received. For example, interference between broadcasting stations may be considerably reduced by broadcasting energy from each station in such a manner that the side bands are transmitted at full amplitude, while the carrier wave is transmitted at much reduced amplitude. It can be demonstrated that when interfering stations also transmit with reduced carrier in this manner, interference is effectively reduced. In order to receive such broadcast energy it is necessary at the receiving point to amplify the carrier wave of the received energy more than the side bands so as to bring the carrier up to normal amplitude at the detector input.

Accordingly, it may be stated that it is one of the main objects of the present invention to provide a method of reception of modulated carrier energy wherein the energy is transmitted with the side bands at full amplitude and the carrier at much reduced amplitude, which reception comprises the steps of selectively separating the carrier wave from the side bands, amplifying the carrier from subnormal amplitude to normal amplitude, and then combining the amplified carrier and the side bands, both at normal amplitude, for detection and utilization.

While it has been pointed out heretofore that modulated carrier energy may be deliberately transmitted with a carrier wave of sub-normal amplitude, it is also known that natural phenomena, as represented by the action of the so-called Heavyside layer, result in reception behavior often termed "selective fading". "Selective fading" signifies the attenuation of a relatively narrow portion of the radio frequency band, this attenuation varying with time in an irregular manner, and also shifting from one frequency range to another within the band.

When the attenuation band happens to be at the center of the transmitted frequency band, so that the carrier is reduced in amplitude, distortion occurs in the detection process. Especially is this so if the carrier is reduced to a small fraction of its normal amplitude. According to my present invention it is possible to correct such selective fading, fidelity of reproduction of short waves being particularly improved.

Another important object of the present invention is to provide a novel method of reducing the harmful effects of selective fading, and in general receiving modulated carrier energy wherein the carrier wave is received at subnormal amplitude, the method consisting in separating the carrier wave and the side bands at a relatively low radio frequency, amplifying the separated carrier and side bands independently, and subsequently combining the carrier wave and side bands, both at substantially the same amplitude for detection and utilization.

It has been pointed out heretofore that the present invention may be effectively employed to receive modulated carrier energy in cases where the received energy is collected with its carrier at subnormal amplitude. In each of the cases discussed above it has been the object of the invention to elevate the carrier amplitude from subnormal value to a normal value.

However, the present invention can be utilized, after separation of the carrier wave from the side bands, for elevating the amplitude of the carrier wave from a normal amplitude to a supernormal amplitude. This variation of the present invention can be employed to great advantage in reducing the production of harmonics in the output of a detector circuit.

It is well recognized that rectification of modulated signals produces not only audio frequency currents of the original modulation frequency, but also second, and higher, harmonics, as well as sum and difference frequencies. The amount of extra frequencies depends on the degree of modulation of the carrier wave. Hence, by reducing the effective modulation degree of the received carrier wave, the production of harmonics in the output of the detector will be considerably minimized; it being emphasized that elevation of the carrier amplitude from normal to supernormal value results in reduction of the degree of modulation.

Another important object of the present invention can, therefore, be said to reside in providing a method of separating the carrier wave of received modulated carrier energy from its side bands, and treating the separated carrier wave in such a manner with respect to the side bands that the degree of modulation of the received carrier wave is reduced with the result that production of harmonics in the detector output of the receiver is considerably minimized.

Still another object of the present invention is to provide a method of receiving modulated carrier energy which consists in collecting modulated carrier energy, separating the carrier wave from the side bands, amplifying the separated carrier wave independently of the side bands to a predetermined value, combining the amplified carrier wave and the side bands, and finally detecting the combined energies.

Still other objects of the present invention are to improve generally the efficiency of radio reception, and to particularly provide a radio receiver wherein the carrier of the received signal is amplified more than the side bands thereof thus resulting in a receiver which is not only reliable in short wave reception, but capable of reducing detector distortion, due to harmonic production in the detector output, to a great extent.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawings,

Fig. 1 diagrammatically shows a radio receiver embodying one form of the present invention,

Fig. 2 diagrammatically shows another embodiment of the invention, and

Fig. 3 shows still another form of the invention in diagrammatic manner.

Referring, now, to the accompanying drawings wherein like characters of reference indicate the same parts in the different figures, there is shown in Fig. 1 a radio receiver system wherein modulated carrier energy is collected, amplified and detected for utilization in any well known manner, numeral 1 designating in conventional manner a source of signal energy, as for example an antenna system. It is to be understood that the energy collected at the source 1 is for one reason or another composed of side bands transmitted at full amplitude, and a carrier wave at much reduced amplitude.

As has been hitherto stated, this reduction of carrier amplitude may be due to a deliberate transmission technique. For the reduction of interference between broadcast stations the side bands may be transmitted at normal amplitude, while the carrier may be transmitted from each broadcast station at considerably reduced amplitudes. The manner in which such transmission from broadcast stations is to be accomplished is not illustrated, nor referred to in detail, except to point out that methods are well known to those skilled in the art whereby such transmission may be readily accomplished. To receive such waves at the receiver shown in Fig. 1, the carrier is amplified much more than the side bands, so as to bring the carrier amplitude up to normal at the detector input. This is necessary, as will be readily realized, because detection of the received energy with a carrier of subnormal amplitude would result in serious distortion.

Accordingly, the source 1 is coupled to two different amplification paths. One of these paths comprises a multi-stage radio frequency amplifier 2 which is adapted for tuning to the desired carrier wave frequency. The amplifier 2 is conventionally represented, as any type of multi-stage radio frequency amplifier may be employed which is well known to those skilled in the art, it being understood that the amplifier 2 will include a tuning device 3, such as one or more variable condensers, each condenser being disposed in the input of each stage of amplification in the well known manner, the input of the amplifier 2 being coupled as at M, to the source 1. The output of the amplifier 2 is coupled, as at M_1, to the tunable input of the conventionally represented detector 4.

The tuning means of the detector input may also comprise a variable condenser 5, the latter being connected by any mechanical control device 6 for uni-control with the tuning means of the amplifier 2. The source 1 is, additionally, coupled, as at M_3, to a carrier wave amplifier 7, the input of which is tuned by a variable condenser 8. While the amplifier 7 has been conventionally shown, it is to be understood that it may comprise one or more stages of amplification, as in the case of the amplifier 2, and that each stage of such amplification may be tunable if so desired. The variable condenser 8 is shown connected to the uni-control device 6 for variation therewith whereby the tuning means 3, 5 and 8 may be simultaneously operated for selecting the desired carrier wave frequency.

At 9 there is shown a second amplifier, the conventional representation being understood to designate the same type of amplifier as designated by the reference character 7, whereby further amplification of the separated carrier wave may be secured. The carrier wave amplifiers 7 and 9 are coupled by a piezo-electric coupling arrangement to insure complete separation of the carrier wave from its associated side bands. Thus, the piezo-electric arrangement comprises a quartz crystal 10 disposed between the two pairs of metallic plates in a manner well known to those skilled in the art. The crystal coupling will transmit a band including 100 cycles or less and therefore may be considered as insuring a substantially complete separation of carrier wave and side bands.

Hence, the path including the amplifier 7, the coupling 10 and the amplifier 9 may be considered as a carrier wave amplifier, and it is to be clearly understood that the characteristics of these three elements are so chosen that the carrier wave energy is amplified more than the side band energy, the amplifier 2 being employed primarily for amplifying the side band energy.

For controlling the gain of each amplifier 2, 7 and 9, it is desirable to include a volume control device in the circuit of each of these amplifiers. Each volume control device may be conventionally disposed in its amplifier circuit. Thus, variation of amplifier grid bias, cathode emission, or any other very well known type of gain control device may be employed.

In order to adapt the carrier wave amplifier band to different carrier wave frequencies, the crystal 10 is conventionally represented as variable by an arrow, the arrow being shown connected, as at 8', to the uni-control tuning means 6 for simultaneous operation therewith.

It is not believed necessary to disclose herein the construction of a variable crystal coupling device, it being pointed out that any means well known in the prior art which is capable of replacing a crystal of one definite frequency by a crystal of another definite frequency may be employed. Such a variable piezo-electric arrangement is disclosed, for example, by Trogner in

U. S. Patent 1,727,575. Other variable, piezo-electric devices may be employed, it being understood that it is desirable to have the piezo-electric coupling between the carrier wave amplifiers 7 and 9 adapted for adjustment to different carrier wave frequencies simultaneously with the tuning devices 3, 5 and 8.

The amplified outputs of the amplifiers 9 and 2 are impressed upon the input circuit of the detector 4, as at 11. The combined carrier wave and side band energy is then detected by any of the detection methods desired. Detected energy may then be directly utilized by head phones or a loud speaker, or the usual audio frequency amplifier, of one or more stages, may be disposed between the detector and the utilization means. When the receiving circuit shown in Fig. 1 is employed in a system for reducing interference between broadcast stations by transmitting side bands at full amplitude and carrier at reduced amplitude, it is necessary that interfering stations also transmit with reduced carrier.

Then, when the receiver is tuned to one station, other stations on different frequencies may interfere by forcing their side band currents into the receiver, but the carriers of these interfering stations will be very weak, and hence, the interfering side bands, beating with their own carriers, will produce only a small amount of audio frequency current in the detector. The interfering side bands will beat with the carrier of the desired station, but the result of this will be currents of very high audio frequency to which the audio amplifier and loud speaker will not respond. The resulting interfering currents in the loud speaker will not be as troublesome as those received under present conditions where the carrier is transmitted at full amplitude.

The reception method shown in Fig. 1 could also be utilized in a receiver in which the received carrier is augmented for the purpose of getting greatly improved fidelity of reproduction, and improved selectivity, in addition to a reduction of the harmful effects of selective fading, and possibly a slight reduction of static disturbances. It has been explained that the phenomenon termed "selective fading" occurs mainly in the transmission and reception of short waves. Thus, the energy is usually collected, at a point remote from the transmitter, with the carrier wave at subnormal amplitude, and the side bands at normal amplitude. By regulating the amount of increase of carrier the reception method disclosed in Fig. 1 can be effectively employed to amplify the carrier wave much more than the side bands so as to bring the carrier up to normal amplitude at the detector input. The regulation of the increase of carrier will be treated more fully at a later point.

The effective modulation degree of the received carrier wave may be reduced by the system shown in Fig. 1. It has already been explained that the amount of harmonics produced in the process of rectification of modulated signals depends on the degree of modulation of the carrier wave. Where a considerable amount of harmonics is produced, distortion results. Thus, to reduce the amount of harmonic production in the detector output, it is merely necessary to reduce the effective degree of modulation of the carrier wave. This is accomplished in the system shown in Fig. 1 by designing the amplifiers 7 and 9 in such a manner with respect to the amplifier 2 that the carrier is amplified to super-normal amplitude. In other words, in this utilization of the system shown in Fig. 1 the side bands and carrier wave are received at normal amplitude.

It is desired to increase the amplitude of the carrier wave with respect to the side band amplitude in order to reduce the effective degree of modulation of the carrier wave. Thus, it will be seen that the essential distinction between this use of the system and the previous two uses resides in the amplification of the carrier to super-normal amplitude from normal amplitude. However, it should be simultaneously observed that all three utilizations of the reception method shown in Fig. 1 involve the common method of separating the carrier wave from its associated side bands, amplifying the carrier wave independently of the side bands, and then combining both carrier wave and side bands for detection and subsequent utilization.

It will be realized that the aforementioned third use of the present reception method, that is amplification of carrier amplitude to super-normal amplitude for reducing detector output harmonics, may be employed in conjunction with either of the first two uses.

For example, the amplifiers 7 and 9 may be so designed that a carrier wave, received at normal amplitude, will not only be amplified in order to eliminate the effects of selective fading, but will be amplified to super-normal amplitude, with respect to side band amplitude, to reduce the effective degree of modulation of the carrier wave thereby minimizing the production of harmonics in the output of the detector circuit. Of course, the same treatment may be accorded a carrier wave which is deliberately transmitted at reduced amplitude in order to reduce interference between broadcast stations.

While Fig. 1 discloses the basic method of separating the carrier wave from its associated side band for independent amplification, it will be realized that the method shown therein requires the use of a different piezo-electric crystal 10 for every carrier wave frequency desired. In Fig. 2, there is illustrated a method of filtering a carrier frequency out of a modulated wave in a more advantageous manner. A tuned multi-stage radio frequency amplifier 2 receives the modulated carrier energy from a source 1 through a coupling M. The tuning device 3 is shown as a suggested arrangement for selecting any desired carrier wave frequency, the uni-control arrangement 6 being employed as in the case of Fig. 1. The amplified carrier energy is impressed upon the input of a first detector 4 through a coupling M_1, the tuning condenser 5 being employed to select the carrier wave frequency. A local oscillator 4', including a tuning condenser 5', is arranged to impress voltage, as at M_2, upon the input of the first detector 4.

The output circuit of the first detector, or frequency changing device 4, includes the intermediate frequency energy. The intermediate frequency current is now diverted into two separate paths. One of these paths includes an intermediate frequency amplifier 11, the input thereof being fixedly tuned to the desired intermediate frequency by the fixed condenser 12, the input of the amplifier 11 being coupled to the output of the detector 4, as at M_3. The amplifier 11 may include, as is well known to those skilled in the art, one or more stages of amplification, and its output is coupled, as at M_4, to the input circuit of a second detector, or frequency changing device 13, whose input circuit is fixedly tuned to

the intermediate frequency by a fixed condenser 12'.

The second path through which the intermediate frequency current is diverted includes an intermediate frequency amplifier 14 having its input circuit fixedly tuned to the intermediate frequency by a fixed condenser 15, the input circuit of the amplifier 14 being coupled, as at M_5, to the output circuit of the detector 4. A second amplifier 14', similar to the amplifier 14, has its input circuit coupled to the output circuit of the amplifier 14 through a piezo-electric crystal 10. This coupling is accomplished in any manner well known to those skilled in the art, the particular type of coupling shown herein involving the well known device of disposing the crystal between two pairs of metallic plates, each pair of plates being connected to a particular amplifier circuit. The amplified output of the amplifier 14' is impressed upon the input circuit of the second detector 13 through a coupling M_6. Energy from the local oscillator 4' is likewise impressed upon the input circuit of the detector 13 through a coupling M_7.

The operation of the system shown in Fig. 2 will now be explained up to the detector 13, as a clear understanding of the reception method depends upon a clear appreciation of the action of the second detector 13. It has been pointed out that the intermediate frequency current existing in the output circuit of the first detector 4 is transmitted through a second path including a piezo-electric element 10. In passing the intermediate frequency current through the second path, such current is in effect passed through a very selective circuit, highly selective by virtue of the utilization of the quartz crystal 10 as the frequency selecting element, which transmits the carrier but not the side bands.

The amplified unmodulated carrier is impressed through the coupling M_6 upon the second detector 13 simultaneously with heterodyne voltage, obtained from the local oscillator 4', which was utilized in connection with the first detector 4 to obtain the intermediate frequency energy. Thus, it is possible to restore, through the action of the second frequency changing device 13, the carrier wave to its original received frequency.

For example, if the oscillator 4' is assumed to produce heterodyne voltage at 900,000 cycles, and the received carrier frequency is assumed to have a value of 1,000,000 cycles, while a certain side band has a value of 1,001,000 cycles, it will be obvious that the intermediate frequency energy produced in the output circuit of the detector 4 will include a frequency of 100,000 cycles, corresponding to the carrier frequency, and a frequency of 101,000 cycles corresponding to the side band. The amplifier 11 is designed to amplify intermediate frequency energy, including both the carrier wave and side band, in the usual fashion. On the other hand, the crystal 10 is chosen so as to pass only the 100,000 cycle energy corresponding to the carrier wave. Furthermore, the amplifiers 14 and 14' are so chosen with respect to the amplifier 11 that energy of 100,000 cycles is amplified to a greater extent than the energy amplified by the amplifier 11.

It will now be seen that there is impressed upon the input circuit of the second detector 13 the 100,000 cycle energy from the carrier wave amplifier, 900,000 cycle energy from the oscillator 4', and amplified intermediate frequency current from the amplifier 11. Thus, by tuning the output circuit of the detector 13, after including a tuning condenser 16 therein, to the sum frequency of the 900,000 cycle energy and the 100,000 cycle carrier wave energy, there is obtained in the output circuit of the second detector the original carrier frequency of 1,000,000 cycles. The tuned output of the detector 13 is designed so as to select the sum frequency, and reject the difference frequency and the other frequencies present in the output circuit of the second detector 13.

Obviously, the original side band frequency of 1,001,000 cycles will also be present in the tuned output circuit of the second detector. It is now only necessary to couple a third detector 18, having its input circuit tuned by a condenser 17, to the output of the second detector 13, as at M_8, in order to detect the carrier and side band energy. The detected output of the detector 18 may then be amplified at audio frequency in any well known manner and subsequently utilized by head phones, a loud speaker, or in any other similar manner. The tuning devices 3, 5 and 5', 16 and 17 are all shown arranged for mechanical uni-control by the element 6, it being obvious that such uni-control operation may be varied depending upon the variations of the basic method disclosed in Fig. 2.

While it may appear that the arrangement shown in Fig. 2 involves a certain degree of complexity in separating the carrier wave from its side bands, with respect to the method shown in Fig. 1, it is pointed out that it is much easier to accomplish the filtering of the carrier wave from side bands at a relatively low frequency, such as at 100 or 200 kilocycles, than at a higher frequency, since circuits are much more selective at low frequencies.

Additionally, the arrangement shown in Fig. 2 permits the use of a quartz crystal which is the most selective circuit that can be obtained. Instead of tuning the selective circuit to the carrier frequency, which is either impossible since the resonant frequency of a quartz crystal cannot be changed, or highly complicated as a series of different quartz crystals are to be used, the frequency of the received signal is changed to agree with the frequency of the selecting circuit.

Thus, it will be realized that the method shown in Fig. 2 offers a simple and practicable method of accomplishing a result which can be obtained only with great difficulty by other methods. It is intended to be used in a receiver, in which the received carrier is amplified from sub-normal amplitude (caused by selective fading phenomena or by deliberate transmission of carrier at reduced amplitude to minimize interference between broadcast stations) for the purpose of getting greatly improved fidelity of reproduction, and improved selectivity, in addition to a reduction of the harmful effects of selective fading, and possibly a slight reduction of static disturbances. It is likewise pointed out that the method shown in Fig. 2 can be employed for reducing the production of the second harmonic in the output of detector 18 by so designing the amplifiers 14 and 14' with respect to the amplifier 11 that the carrier wave amplitude is increased to super-normal amplitude, thereby reducing the effective degree of modulation of the carrier wave.

The manner of dealing with selective carrier fading, and general carrier fading, will now be considered in detail.

There are two general methods of correcting selective fading (when it acts on the carrier). One is to amplify the carrier in a separate channel, control the amount of carrier output from

this channel so that when the received carrier is strong, the carrier output from the carrier channel is weak, and vice versa, and then add this extra carrier to the currents (including carrier) in the other channel. If the carrier channel is working right, then the sum of the carrier output of the signal channel and the output of the carrier channel will be constant. This sum energy is then impressed on the detector.

The other method is to amplify the carrier to a high level in a separate channel, possibly using a limiter to keep the carrier from exceeding a certain maximum value. This extra carrier is then added to the signal output of the signal channel, and impressed on a linear detector. A linear detector has the property that if the carrier is much larger than the side bands, the carrier amplitude may vary without changing the output.

If the carrier varies, the output of the linear detector remains constant. Therefore if the carrier is made large enough, it can vary considerably (fade) and yet cause no trouble.

Another method of signal correction is to be distinguished from the above two methods, as it does not correct for selective fading though it would probably reduce the bad distortion occurring when the carrier fades out too much, but only for general fading of the whole frequency band.

In this scheme, when the signal fades, the extra carrier channel injects more carrier into the signal channel just ahead of the second detector (which must be a square-law detector) so that the carrier at the detector grid increases when the signal fades, and vice versa. Thus, when the signal is weak, the extra carrier shifts operation to the steepest part of the detector curve, where the detector is relatively efficient, and when the signal is strong the extra carrier is reduced so much that the total carrier is less than before, and detection occurs at a point on the characteristic where the efficiency is lower so that the larger side bands produce only as much audio output as before.

In Fig. 3 there is shown an embodiment of the present invention particularly adapted for use in a system requiring correction for signal fading. Assume that the source 1' collects modulated carrier energy with the carrier at a subnormal amplitude because of fading phenomena. The collected energy is fed into a radio frequency amplifier 2' comprising one or more stages of tuned radio frequency amplification, through a coupling M_1. The amplified output of the amplifier 2' is then diverted into two paths, one of which paths comprises a second radio frequency amplifier 3', whose input is coupled as at M_2, to the output of the amplifier 2'. The output of amplifier 3' is coupled, as at M_3, to the detector, or demodulator 4, the latter having a square law characteristic.

The second path into which the amplified currents of the amplifier 2' are diverted comprises an amplifier 5' having a tuned input circuit coupled, as at M_4, to the output circuit of the amplifier 2'. A carrier frequency oscillator 7' has its input circuit coupled, as at M_5, to the output of the amplifier 5', the output of the oscillator being coupled to the input of the demodulator tube 4'.

Tuning condensers are conventionally shown disposed in each of the input circuits of the amplifiers 2', 3', 5', the demodulator 4' and the carrier frequency oscillator 7', all the condensers being shown as arranged, for mechanical uni-control, as at 6. The output of the demodulator 4' may be impressed upon an audio amplifier and subsequently utilized in any desired fashion.

The operation of the arrangement shown in Fig. 3 has been explained heretofore. The collected modulated carrier energy is diverted into two channels after amplification at 2'. The first channel amplifies the radio frequency and feeds into the demodulator 4'. The demodulator 4' comprises the square law second detector already referred to.

It will be noted that the screen grid tube V_1 functions as a detector whose input electrodes are connected across the output of amplifier 5'. Bias for the grid of amplifier tube V_3 is secured across the resistor R_2. This bias increases with increase of detector (V_1) swing, thus reducing the amplification of V_3, and the amount of energy from oscillator 7' fed into the demodulator input 4' through coupling M_9. The demodulator 4' operates along a square law characteristic, and as the total energy goes down, the carrier increases, thus suppressing fading.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. A method of reception which consists in collecting modulated carrier energy, producing local oscillations, combining the collected energy and the local oscillations to produce intermediate frequency energy, separating the carrier of the intermediate frequency energy from its associated side bands, amplifying the separated carrier to a greater extent than the side bands, combining the amplified carrier and said side bands, selecting the sum frequencies of said last mentioned combined energy and detecting the selected sum frequency energy.

2. The method of overcoming selective fading due to a phase shift of the carrier with respect to the side bands in a carrier system in which the transmitted carrier is set out at a lower value than the side band amplitude, which consists in collecting at the receiver the transmitted energy, separating the carrier wave from its associated side bands, amplifying the separated carried wave independently of the side bands to a value equal to that of the side band amplitude without affecting the side bands, combining the amplified carrier wave and side bands and detecting the combined energy.

3. The method of overcoming selective fading due to a phase shift of the carrier with respect to the side bands in a carrier system in which the transmitted carrier is sent out at a different value than the side band amplitude, which consists in collecting at the receiver the transmitted energy, separating the carrier wave from its associated side bands, amplifying the separated carrier wave independently of the side bands to a value higher than that of the side band amplitude, combining the amplified carrier wave and side bands and detecting the combined energy.

4. The method of overcoming selective fading due to a phase shift of the carrier with respect to the side bands in a carrier system in which the transmitted carrier is sent out at a lower value than the side band amplitude, which consists in collecting at the receiver the transmitted energy, separating the carrier wave from its associated

side bands, amplifying the separated carrier wave independently of the side bands to a value higher than that of the side band amplitude, combining the amplified carrier wave and side bands and detecting the combined energy.

5. In a carrier current system for overcoming selective fading in which the carrier is transmitted at a subnormal amplitude, the method of reception which consists in collecting signal energy, filtering the carrier wave from its associated side band, amplifying the filtered carrier wave to a greater extent than the side bands to raise the carrier to normal amplitude so as to maintain a predetermined relationship between the carrier and the side band amplitudes, combining the amplified carrier and side bands and detecting the combined energy.

6. The method of overcoming selective fading due to a phase shift of the carrier with respect to the side bands in a carrier system in which the transmitted carrier is sent out at a different amplitude than the side band amplitude, which consists in collecting at the receiver the transmitted energy, separating the carrier wave and side bands at a relatively low radio frequency, amplifying the separated carrier and side bands independently, obtaining a greater amplification of the carrier than the side bands, and subsequently combining the carrier wave and side bands, both at substantially the same amplitude.

7. In a carrier system for overcoming selective fading wherein a carrier and sidebands are transmitted, a receiver comprising an energy collector, a radio frequency amplification path arranged to amplify the collected energy coupled to said collector, a tuned circuit in said path, a second amplifying path connected to said energy collector, and a tuned circuit connected in said second path, a piezo-electric filtering means in said second path for discriminating against frequencies other than said carrier frequency, said second path being arranged to amplify said carrier wave to a predetermined value at least equal to that of said side bands, output circuits for said two paths, and a detector coupled to said output circuits, a tuned circuit associated with said detector, and unicontrol means mechanically linked with all three of said tuned circuits.

8. In a carrier system for overcoming selective fading wherein a carrier and sidebands are transmitted, a receiver comprising an energy collector, an amplifier for amplifying the received energy, a first detector coupled to said amplifier, and a local oscillator coupled to said first detector for producing an intermediate frequency, a second detector having input and output circuits, an intermediate frequency amplifier coupling the input of said second detector with the output of said first detector, and a second intermediate frequency amplifier for amplifying the intermediate carrier frequency to an extent greater than that afforded said side bands by said first intermediate frequency amplifier, and coupling coils for coupling both said local oscillator and the output of said second intermediate frequency amplifier with the input of said second detector, and means in circuit with the output of said second detector for obtaining the sum frequencies of said local oscillator and the intermediate carrier frequency.

9. In a radio receiver, a modulated carrier energy amplifier, a detector circuit, a path extending from the output of said amplifier to the input of said detector arranged to pass both the carrier and its associated sidebands, and means including an oscillator in circuit with said path tuned to the carrier for amplifying the carrier independently of the sidebands.

10. A method of reception which includes the steps of collecting signal modulated carrier energy, producing local oscillations of the same frequency as the collected carrier energy, controlling the amplitude of the generated oscillations in accordance with the intensity of the collected carrier energy, controlling the phase of the generated oscillations in accordance with the collected carrier energy and combining at least a portion of the generated oscillations with the collected modulated carrier energy in such a way that the resultant product energy comprises modulated carrier energy, the carrier component of which is of approximately constant amplitude and of proper phase relationship with respect to its associated side bands, and deriving the desired signals from the resultant product energy.

11. A method of reception which includes the steps of collecting modulated carrier energy, producing local oscillations, combining the collected energy with a portion of the locally produced oscillations to produce intermediate frequency energy, separating the carrier of the intermediate frequency energy from its associated side-bands, amplifying the separated carrier and the side-bands, the separated carrier being amplified to a greater extent than the side-bands, combining the amplified carrier, the amplified side-bands and another portion of the locally produced oscillations, selecting from said combination the sum frequency of the frequency of the amplified carrier and the frequency of the locally produced oscillations, detecting the selected sum frequency energy and utilizing the detected energy to produce the desired signals.

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