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R. K. POTTER

TRANSMISSION LINE CONTROL SYSTEM

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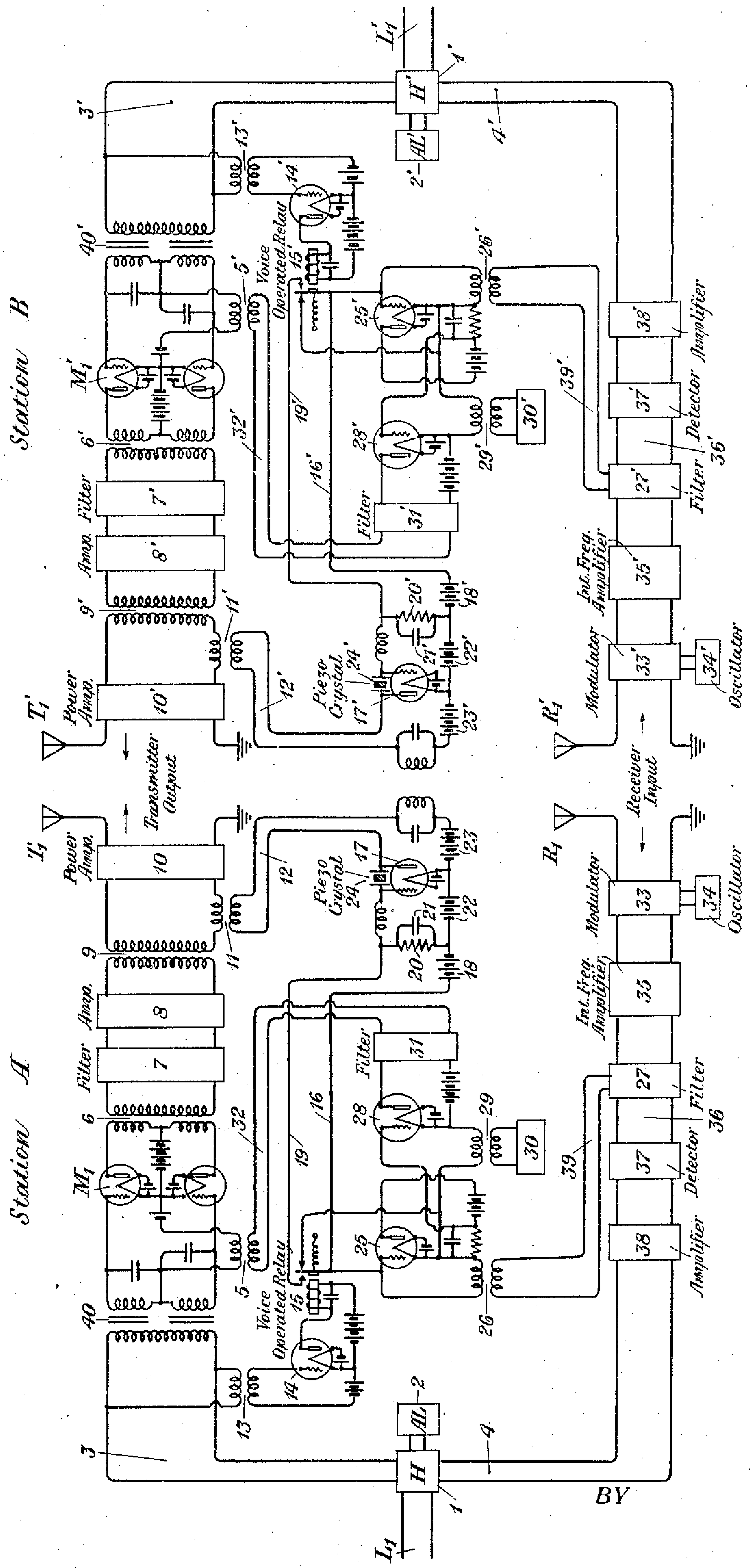

Fig. 1

Fig. 2

INVENTOR
R. K. Potter
BY
ATTORNEY

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RALPH K. POTTER, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TRANSMISSION-LINE CONTROL SYSTEM.

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This invention relates to transmission level control systems and particularly to a system of that type in which the ratio of the transmission level of the communication signal to the noise level existing between two stations of the system is maintained constant by a control signal transmitted from the station that is receiving the transmitted signal.

In transmission level control systems which have for their object the maintenance of a constant ratio between the communication signal level and the noise level over the transmission path between the communicating stations of the system, it is customary to transmit from the communicating stations a control signal, in order to vary the level of the transmitted communication signal in accordance with variations in the noise level existing at any instant. While both stations are adapted to transmit communication signals and control signals, and also to receive such signals from the other station, only the control signal of the station that is receiving at any instant is employed to control the transmission level of the communication signal at the station that is transmitting at that instant. Therefore, the transmission of the control signal energy from the station that is transmitting at that instant serves no useful purpose, and is in fact detrimental in that it tends to overload the power amplifier in the transmitting branch of the station transmitting at that time.

One of the objects of this invention is to provide means to prevent the generation and radiation of the control signal frequency at each station during the time in which that station is transmitting communication signals to another station or stations of the system.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing, of which Figure 1 shows schematically one form of embodiment of the invention, which figure will be designated station A of the system, and Fig. 2, which is a duplication of Fig. 1, represents a second station designated B of the system.

In Fig. 1, the line L_1 represents a wire circuit to which a subscriber's telephone may be connected either directly or through the intermediation of central offices or other switching devices. The line L_1 is connected with the transmitting and receiving branches of the terminal station A of the radio system by means of the hybrid coil 1. Associated with the hybrid coil is the artificial line 2 designed to simulate electrically the line L_1. This coil is of the well-known type having a plurality of windings so arranged and proportioned that when energy is impressed upon the coil by the line L_1, it will pass into the transmitter branch circuit 3, and into the receiver circuit 4. It will, however, produce no effect in the latter circuit, since a unilateral device such as a vacuum tube amplifier is connected in that circuit. The transmitter circuit 3 is coupled to a modulator M_1 which preferably is of the type in which the carrier frequency is suppressed. This carrier is supplied to the input circuit of the modulator through the transformer 5. The manner in which the carrier frequency is generated and supplied will be later described in detail. The output circuit of the modulator M_1 is coupled by the transformer 6 with the filter 7, which is of a type designed to suppress one of the bands resulting from modulation. This filter is connected with an amplifier 8 which in turn is connected by the transformer 9 with the input circuit of the power amplifier 10. Also connected with the input side of this amplifier by the transformer 11 is the circuit 12 which is connected with a source of control frequency oscillations. The output side of the amplifier 10 is connected with the antenna T_1.

Bridged across the circuit 3 is a winding of the transformer 13, the other winding of which is connected with the input side of an amplifier 14 having its output side connected with the winding of a voice-operated relay 15. The function of this relay is primarily to prevent the generation of oscillations of the control signal frequency during the time in which a communication signal is being transmitted from the antenna T_1 of station A, inasmuch as such transmission of the control frequency at that time performs no useful function and simply tends to overload the power amplifier 10 during the time in which the communication signaling wave is passing through this amplifier. The armature of the relay 15 which is normally biased by a spring or otherwise, to remain upon its back contact when the relay is not energized, is connected by conductor 16 with the input side of the control signal oscillator 17, the connection including a source of current 18. The front contact of relay 15 is also connected by conductor 19 with the input circuit of the oscillator 17, the said conductors 16 and 19 being bridged across the resistance 20 which is shunted by the condenser 21. A source of negative biasing potential 22 is connected with the input side of the oscillator, and a source of plate potential 23, with the output side of the said oscillator. Connected between the plate and the grid is a piezo crystal 24 which functions in a well-known manner to transfer from the plate to the grid only a single frequency which is the frequency of the control signal oscillations. It is desirable to point out at this point that when the armature of relay 15 is in the position shown in the figure, a negative potential will be applied by the source 22 to the grid of the oscillator 17, which causes the oscillator to oscillate at the frequency transferable through the crystal 24, and the said oscillator will continue to oscillate at that frequency as long as the armature remains in the position shown. These oscillations will be transmitted by the circuit 12 to the input circuit of the power amplifier 10 through the transformer 11, and will be radiated from the antenna T_1. The back contact of the relay 15 closes a circuit between the grid and the filament of the amplifier 25, which path shunts the winding of the transformer 26 which connects the filter 27 of the receiving circuit with the said amplifier, the purpose of doing which will be clear from subsequent description of the receiving circuit. The output side of the amplifier is connected with the vacuum tube regulator 28, to the input side of which is also connected, through the transformer 29, a source of carrier oscillations 30. These oscillations pass through the filter 31 and thence over the branch circuit 32 to the input side of the modulator M_1 through the transformer 5. The receiving circuit of the station comprises a receiving antenna R_1 which is connected with a modulator 33 which may be of any type, but preferably is of a type having a source of local oscillations 34 connected therewith to beat down the received frequency to an intermediate frequency, which intermediate frequency is amplified by the amplifier 35 and impressed upon the filter 27. This filter is of a type adapted to transmit therethrough two frequencies or groups of frequencies, impressing them upon their appropriate circuits, depending upon the frequencies involved. Thus the communication frequency or band passes to the circuit 36 and is impressed upon the detector 37 which reduces the intermediate frequency to an audio frequency and transmits the communication signal to the amplifier 38 and thence to the line L_1 through the hybrid coil 1. The other frequency which comes into this receiving circuit, namely the control signal frequency, is diverted by the filter 27 into the branch circuit 39 which is coupled by the transformer 26 with the input side of the amplifier 25.

Another station of this system, which has been designated B, is shown in Fig. 2. In this figure, which is a duplicate of the circuit shown in Fig. 1, the same reference figures have been used with the addition of prime marks to distinguish between the figures.

The manner in which the invention attains its object will probably be better understood by considering first the manner in which a communication signal, such as a speech signal, is transmitted from station A to station B, and then by considering the manner in which the control signal is transmitted and received at the respective stations.

When a band of speech frequencies is impressed upon the line L_1 and transmitted thereover to station A, these frequencies will be impressed by the hybrid coil 1 into the transmitting circuit 3, and voltages will be set up across the transformers 13 and 40. The voltage set up across the transformer 40 will serve to modulate the high frequency oscillations which are impressed upon the common conductor of the modulator M_1. These high frequency oscillations which are produced by the device 30 are in turn impressed by the transformer 29 upon the input circuit of the regulator 28 which is in the nature of a power limiting device, and they pass through the filter 31 and over the branch circuit 32 to the input side of the modulator. The high frequency speech signal will then be impressed by the transformer 6 upon the filter 7, which suppresses one side band and impresses the other upon the amplifier 8, which in turn impresses the band upon the power amplifier 10. The speech signal then passes to the antenna T_1 and is radiated to the distant station B. At the distant station it is received by the antenna R'_1 and is beaten down to an intermediate frequency by the modulator 33′ and amplified by the amplifier 35′. This intermediate frequency band carrying the speech signal passes through the filter 27′ to the circuit 36′, and the speech band is detected by the detector 37′. This speech band is amplified by the amplifier 38′ and is impressed upon the line L'_1 through the hybrid coil 1′.

A small part of the speech energy in the circuit 3 at station A passes through the transformer 13 to the amplifier 14, with the plate circuit of which the winding of the voice-operated relay is connected. This relay will, accordingly, be operated by attracting its armature to its front contact. The effect of this is to close a circuit from the source of current 18, over conductor 16, through the front contact of relay 15, thence over conductor 19 and through the resistance 20 to the said source of potential. It will, accordingly, be seen that this current will flow through the resistance 20 in an opposite direction to the flow of current therethrough from the source 22. The effect thereof is to neutralize the potential that is normally applied by the source 22 to the grid of the oscillator 17. This results in a stoppage of oscillations, and in consequence thereof no oscillations of the control signal frequency, will be transmitted to the amplifier 10 of the antenna T_1. It will, accordingly, be seen that when station A is transmitting to station B, the communication signal that is received over the line L_1 at station A, there will be no radiation from the antenna T_1 of a control signal, inasmuch as the voice frequency impressed by the line L_1 upon the transmitting circuit 3 energizes the voice-operated relay 15 and closes the circuit which in part contains the source of potential 18 and the resistance 20, and stops the production of oscillations by the source 17.

Since station B is at this instant receiving the speech signal from station A, the voice-operated relay at station B will not be energized, and consequently the source of the control signal oscillations 17′ at station B will be operating, impressing its oscillations upon the circuit 12′ and thence upon the input circuit of the power amplifier 10′ through the transformer 11′. This control signal is radiated by the antenna T'_1 and is received by the antenna R_1 at station A during the time in which the speech signal is being radiated from station A, both of the signals traversing substantially the same path between the two stations, but in opposite directions. The control signal received by the antenna R_1 is beaten to an intermediate frequency by the device 33, which intermediate frequency signal is amplified by 35, and by the action of the filter 27, this control signal is diverted into the branch circuit 39 and impresses a voltage depending upon the magnitude of the control signal upon the winding of the transformer connected with the grid circuit of the rectifier 25. Since station A is at this instant transmitting a speech signal to station B, the voice-operated relay 15 will be energized, and, as mentioned before, the shunt across the winding of the transformer 26 connected with the grid circuit of the rectifier 25, will be open, thereby rendering the control signal effective in applying its voltage to the grid of the rectifier 25. The resultant current or voltage is in turn applied to the grid of the regulator 28, to the input side of which is connected the source of carrier oscillations. In this manner, the amplitude of the carrier oscillations is varied by the received control signal oscillations. If the said control signals are greatly attenuated in transmission from station B to station A, the amplitude of the carrier oscillations produced by 30 will be increased by the regulator 28, and consequently the level of the speech signal produced by the modulation of the carrier oscillations by the incoming speech band will be raised in order to maintain it well above the level of interference between station A and station B. As soon as the subscriber connected with the line L_1 ceases talking and begins to listen to the subscriber connected with the line L'_1 at station B, the voice-operated relay 15 at A will be deenergized, thereby putting a shunt across the winding of the transformer 26 which renders this device ineffective and thereby reduces the intensity of the carrier oscillations applied to the modulator M_1 during the interval in which speech signals are not being transmitted from the antenna T_1. Furthermore, since the relay 15 is deenergized, the control signal oscillator 17 begins to function and transmit from the antenna T_1 to the receiving circuit at station A, a control signal to effect the proper regulation of the speech signal being transmitted from station B to station A at that instant. This speech signal passes through the receiving circuit from the antenna R_1 to the hybrid coil 1, and is there impressed upon the line L_1 for transmission to the listening subscriber.

While this invention has been disclosed as embodied in a particular form, it is obviously capable of embodiment in other forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a signaling system having a signal input circuit, a high frequency modulating and transmitting circuit, and a source of control signaling oscillations, the method for preventing the transmission of control signal oscillations during the transmission of a communication signal which consists in receiving a signal current in the signal input circuit, diverting a portion of the said signaling current, modulating a carrier frequency by the remaining portion of the signal current, and effectively stopping the production of control signal oscillations by the diverted portion of the signal current.

2. In a signaling system having a signal input circuit, a high frequency modulating and transmitting circuit, and a source of control signal oscillations, the method for preventing the transmission of control signal oscillations during the transmission of a communication signal which consists in re-

ceiving a signal current in the signal input circuit, diverting a portion of the said signaling current, modulating a carrier frequency by the remaining portion of the signal current, and effectively stopping the transmission of the said control signal oscillations by the diverted portion of the signal current.

3. In a signaling system having a signal input circuit, a high frequency modulating and transmitting circuit, and a source of control signal oscillations, the method for preventing the transmission of control signal oscillations during the transmission of a communication signal which consists in receiving a signal current in the signal input circuit, diverting a portion of the said signaling current, modulating a carrier frequency by the remaining portion of the signal current, amplifying the said diverted portion to such degree as is necessary to operate an electro-responsive device, and controlling the production of control signal oscillations by the operation of the said device.

4. In a signaling system comprising a plurality of stations each having a transmitting branch, a receiving branch, a source of control signal oscillations, a source of carrier oscillations and a control circuit therefor, the method of controlling the level of transmission between two stations which consists in receiving at one station a signal current, modulating the carrier oscillations by the said signal current to produce a communication signal, and transmitting the said communication signal to a second station, simultaneously diverting a portion of the signal current from its source and effecting by the said diverted current the prevention of transmission of control signal oscillations from the said first station, transmitting from the second station control signal oscillations, receiving the said control signal oscillations at the said first station, and effecting the control of the amplitude of the said carrier oscillations by the received control oscillations.

5. In a signaling system characterized by a source of control signaling oscillations at each of the stations for controlling the transmission level of communication signals transmitted between stations of the said system, the method for preventing the transmission of a control signal from one station of the system to a second station during the interval in which the said first station is transmitting a communication signal which consists in receiving at the first station a signal, modulating the carrier wave by the said signal and transmitting the wave as thus modulated, diverting a portion of the signal energy from the said source of the signal, and controlling the generation of the control signal frequency at the said first station by the said diverted energy.

6. In a signaling system, the combination with a high frequency transmitter having a modulating device, of a source of carrier oscillations connected therewith, a source of signals to modulate the said carrier oscillations also connected with the said modulating device, a source of control signal oscillations, and means connected with the said source of signals to control the operation of the said source of control signal oscillations.

7. The methd of maintaining substantially constant the ratio of the signal level to the noise level in a signaling system, which consists in transmitting a signal wave from A to B, simultaneously transmitting a control wave from B to A, the frequency of the control wave differing from that of the signal wave, and varying the amplitude of the signal wave as transmitted from A by and in accordance with changes in the amplitude of the control wave as received at A to maintain constant the ratio of the signal level to the noise level throughout the system.

8. The method of maintaining substantially constant the ratio of the signal level to the noise level in a signaling system, which consists in transmitting a signal wave from A to B, simultaneously transmitting a control wave from B to A, traversing substantially the same path as the signal wave and exposed to the same energy-dissipating forces, the frequency of the control wave differing from that of the signal wave, receiving the control wave at A and varying the level of the transmitted signal wave inversely with changes in the level of the control wave as received.

9. In a signaling system characterized by a plurality of stations connected by a transmitting medium in which disturbing voltages may be created by sources foreign to the system itself, the method of maintaining substantially constant the ratio of the signal level to the disturbing voltage level, which consists in transmitting a signal wave from one of the stations of the said system to another station thereof, simultaneously transmitting a control wave from the said other station to the said first station, the said control wave differing in frequency from the said signal wave, and varying at the said first station the level of the signal wave as transmitted inversely with the level of the control wave as received at the said first station.

10. The method for maintaining substantially constant the ratio of the signal level to the noise level in a signaling system embracing a plurality of stations, which consists in generating a carrier wave at one of the said stations, modulating the said carrier by a signal, transmitting a side band of such

modulation and suppressing the transmission of the unmodulated carrier wave, transmitting to the said first mentioned station a control wave having constant amplitude as transmitted, and directed along substantially the same path as the said side band transmitted from the first mentioned station, receiving the said control wave at the first mentioned station and effectively governing the amplitude of the side band by the said control wave as thus received.

11. The method for maintaining substantially constant the ratio of the signal level to the noise level in a signaling system embracing a plurality of stations, which consists in generating a carrier wave at one of the said stations, modulating the said carrier by a signal, transmitting a side band of such modulation and suppressing the transmission of the unmodulated carrier wave, transmitting to the said first mentioned station a control wave having constant amplitude as transmitted, and directed along substantially the same path as the said side band transmitted from the first mentioned station, receiving the said control wave at the first mentioned station and varying the amplitude of the carrier employed in modulation at the first mentioned station inversely with changes in the amplitude of the control wave as received thereat.

12. The method for maintaining substantially constant the ratio of the signal level to the noise level in a signaling system embracing a plurality of stations, which consists in generating a carrier wave and a control wave at each of the said stations between which communication is to be maintained, modulating the said carrier at one of the communicating stations, transmitting a side band resulting from the said modulation and preventing the transmission of the unmodulated carrier, simultaneously transmitting from the other of the communicating stations the control wave, receiving the said control wave at the first mentioned station, and controlling the amplitude of the side band by the control wave as received at the first mentioned station.

13. The method for maintaining substantially constant the ratio of the signal level to the noise level in a signaling system embracing a plurality of stations, which consists in generating a carrier wave and a control wave at each of the said stations between which communication is to be maintained, modulating the said carrier at one of the communicating stations, transmitting a side band resulting from the said modulation and preventing the transmission of the unmodulated carrier, simultaneously transmitting from the other of the communicating stations the control wave, receiving the said control wave at the first mentioned station, and varying the amplitude of the carrier employed in modulation at the first mentioned station inversely with the changes in amplitude of the control wave as received thereat.

14. The method for maintaining substantially constant the ratio of the signal level to the noise level in a signaling system embracing a plurality of stations, which consists in the simultaneous transmission of signal oscillations and control oscillations in opposite direction between stations of a system, the control oscillations differing in frequency from the signal oscillations, receiving the control oscillations at the station transmitting the signal oscillations, separating the control oscillations from other oscillations that may be present at the last mentioned station by virtue of the frequency difference existing between the said types of oscillations, and varying the strength of the signal oscillations as transmitted inversely with changes in the strength of the control oscillations as received at the station transmitting the signal oscillations.

15. In a signaling system the combination with a transmitting branch having a source of signals, a source of carrier oscillations, a carrier suppression modulator connected with both of said sources for the production of side bands of the said carrier by the said signal, a transmission medium upon which is impressed one of the said side bands, and a source of transmission level control oscillations, differing in frequency from the carrier oscillations, connected with the said transmission circuit, and a receiving branch having means to separate the signal side band from the control oscillations, and means responsive to the amplitude of the control oscillations to govern the amplitude of the carrier oscillations created by the source connected with the said transmitting branch.

16. In a signaling system comprising a plurality of stations, each having a transmitting branch and a receiving branch, the transmitting branch comprising a source of signals, a source of carrier oscillations, a carrier suppression modulator connected with both of said sources for the production of side bands of the said carrier by the said signal, a source of control oscillations differing in frequency from the carrier oscillations, a transmission medium upon which are impressed a signal side band from the said modulator and control oscillations, and a receiving branch comprising means to separate by filtering the side band and the control oscillations received from another of the said stations, means to detect the signal embraced by the said side band, and means responsive to the amplitude of the control oscillations to govern the amplitude of the carrier oscillations created by the source connected with the said transmitting branch.

17. In a signaling system in which signals are transmitted between stations by carrier oscillations modulated by the said signals, the method of controlling the transmission level of the signals which consists in transmitting control oscillations from a station that is then receiving signal modulated carrier oscillations from another station, the control oscillations differing in frequency from the carrier oscillations, receiving the said control oscillations at the said other station and varying the amplitude of the carrier oscillations at the said other station by changes in amplitude of the control oscillations received thereat.

In testimony whereof, I have signed my name to this specification this 1st day of December, 1925.

RALPH K. POTTER.