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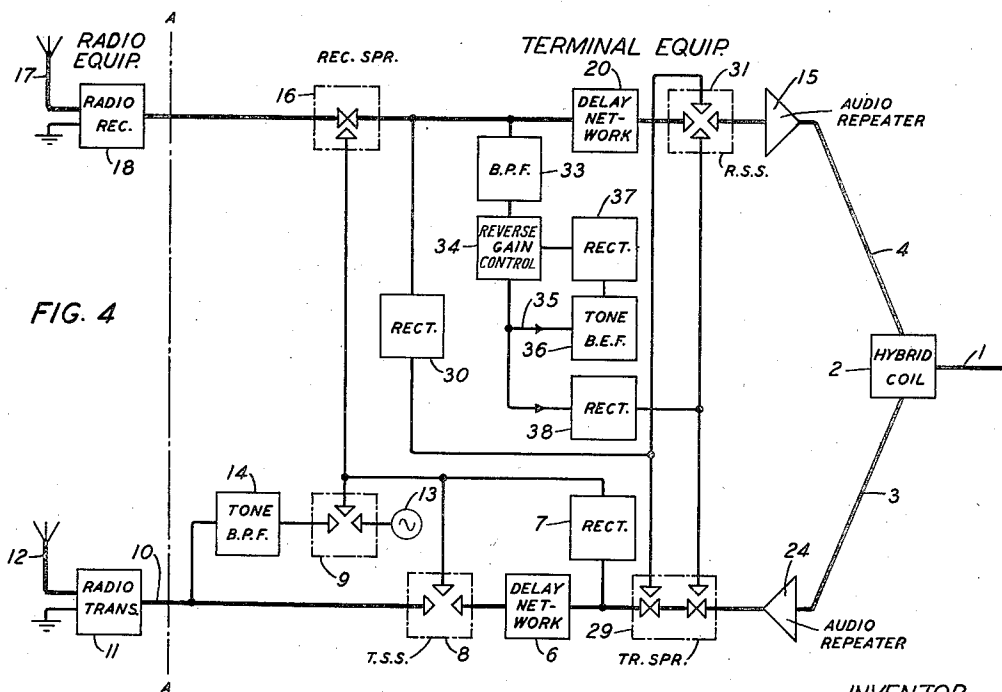
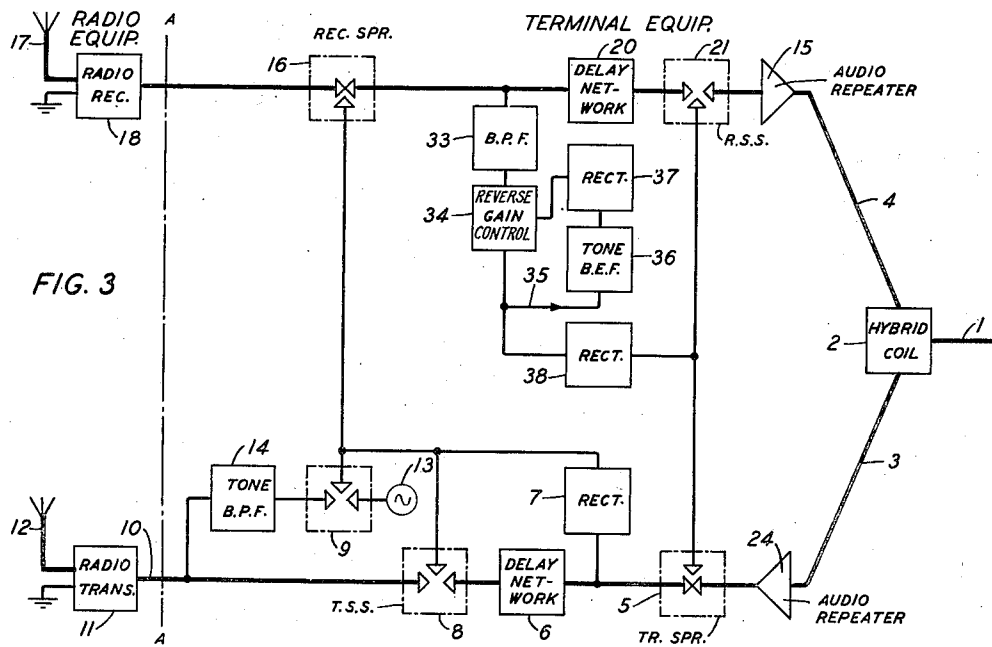
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SIGNAL WAVE TRANSMISSION SYSTEM

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SIGNAL WAVE TRANSMISSION SYSTEM

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6 Claims. (Cl. 178—44)

This invention relates to signal wave transmission systems and more particularly to wave-operated switching circuits for controlling signal transmission in such systems.

The invention, in particular, refers to two-way carrier wave signaling systems, for example, radio telephone systems in which, in order to overcome fading and other variations that affect the amplitude of the received signal, the gain of the receiver is automatically controlled by the magnitude of the received carrier wave component or by other control energy.

In systems of the type to which reference has been made it is often desirable to so condition the transmitting and receiving circuits that singing does not take place even if the receiving channel is not perfectly conjugate to the high power transmitting channel. Unless this is done, the local transmitter may subject its local receiver to an overpowering side-tone. It is also desirable to prevent the retransmission over the transmitting channel of line noise during non-signaling intervals or of line echoes of the received signal during periods when the receiver is functioning. These and similar purposes may be fulfilled by apparatus of the so-called "vodas" type (voice-operated detector anti-singing).

An object of the invention is to improve the coordination between the terminal apparatus of two-way radio telephone equipment by rendering more certain the proper actuation of the circuit conditioning devices.

Another object of the invention is to insure that in two-way signaling systems employing tone control the tone shall not be adversely affected relative to noise or interfering impulses because of the action of automatic volume control apparatus.

An additional object is to reduce the effects of selective fading on the circuit controls of two-way signal wave transmission circuits.

Since "vodas" apparatus should respond to incoming or outgoing speech waves but not to noise there is the problem of insuring against false operation which may occur under severe conditions of fading or other conditions during which the available incoming speech level may fall within the range of the maximum noise level.

In accordance with one embodiment of the invention as applied to radio telephone systems, speech currents originating at one terminal of the two-way system cause a tone to be applied as a modulation of the outgoing carrier wave. The tone, which is preferably of a frequency adjacent to one limit of the essential speech frequency range, serves after detection at the remote radio receiver to condition the receiving circuit of which the remote radio receiver forms a part and, also, to disable the transmitting

circuit which is associated with the remote radio receiver at the remote terminal. The tone so derived from the output current at the remote receiver reflects in its magnitude the effects of the automatic volume control action of the radio receiver and since noise will be varied in amplitude by adjustments of the automatic volume control in the radio receiver, the minimum amplitude of the tone relative to that of the maximum amplitude of interfering noise may, at times, have been reduced. The invention overcomes this effect by subjecting the tone to a gain control which is the reverse of that occurring in the receiver so that the tone as utilized for operation of the circuit conditioning apparatus is free from the limitations as to magnitude that the automatic volume control might tend to impose.

In the drawings, Fig. 1 illustrates in schematic diagram the elements of one terminal of a two-way radio telephone system with its associated land line comprising one embodiment of the invention.

Fig. 2 illustrates a similar system provided with an auxiliary circuit conditioning apparatus.

Fig. 3 illustrates a modification of the system of Fig. 1 in which the reverse gain control apparatus is included as an immediate adjunct of the two-way transmission line rather than of the radio receiver.

Fig. 4 illustrates a modification of the system of Fig. 3 in which auxiliary circuit conditioning apparatus is provided.

The system is illustrated in the drawings not by actual circuit diagram but instead by a single line layout, each line indicating a two-wire transmission path. A break in the path represented by separated arrow-heads indicates that the path is normally disabled at that point and an arrow pointing toward such a break from a control device (rectifier, which ordinarily signifies a thermionic amplifier and detector combination) indicates that the path will be made operative by operation of the control device. A closed circuit condition represented by contacting arrow-heads indicates that the path is operative at that point and an arrow pointed towards the contacting arrow-heads from a control device (rectifier) indicates that the path will be disabled at that point by operation of the control device. An arrow pointing from one box representing a control device to another box representing another apparatus indicates that the former device in some manner controls the adjustment or rearrangement of the latter apparatus.

The invention may be readily understood from a consideration of the operation of the circuit in which it is embodied. Referring to Fig. 1

which illustrates a two-way radio terminal station associated with a two-way conductive transmission system, the two-way telephone or other communication conductive system 1 is associated through the hybrid coil 2 with an outgoing channel 3 connected to the radio transmitting equipment and an incoming channel 4 connected with radio receiving equipment. The broken line A—A serves to indicate the division between the line terminal equipment on the one hand and the radio equipment on the other. The radio receiving apparatus and the radio transmitting apparatus may both or either be located at sites remote from the line terminal equipment. Speech currents arriving over the line 1 are transferred by the hybrid coil 2 to channel 3 and are repeated by an audio frequency repeater 24 of well-known thermionic type. After an amplification which may yield a gain as high as 40 to 45 decibels, the speech currents pass by way of the normally closed circuit of transmitting suppressor 5 to a delay network 6. The transmitting suppressor 5 may be of the well-known type of control apparatus disclosed in Fig. 2 of U. S. Patent 2,098,286, issued November 9, 1937 to O. R. Garfield. Control apparatus of this character ordinarily involves a rectifier responsive to speech or other currents to produce a resulting rectified current electromotive force which is then applied to the input circuit of an amplifier in the space path of which is included an electromagnetic relay, the contacts of which are associated with the circuit to be controlled.

Speech or other signal electromotive forces impressed upon the delay network 6 are simultaneously impressed upon the input terminals of a rectifier 7 the output terminals of which are associated with transmitting singing suppressor 8 and control device 9. It will be understood that the devices 8 and 9 each involve normally open circuit apparatus provided with electromagnetic or other equivalent circuit closers operated by the rectified currents from rectifier 7. Operation of the device 8 to close its circuit permits the speech currents to be transmitted over circuit 10 to a radio transmitter 11 at which they are employed to modulate an outgoing carrier wave which is thereafter radiated from transmitting antenna 12. The delay network 6 serves to delay transmission of the speech currents sufficiently to enable the device 8 to establish an outgoing path for the speech. A delay of the order of 20 milliseconds affords sufficient time for the mechanical circuit conditioning equipment to operate.

In order to effect certain circuit conditioning operations at the remote station, it is desirable to transmit as a modulation of the outgoing carrier wave a tone frequency. For this purpose a source 13 is used to produce a tone lying at one fringe of the essential signal frequency range. In what follows it will be assumed that the signal waves are speech waves and that the frequency of the tone is 150 cycles although it might equally well be 3500 cycles. The source 13 of tone current is connected to the radio transmitter 11 by way of the control apparatus 9 and a tone band-pass filter 14 of sufficiently narrow transmission range to freely transmit the tone but to exclude other currents in the speech frequency range. The radio transmitter may be of the type in which the unmodulated carrier wave is transmitted whenever the transmitting apparatus is energized or it may be of the type in which the unmodulated component is not transmitted except during

signal transmission or is partially suppressed even during carrier wave modulation by the signal. Assuming that the transmitter is energized, the antenna 12 will radiate carrier waves modulated in accordance with both speech and tone whenever speech currents are received from the line 1.

In order to guard the outgoing transmitting circuit against undesired operation of its circuit conditioning devices because of energy received over the radio receiving channel, there is also connected to the output of the rectifier 7 a receiving suppressor 16 which is in series with the incoming channel and serves to disable that channel during outgoing message intervals.

Inasmuch as the remote radio apparatus cooperating with that of Fig. 1 may be similar in all respects thereto, except that the transmitting carrier wave of one is the receiving carrier wave of the other, it will suffice to trace an incoming call at the radio receiver associated with the terminals of Fig. 1. Radio receiving antenna 17 is, of course, tuned to the same carrier frequency as the remote transmitting antenna from which it receives modulated carrier waves. It is preferably but not necessarily tuned to a different frequency from that of its local transmitter. Incoming carrier waves modulated in accordance with signals and with control tone are impressed by antenna 17 upon the radio receiver which may be of any well-known type involving the usual automatic volume control apparatus to overcome the effects of failure. Speech frequency current and tone current resulting from the demodulating operation of the radio receiver 18 upon incoming carrier waves are impressed from its output upon a tone band exclusion filter 19 which serves to transmit freely currents of all the essential speech or other signal frequencies with the exception of a very narrow band including the tone frequency. Such a filter may be of the high-pass type if the tone is at the lower edge of the signal frequency range, of the low-pass type if the tone is at the upper edge of the essential frequency range, or it may be of the so-called suppression type which suppresses a narrow band. The speech signal currents in the output of device 19 are transmitted by way of the normally closed circuit of receiving channel suppressor 16 to a delay network 20 which serves to delay the signal current sufficiently to enable the operation of the electromechanical control of the normally open-circuited receiving channel singing suppressor 21. In order to remove the normally disabled condition of the path at device 21 there is connected to the output of the receiving channel suppressor 16 in parallel to the input terminals of the delay network 20 a narrow band-pass filter 22, the characteristics of which are such as to permit transmission of a narrow band of frequencies in the neighborhood of the tone, possibly 150 cycles wide. A rectifier-amplifier 23 connected to the output of band-pass filter 22 applies rectified electromotive force to operate devices 5 and 21 simultaneously disabling the outgoing circuit at 5 and completing the incoming circuit at 21. The speech currents delayed in the network 20 may therefore traverse device 21 and are repeated by audio repeater 15 from the output circuit of which they are transferred by hybrid coil 2 to the line 1. Since it is desired that the control of devices 5 and 21 be effective only in response to tone current and not in response to noise current, it is desirable that the ratio of tone current to noise energy be maintained as high as possi-

ble, in order to prevent operation of devices 5 and 21 at undesired moments because of receipt of incoming carrier waves having noise modulation in the region of the tone frequency. It transpires, however, that an automatic volume control apparatus may at times affect the ratio of tone to noise unfavorably. This is because of the fact that selective fading as between various transmitted frequencies may occur thus at times causing the tone frequency to fade to a greater extent than does the carrier wave upon which the automatic volume control depends. Under such conditions the automatic volume control may actually reduce the amplification of the receiver when the incoming carrier wave component has increased and so may reduce the resulting control tone at a time when it has already faded. The net result of this effect is an increase in the fading range of the control tone. The undesired discrimination against the tone frequency could be prevented if the tone component were not subject to the automatic volume control. However, it would be difficult and expensive to separate the tone control component from the signal component at the frequency of the incoming carrier wave. An important feature of the present invention relates to the method by which this is effectively accomplished without resort to separation at the radio frequency. Connected to the output of the radio receiver and in parallel to the input terminals of tone band exclusion filter 19 is a tone band-pass filter 25. The transmission range of this filter may be made of the same order as that of the other tone band-pass filters in the circuit; for example, 100 cycles wide. The tone selected from the output of the radio receiver 18 by the filter 25 is then applied to a reverse gain control apparatus 26. Apparatus 26 serves to variably amplify the tone current impressed thereon but in a fashion reverse in manner to that of the automatic volume control apparatus of the radio receiver 18. For this purpose there is supplied to it over the path 27 from the automatic volume control apparatus of the radio receiver a potential which is the same as that used for the automatic volume control operation of the radio receiver. This control potential is applied by the circuit 27 to the reverse gain control apparatus 26 with such polarity as to cause an increase in gain to the tone which is the converse of the decrease in gain received at the radio receiver and to supply a decrease in gain at the reverse gain control apparatus which is the converse of an increase in gain applied to the radio receiver 18. It follows that the tone output from the reverse gain control apparatus 26 in effect has been unaffected by the automatic volume control apparatus of the radio receiver 18 since the amplitude variations to which it was subjected as a radio frequency component in traversing the radio receiver have been counteracted by the amplitude variations to which it has been subjected in the reverse gain control apparatus as a tone control frequency component. Tone control current in the output of the device 26 will be transmitted through the normally closed contacts of the receiving channel suppressor 16, the band-pass filter 22 to rectifier 23, where it will be rectified and caused to disable the outgoing channels at 5 and to make effective the transmission path of the incoming channel at 21. Accordingly, any unbalance at the hybrid coil 2 will not result in causing received currents to recirculate through the outgoing channel 3 to the

radio transmitter 11 since the outgoing channel is interrupted at 5.

Fig. 2 shows a modification of the system of Fig. 1 provided with additional auxiliary control apparatus which is not essential where control tone is used but may be helpful to enable the control function to be carried on in response to received speech when the tone has faded badly. Apparatus of Fig. 2 which functions in precisely the same manner as that of Fig. 1 is designated by the same reference characters. In the operation of the system of Fig. 2 speech currents originating in line 1 are passed by the hybrid coil to the outgoing circuit 3 over an audio repeater 24 from which they are passed to a transmitting singing suppressor 29 which corresponds generally to device 5 of Fig. 1 except that it has two control points in tandem. One of these control points is controlled by the amplifier-rectifier 23 just as in the case of Fig. 1. The other is controlled by the output of an auxiliary rectifier 30 connected to the receiving channel between the control point 16 and the delay network 20. Speech currents traversing the outgoing channel are supplied to the delay network 6 and the rectifier 7 which serves to make operative the paths at 8 and 9 for the speech currents and tone currents respectively in order that these currents may be impressed over line 10 upon the radio transmitter 11 and radiated from the antenna 12 as modulations of the outgoing carrier wave. Incoming carrier waves modulated in accordance with speech and control tone received over antenna 17 are demodulated by radio receiver 18 and the speech and tone control currents are separated by the filters 19 and 25, respectively, as in the system of Fig. 1. After the reverse gain control operation upon the tone current the speech and tone control currents traverse the control point 16 and are applied to both the rectifier 30 and the band-pass filter 22 in parallel. If the amplitude of the tone control current is sufficient the operation of the system is exactly the same as in that of Fig. 1, the outgoing channel being disabled at the first set of terminals of the device 29 and the incoming channel, which is normally open at the contact of the receiving singing suppressor 31, being closed. It will be noted that the device 31 is provided with two controls, the operation of either of which serves to close it. Similarly, the device 29 is provided with two controls, the operation of either of which serves to disable its transmitting path. The rectifier 30 is provided with a tuned input circuit preferably tuned to about 1300 cycles and hence is sensitive to speech but insensitive to tone. If, therefore, the tone has considerably faded but the speech has not, the device 30 will serve to operate the controls 29 and 31.

Fig. 3 illustrates a system in which the reverse gain control apparatus for the tone is located at the terminal station associated with the two-way transmission line 1 rather than at the remote radio receiving station as in Figs. 1 and 2. Apparatus which is similar in construction and function to that of Fig. 1 is similarly designated and will accordingly require no explanation. There is provided at the receiving channel in parallel to the input circuit of the delay network 20 a band-pass filter 33 which transmits a narrow band in the neighborhood of the tone and of the order of 150 cycles in width. Accordingly, the band filter 33 accepts and transmits only the tone and noise or static impulses in the frequency region of the tone. Connected to the output

terminals of the band-pass filter 33 is a reverse gain control device 34 similar in its structure and operation to the device 26 of Figs. 1 and 2 but differing in that it does not respond to the same control tone potential as does the automatic volume control of the radio receiver 18. The output control tone and static impulses from the reverse gain control device 34 are impressed upon a path 35 in which is a tone band exclusion filter 36 which serves to transmit the static impulses but to exclude all components in a very narrow band of perhaps 10 cycles in width including the control tone itself. Accordingly, there is impressed by the device 36 upon the rectifier 37 only static impulses in the region of the control tone frequency. These are rectified and caused to yield a control potential which is applied to the reverse gain control apparatus to control the gain. In general, the static and other noise received at the radio receiving station may be assumed to be fairly constant. However, in the course of the radio receiving operation, all received energy, including that of the static, is subjected to the variable amplification imposed by the automatic volume control apparatus of the radio receiver 18. This means that both the control tone and the incoming static of substantially constant energy level are likewise varied by the automatic volume control apparatus. Since the filter 36 selects the static energy, rectifies it and controls the reverse gain control apparatus 34 in accordance with the rectified potential to maintain the substantially constant level of static at the output of the device 34 in the manner of an automatic volume control apparatus, the control tone traversing the device 34 is similarly varied in level and restored to its initial intensity as received at the radio receiver 18. A selective amplifier-rectifier 38 tuned to select the control tone and to amplify and rectify it in order to derive a control potential therefrom serves to control the apparatus 5 and 21 in the manner which has previously been explained in connection with the systems of Figs. 1 and 2. In other respects, the operation of the system of Fig. 3 is identical with that of Fig. 1.

The system of Fig. 4 resembles that of Fig. 3 in that the reverse gain control apparatus for the tone is located at the terminal station for the transmission line 1 and is operated in response to rectified static energy of the frequency region of the control tone itself. In order, however, to insure that there will be effective control of the incoming and outgoing channels at times when the control tone may for some reason have been subjected to such severe fading action as not to be usable, an auxiliary control comprising the rectifier 30 and the double control units 29 and 31 are added as in the system of Fig. 2. The operation of the system of Fig. 4 will therefore be evident without further explanation.

What is claimed is:

1. The method which comprises modulating a carrier wave simultaneously by two different electromotive forces, transmitting the modulated wave over a variable attenuation path, thereafter subjecting the modulated carrier wave to a receiving and detecting operation while controlling the volume of the detected energy in accordance with the strength of the received carrier wave, selecting one of the two different modulations from the detected wave and subjecting the selected modulation to a gain control operation which is the reverse of that experienced in the

detecting operation by virtue of the automatic volume control whereby the selected modulation remains relatively unaffected by the volume control operation.

2. A wave transmission system comprising a source of carrier waves, means for simultaneously modulating the waves by signals and by a control tone, means for transmitting energy of the modulated waves to a remote point, means at the remote point for receiving and detecting the modulated carrier waves, said means including an automatic volume control, means for selecting the control tone from the detected wave, and means for subjecting the selected control tone to an automatic volume control operation which is the reverse of that experienced in the receiving means to eliminate the effect of automatic volume control.

3. A receiver for modulated waves comprising a demodulator upon which received modulated waves may be impressed, means for selecting from the output of the demodulator waves of a desired frequency, means associated with the receiver for deriving from the received waves an automatic volume control potential which has at all times such intensity and frequency characteristics as to enable compensation for fading which has been experienced by modulated waves as received, and means for utilizing the control potential for controlling the amplitude of the selected demodulated waves to cause them to experience an attenuation corresponding to the attenuation experienced by the modulated waves before they were received.

4. A carrier wave system comprising means for transmitting carrier waves modulated in accordance with signal waves, means for modulating the same carrier wave in accordance with control tones, a high frequency receiver for receiving the modulated carrier waves, said high frequency receiver comprising means to demodulate the carrier waves to reproduce the modulating signal waves and control tones, the receiver also including automatic volume control apparatus, and means for removing the effect of the automatic volume control upon amplitude of the control tones yielded by the receiver.

5. The method of two-way signaling by carrier waves modulated in accordance with signals which comprises modulating outgoing carrier waves by control tone, receiving and demodulating incoming carrier waves to reproduce the control tone while causing the volume to be automatically controlled in such manner as to compensate for variations in attenuation during transmission, selecting the control tone and thereafter subjecting it to a reverse gain control operation which removes the effect of any automatic volume control operation to which it was subjected during reception and demodulation of the incoming carrier wave.

6. A carrier wave system comprising a carrier wave source, means for modulating carrier waves supplied by the source of speech signals and by control tone of a neighboring frequency, a receiver for demodulating the modulated wave and for maintaining at substantially constant level the volume of the speech signals derived therefrom, and means whereby the control tone derived from the receiver is freed from the volume regulation to which the derived speech signals are subjected so that the fading range of the control tone may not be increased to such a point as to cause the control tone to be overridden by noise.

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