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CARRIER AMPLITUDE CONTROL SYSTEM

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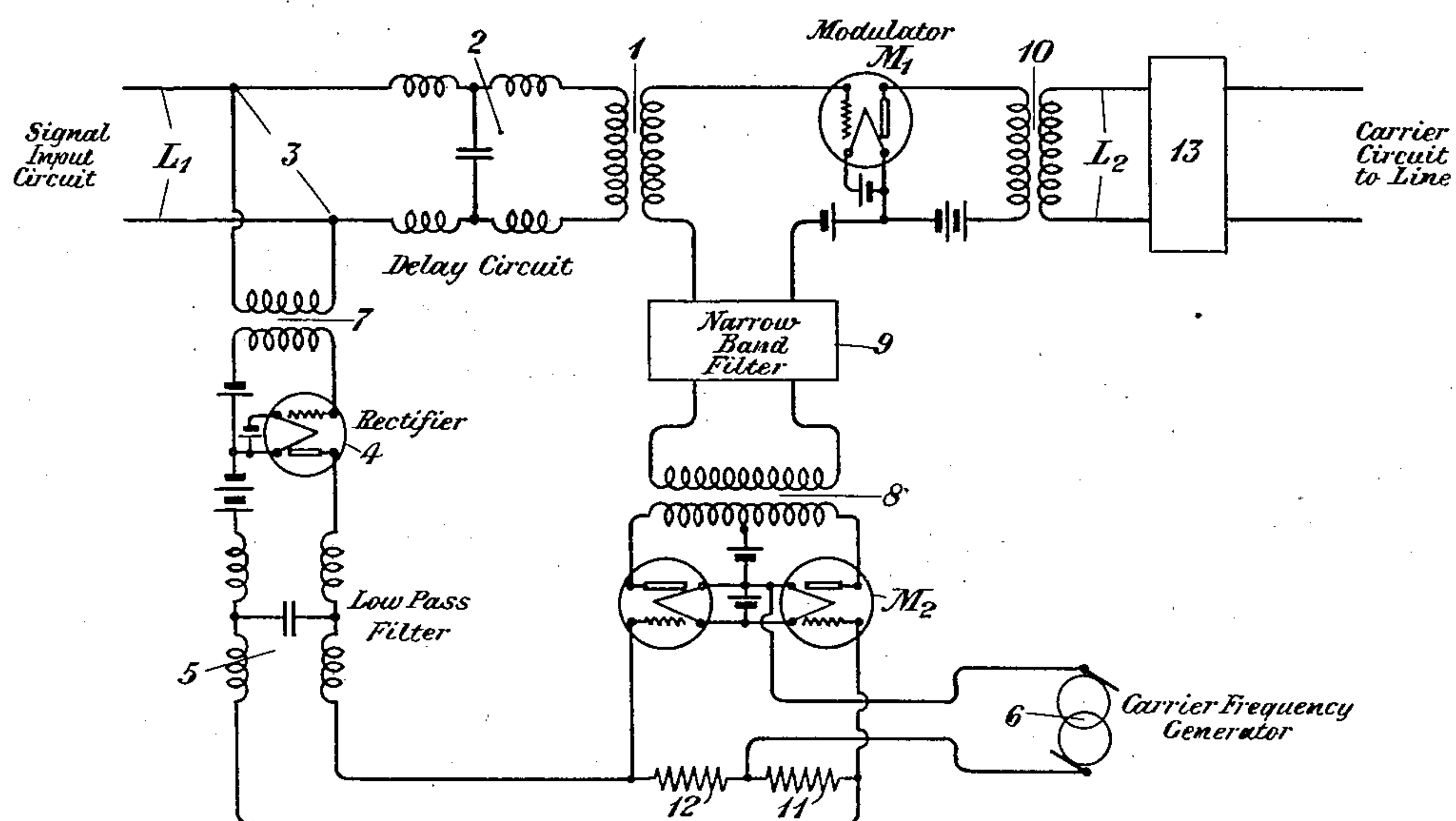


Fig. 1

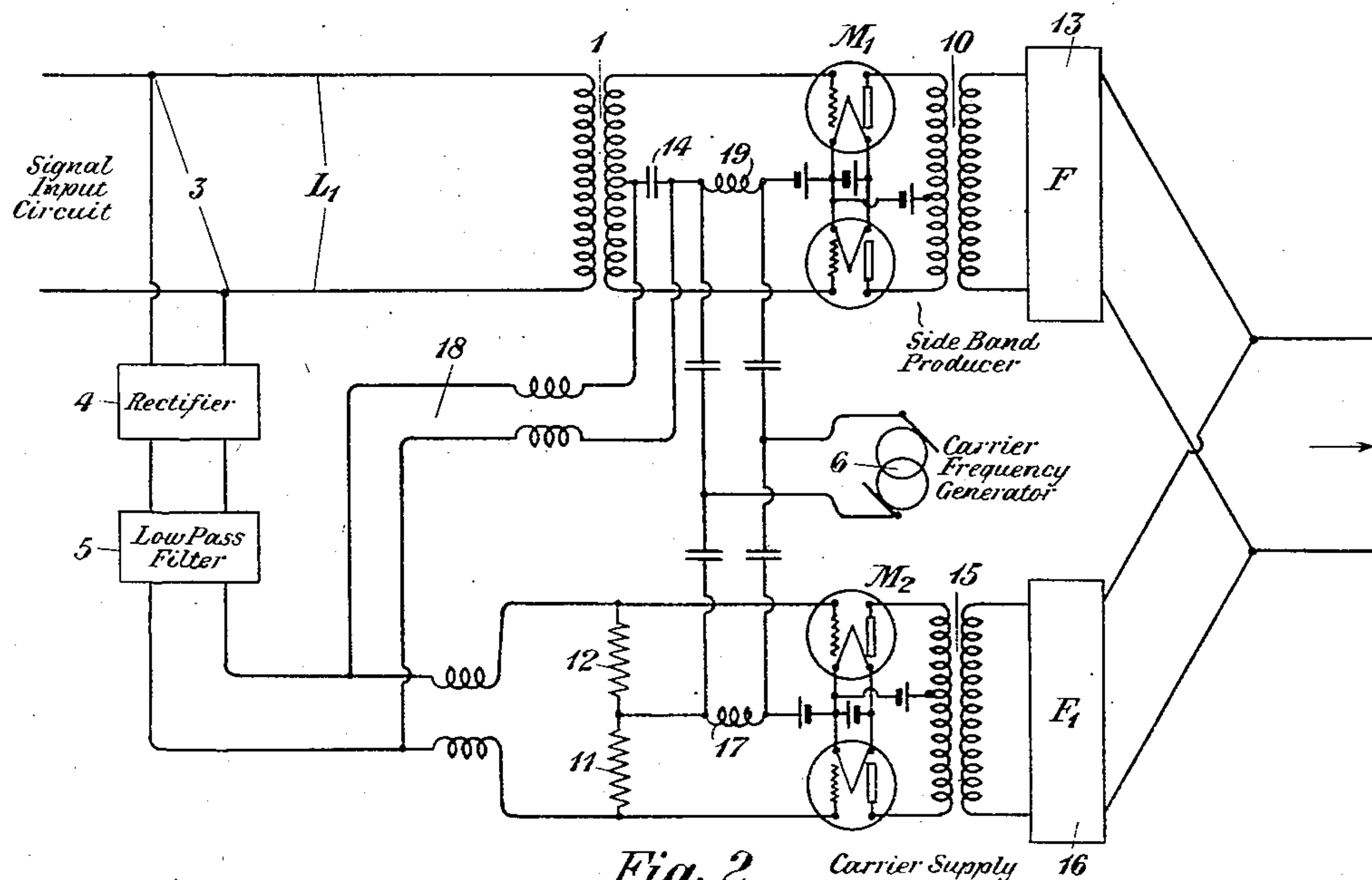


Fig. 2

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CARRIER AMPLITUDE-CONTROL SYSTEM.

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This invention relates to a carrier or radio system characterized by the simultaneous transmission of the carrier frequency and one or both of its side bands, and particularly to a method and means for controlling the amplitude of the carrier frequency in accordance with variations in amplitude of the side band corresponding to changes in the instantaneous values of the signal frequency load being transmitted over the carrier or radio system.

In the method heretofore employed in radio transmission or broadcasting, and also in carrier systems in which the carrier frequency is simultaneously transmitted with one or both of the side bands resulting from modulation of the carrier by a frequency or band of frequencies representing the load to be transmitted by the carrier, the amplitude of the carrier frequency per se remains substantially constant, whereas the amplitude of the side bands increases and decreases in accordance with the instantaneous values of the frequency or frequencies employed in modulating the carrier. For example, during the transmission of speech over a carrier system, there will be times when the side bands will cease to exist, which times correspond to a pause in the speech being impressed upon the transmitter of the system. In such intervals, the carrier frequency continues to flow over the system to the detector at the receiving station. Any extraneous interference or noise lying within the frequencies of the side band will be demodulated with this carrier by the detector at the receiving station. The objection to this situation is that during these pauses the receiving system is as susceptible to noise conditions on the circuit as it is when the speech band is being received.

One of the objects of this invention is to overcome the objection set forth above by causing the sensitivity of the receiving system to be reduced during periods of light load, or no load, corresponding, for example, to pauses in a speech or musical program. This result is accomplished by causing the amplitude of the carrier to be varied directly with variations in the magnitude of the audio frequency input, and simultaneously subjecting the gain applied to the side

bands to similar control, but in an inverse sense.

This invention will be clearly understood from the following description when read in connection with the attached drawing, of which Figure 1 shows schematically a system characterized by transmission of a carrier of varying amplitude, and Fig. 2 shows schematically a system in which the amplitude of the carrier is varied directly with the amplitude of the voice input, and the gain applied to the side band varied inversely with the amplitude of the voice input.

In Fig. 1, the line L_1 represents a signal input circuit having connected with it suitable apparatus for picking up the signals such as speech or music to be transmitted over the carrier system. The line L_1 is connected with the modulator M_1 by the transformer 1, the connection including a network 2 which may be designated a delay circuit, the function of which is to retard the signal which is about to be impressed upon the modulator M_1 and to prevent its effect thereon until certain other operations have taken place. Bridged across the line L_1 at the points 3 is a carrier amplitude control circuit comprising a rectifier 4, a low pass filter 5, a push-pull modulator M_2 , having a carrier frequency generator 6 connected with the input side thereof. This carrier amplitude control circuit is connected with the line L_1 by means of the transformer 7, and the output side of this control circuit is connected with the input circuit of the modulator M_1 by the transformer 8, the connection also including a filter or tuned circuit 9 which transmits substantially only the carrier frequency generated by the source 6. The output side of the modulator M_1 is connected by the transformer 10 with a carrier circuit L_2 which may contain an amplifier and a filter such as 13, and may be connected with the main transmission line in any one of a number of well-known ways. Furthermore, a receiving circuit, which may be of any well-known type adapted to receive the carrier frequency and its side band, and to detect the audio frequency signal, may be connected with the main transmission line.

The manner in which the before-described circuit functions to transmit speech or other signals is as follows: A portion of the speech energy being transmitted by the line L_1 is impressed at the points 3 across the primary of the transformer 7. The tube 4, which is arranged to function as a rectifier, rectifies the speech wave, and the resultant rectified current is smoothed out by means of the network 5 constituting a low pass filter so that only its major variations are transmitted. This rectified current as smoothed out by the low pass filter 5 flows through the resistances 11 and 12 in series across the grids of the push-pull modulator M_2 . The modulator grid is accordingly unbalanced, so that a wave of carrier frequency from the source 6 will be impressed upon the secondary winding of the transformer 8, the amplitude of which will depend upon the degree of unbalance of the said modulator. This in turn depends upon the magnitude of the rectified current flowing through the resistances 11 and 12 in series, which establishes a potential difference across them varying with variations in the magnitude of the signal current. The relation between the amplitude of the carrier and that of the voice input may or may not be arranged to be exactly linear, as desired. The filter 9 is designed to pass only slow variations of the carrier frequency, thus eliminating any residual side band components that might be produced by signal variations in the rectified speech frequency not eliminated by low pass filter 5. This carrier frequency will be modulated by the speech frequency impressed by the transformer 1 upon the modulator M_1 , and the resultant side bands and the carrier frequency will be impressed by the transformer 10 upon the circuit L_2 . A filter 13 may be included to eliminate one of the side bands for transmission and an amplifier may also be inserted. The delay circuit 2, by retarding the speech signal, enables the change in the amplitude of the carrier current to be effected before the speech reaches the input of the modulator M_1 . It will accordingly be seen that as the speech diminishes in intensity, the amplitude of the carrier is likewise reduced, and by proper adjustment of the rectifier, entire suppression of the carrier in so far as it affects the input of the modulator M_1 may be effected when there is a pause or cessation of speech.

In the system before described, there may be distortion of the speech as detected at the receiving station due to the fact that the volume changes of the voice will be exaggerated. This follows because the modulator circuit and the demodulator circuit no longer function as substantially constant gain devices, since their gain depends on the supply of carrier current, which is variable and great-

est when the voice input is greatest, and vice versa, least when the voice input is lowest. The arrangement shown in Fig. 2 serves to overcome this defect in the arrangement shown in Fig. 1 by feeding the side bands and the carrier frequency to the line through separate sources, and causing the gain of the modulator which produces the side bands to fall off when the amplitude of the carrier supplied to the line is increased, and vice versa. In Fig. 2 of the drawing, the signal input circuit L_1 has bridged across it at the points 3 a control circuit having a rectifier 4 and a low pass filter 5, which elements, while shown schematically in Fig. 2, are preferably of the form shown in greater detail in Fig. 1. The output circuit of the rectifier is bridged across the resistances 11 and 12, connected with the grids of the balanced modulator M_2 , and is also connected across a condenser 14 in the common or middle conductor of the modulator M_1 . The source of carrier frequency 6 is connected across the impedances 17 and 19 in the common conductors of the modulators M_1 and M_2 . The modulator M_1 is connected with the input circuit L_1 by the transformer 1, and is connected with an output circuit by the transformer 10, which connection may include a filter 13 designed to pass one of the side bands of modulation. The modulator M_2 , which controls the amplitude of the carrier current supplied to the line, is connected by a transformer 15 with the line, the connection including a filter 16 corresponding to filter 9 in Fig. 1. The carrier frequency current, which is supplied by the source 6 to the modulator M_2 , being applied across the impedance 17 in the common conductor of the modulator, is varied in amplitude in the same way in which the carrier current is varied in Fig. 1 by means of the rectified signal current flowing through the resistances 11 and 12. The gain applied to the side bands is controlled by a portion of the rectified signal current that flows over the branch circuit 18, which is bridged across the condenser 14 in the common conductor of the modulator M_1 . This rectified current, which, of course, varies with the level of the signal upon the line L_1 , produces a correspondingly varying potential to the grids of the modulator M_1 , and is so applied that it will reduce the gain applied to the side bands whenever the amplitude of the carrier is increased, and, vice versa, it will increase the gain applied to the side bands, when the amplitude of the carrier diminishes. It is intended that for an increasing speech input current the connection shall be so arranged that the effective grid potentials will be varied in such a manner as to decrease the gain of the modulator M_1 while for a decreasing speech input current, the gain of the balanced modulator M_1 will be increased. The amplitude of the carrier may be varied

in accordance with any root or power of the voice input, and the gain applied to the side band will be given an inverse variation. This will tend to insure at the receiving station the proper relation between side band and carrier amplitude to avoid the possibility of distortion mentioned hereinbefore, and, at the same time, a reduction is likewise effected in the carrier amplitude during the period in which little or no speech is being transmitted.

While this invention has been disclosed in certain forms, it is to be understood, of course, that such forms are merely schematic, and that the invention is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a carrier or radio signaling system in which a carrier frequency is modulated by a signal frequency, the method which consists in producing a carrier frequency, varying the energy level of the carrier frequency by variations in the level of the signal frequency, and simultaneously modulating by the said signal the carrier frequency as thus varied.

2. In a carrier or radio signaling system in which a carrier frequency is modulated by a signal frequency, the method which consists in controlling the amplitude of a carrier frequency by the amplitude of a signal frequency, and simultaneously modulating by the said signal frequency the said carrier frequency as thus controlled.

3. In a carrier or radio signaling system in which a carrier frequency is modulated by a signal frequency, the method which consists in producing a signal frequency and also a carrier frequency, rectifying a portion of the signal frequency, varying the level of the carrier frequency by and in accordance with changes in amplitude of the rectified signal frequency, and modulating the said carrier frequency by the said signal frequency.

4. In a carrier or radio signaling system in which a carrier frequency is modulated by a signal frequency, the method of regulating the amplitude of the carrier frequency transmitted over the said system, which consists in rectifying a portion of the signal frequency energy, controlling the amplitude of the carrier frequency in accordance with changes in magnitude of the energy level of the signal frequency as represented by the rectified signal current, and modulating the said carrier frequency by the signal frequency.

5. In a carrier or radio signaling system in which a carrier frequency is modulated by a signal frequency, the method which consists in modulating a carrier frequency by a signal frequency, transmitting the frequencies resulting from modulation, and controlling the said modulation so that the amplification applied in the modulation process

varies inversely with variations in the level of the signal frequency, and simultaneously transmitting and controlling the said carrier frequency so that its level as transmitted varies directly with variations in the energy level of the said signal frequency.

6. In a carrier or radio signaling system in which a carrier frequency is modulated by a signal frequency, the combination with a source of carrier frequency of a source of signal frequency, a modulator connected with both sources to modulate the said carrier frequency by the said signal frequency, and means connected with the said source of signal frequency and responsive to variations in the energy level of the signal frequency to control the amplitude of the carrier frequency.

7. In a carrier or radio signaling system in which a carrier frequency is modulated by a signal frequency, the combination with a source of carrier frequency of a source of signal frequency, a modulator connected with both sources to modulate the carrier frequency by the signal frequency, means connected with the source of signal frequency to rectify a portion thereof, and means connected with the source of carrier frequency and controlled by the rectified signal voltage to vary the amplitude of the carrier frequency as transmitted in accordance with variations in the energy level of the signal frequency.

8. In a carrier or radio signaling system in which a carrier frequency is modulated by a signal frequency, the combination with a source of carrier frequency of a source of signal frequency, a modulator connected with both sources to produce side bands of the said carrier frequency by the said signal frequency, a transmission circuit connected with the output side of said modulator, a second modulator of the balanced type connected between the said source of carrier frequency and the said transmission circuit in such manner that the transmission of the carrier frequency is normally suppressed, and rectifying means connected between the said source of signal frequency and the said second modulator to apply rectified signal voltage to the second modulator to effect the transmission of the carrier frequency by unbalancing the said modulator, the degree of unbalance varying directly with variations in the energy level of the said signal frequency.

9. In a carrier or radio signaling system in which a carrier frequency is modulated by speech frequency, the method which consists in controlling the amplitude of the carrier in accordance with variations in the envelope of the speech band, and varying the amplitude of the side band inversely with changes of the amplitude of the carrier.

10. In a signaling system, a source of low frequency signals, a carrier frequency, means for changing the amplitude of the carrier frequency to correspond to changes in the amplitude of the low frequency signals, and means for superimposing the low frequency signals on the carrier frequency controlled as to its amplitude in accordance with the low frequency signals.

11. In a signaling system, a source of voice frequency signals, means for selecting from said voice frequency signals a low frequency wave corresponding to changes in the amplitude of the voice frequency signals, a carrier frequency, means for controlling the amplitude of the carrier frequency by the amplitude of the selected low frequency wave, and means for modulating the controlled carrier frequency by the voice frequency signals for transmission to a distant point.

12. The method of signaling which consists in generating a carrier transmitting frequency, controlling the amplitude of said carrier transmitting frequency in accordance with the amplitude of incoming voice frequency signals, modulating said controlled carrier transmitting frequency by the incoming voice frequency signals, and transmitting the controlled carrier transmitting frequency after being modulated by said voice frequency signals.

13. The method of signaling which consists in generating voice frequency signals, and superimposing said voice frequency signals on a carrier frequency controlled as to its amplitude by the amplitude of the said voice frequency signals.

14. The method of controlling the amplitude of the carrier frequency in a signaling system which consists in generating voice frequency signals, selecting from the voice frequency signals a wave corresponding to the envelope of the voice frequency signals, controlling the amplitude of the carrier frequency by the envelope of said voice frequency signals, and modulating the carrier frequency controlled as to its amplitude by the voice frequency signals.

15. In a signaling system, the combination with a source of low frequency signals, of a source of carrier frequency, means for controlling the amplitude of the carrier frequency in accordance with the envelope of the low frequency signals, and means for modulating the controlled carrier frequency by the low frequency signals for transmission to a distant point.

16. In a system for the transmission of signals, the combination with a source of low frequency signals, of means for selecting from the low frequency signals a wave corresponding to changes in the amplitude of the low frequency signals, a source of carrier frequency, means for modifying the amplitude of the carrier frequency by the

wave selected from the low frequency signals, and means for superimposing the low frequency signals on the modified carrier frequency for transmission to a receiving station.

17. In a system for the transmission of signals, the combination with a source of low frequency signals, of means for selecting from the low frequency signals a wave corresponding to the envelope of the low frequency signals, means for rectifying the selected wave, a source of carrier frequency, means for modifying the amplitude of the carrier frequency by amounts proportional to the amplitude of the wave selected from the low frequency signals and rectified, and means for superimposing the low frequency signals on the modified carrier frequency for transmission to a distant station.

18. In a system in which a carrier frequency is modulated by low frequency signals, means for controlling the amplitude of the carrier frequency in accordance with the amplitude of the low frequency signals, said means comprising a filter for selecting from the low frequency signals a frequency corresponding to the envelope of the low frequency signals, a rectifier for rectifying the selected frequency, and a modulator upon which the carrier frequency and the rectified selected frequency are impressed for changing the amplitude of the carrier frequency.

19. In a signaling system, the combination with a source of low frequency signaling oscillations of varying amplitude, of a source of high frequency oscillations, a filter for selecting from the low frequency signaling oscillations a wave representing the variation in the amplitude of the low frequency signaling oscillations, means for controlling the amplitude of said high frequency oscillations in accordance with the nature of the wave selected from the low frequency signaling oscillations, a modulator for modulating low frequency signaling oscillations and the high frequency oscillations controlled as to their amplitude, and means for transmitting the products of modulation.

20. In a signaling system, the combination with a source of low frequency signals, of a source of carrier frequency, means for increasing or decreasing the amplitude of the carrier frequency as the amplitude of the low frequency signals increases or decreases, respectively, means for superimposing the low frequency signals on the carrier frequency thus changed as to its amplitude, and means for transmitting the carrier frequency with the low frequency signals superimposed thereon.

21. In a signaling system, the combination with a source of low frequency signals, of a source of carrier frequency, means for

changing the amplitude of the carrier frequency to correspond to changes in amplitude of the low frequency signals, said means comprising a rectifier, a filter connected with the source of low frequency signals so arranged that the amplitude of the current passing said rectifier and said filter varies with the amplitude of the low frequency signals, and also comprising means
10 for controlling the amplitude of the carrier frequency by the amplitude of the current

passing the said rectifier and the said filter, and a modulator for superimposing the low frequency signals on the carrier frequency controlled as to its amplitude in accordance
15 with the low frequency signals.

In testimony whereof, we have signed our names to this specification this 23rd day of February, 1926.

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