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TRANSMISSION CONTROL IN SIGNALING SYSTEMS

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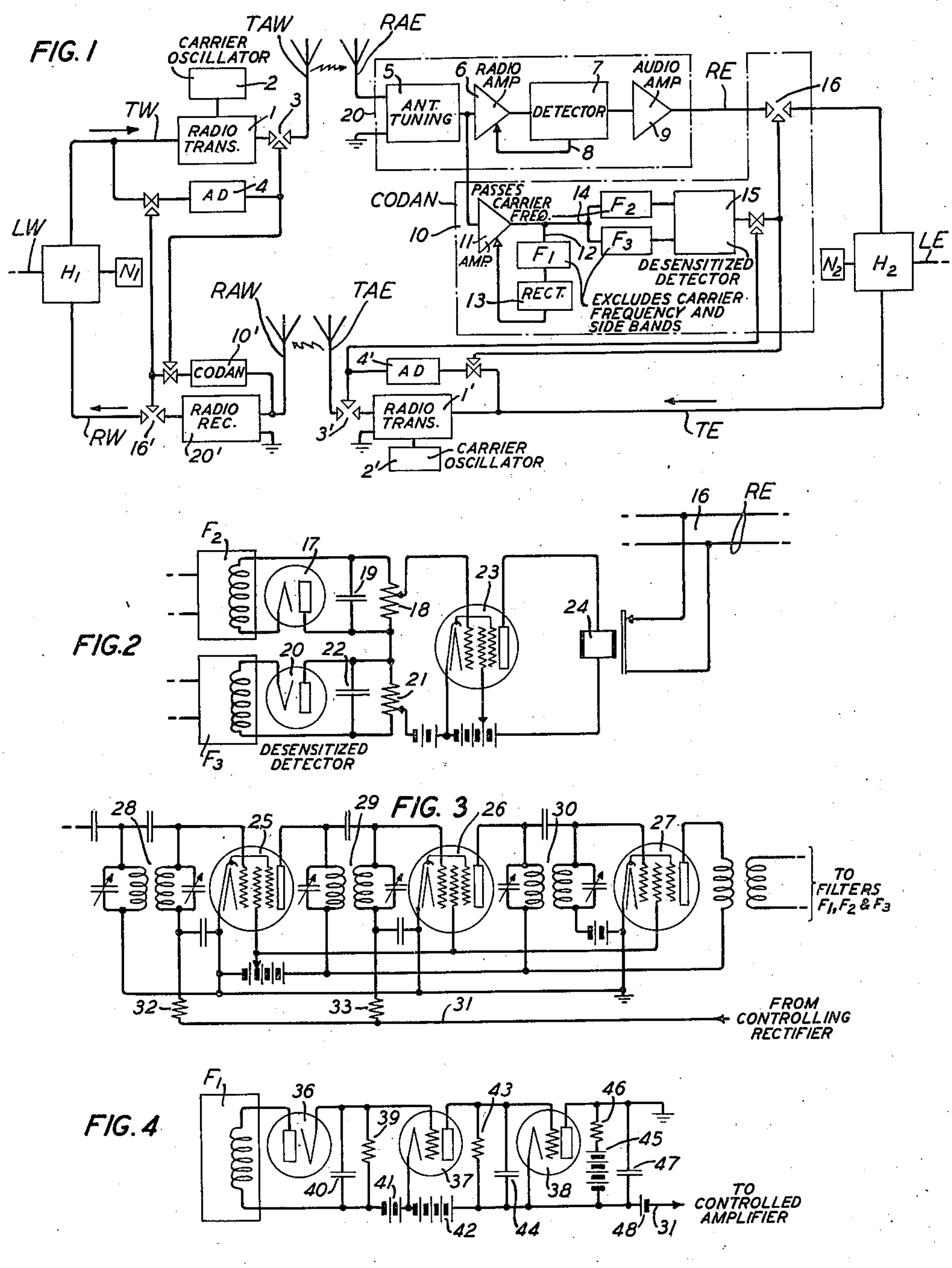

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TRANSMISSION CONTROL IN SIGNALING SYSTEMS

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

The invention has particular reference to so-called Codan (carrier-operated detector anti-noise) circuits employed in connection with two-way signaling systems, for example, two-way radio telephone systems, for disabling the receiving circuit at each terminal station during periods of no signal transmission and removing the disability when signal transmission is taking place. This prevents the reception of interference (static) which, during periods of no signal (no carrier) when automatic gain control receivers are at maximum sensitivity, may be of sufficient amplitude to annoy the receiving subscriber, and to falsely operate the voice-operated switching circuits for controlling the transmission of carrier by the transmitter at the terminal. The usual Codan circuit is arranged to be controlled by the unmodulated carrier, but may be controlled by control energy of distinctive frequency other than the carrier, sent out from the transmitting station under control of the signal waves to be transmitted.

Static may be considered to consist of a more or less steady noise on which is superimposed irregular noise crashes of varying amplitude and shape. Over long periods the long-time static power may vary over a wide range, 50 decibels or more, and the peak factor may vary over a smaller range, of 20 decibels or so.

It is an object of the present invention to improve the operation of such Codan circuits when subjected to interfering waves or static of a wide range of levels and of widely different characteristics.

A more specific object of the invention is to permit unattended Codan operation, that is, to automatically control the sensitivity of a Codan in accordance with the static level so as to reduce the probability of its false operation by static while maintaining it at maximum sensitivity as regards operation by carrier.

These objects are attained in accordance with the invention by employing for the carrier or control energy-operated circuit for operating a switching relay to remove a normal disability in the output of the receiving circuit, during periods of signal transmission, a circuit which will effectively suppress from that relay both slow and fast variations in static when the carrier is not present, and which, when the carrier is present, will act as a static desensitized detector, that is, a detector which is very sensitive to the carrier when the static level is low and the sensitivity of which decreases approximately linearly as the static level rises. For a given level of static, it is only necessary that this detector operate on carrier strong enough to give a commercial circuit, that is, a circuit in which the signal overrides the received static by a sufficient amount to be understood. In one embodiment this circuit comprises two control circuits in tandem. The first consists of an amplifier, the gain of which is adjusted by a relatively slow backward-acting control functioning on slowly varying static to make the average static output of the amplifier constant. The second control circuit comprises a fast forward-acting desensitizing detector with associated filters, for suppressing the fast variations in static from the control relay in its output. The two control circuits are arranged to transmit quickly to the control relay control waves of sufficient amplitude to cause its operation.

The objects and advantages of the invention will be better understood from the following detailed description thereof when read in connection with the accompanying drawing,

Fig. 1 of which shows diagrammatically a two-way radio telephone system embodying the invention; and

Figs. 2 to 4 of which show schematically circuits which may be used for the various elements of the circuit of the invention in the system of Fig. 1.

The diagram of Fig. 1 is not an actual circuit diagram but rather a single line layout, each line indicating a two-wire transmission path. A break in a path, represented by separated arrowheads, indicates that the path is normally disabled at that point, and an arrow pointing toward such a break from a control device (amplifier-detector) indicates that the path will be made operative by operation of the control device. A make in a path, represented by contacting arrowheads, indicates that the path is operative at that point, and an arrow pointing toward the contacting arrowheads from a control device (amplifier-detector) indicates that the path will be disabled at that point by operation of the control device. In the diagram, the triangular boxes represent amplifiers, and an arrow directed at such a box from a control device (detector) indicates that the gain of the amplifier will be adjusted under control of that control device.

Fig. 1 represents a two-way radio telephone system for transmitting telephone signals in opposite directions between a west two-way telephone line LW and an east telephone line LE.

The west terminal of the radio telephone system comprises the transmitting circuit TW including a transmitting antenna TAW, and a receiving circuit RW including a receiving antenna RAW, the input of the circuit TW and the output of the circuit RW being coupled in conjugate relation with each other and in energy transmitting relation with the two-way telephone line LW by the hybrid coil connection H_1 and balancing network N_1 in well-known manner.

Similarly, the east terminal of the radio telephone system comprises the transmitting circuit TE including the transmitting antenna TAE, and the receiving circuit RE including the receiving antenna RAE, the input of the circuit TE and the output of the circuit RE being coupled in conjugate relation with each other and in energy transmitting relation with the two-way telephone line LE by the hybrid coil H_2 and associated balancing network N_2.

The transmitting circuit TW at the west terminal comprises the usual transmission apparatus including the radio transmitter 1 and associated carrier oscillator 2. In the absence of speech wave transmission therein, the circuit TW is arranged in any suitable manner, as indicated by the normal open-circuit 3 between transmitter 1 and transmitting antenna TAW, to prevent the radiation of carrier oscillations to the east terminal station. When speech wave signals are received in the transmitting circuit TW from the line LW, a portion thereof is impressed on the input of the wave-operated control device (amplifier-detector) 4 bridged across the circuit TW in front of the radio transmitter 1, and causes the operation of that device to remove the disability in the circuit TW at the point 3, thereby allowing signal-modulated carrier waves, as well as the unmodulated carrier, to be radiated by the transmitting antenna TAW to the east terminal of the system.

The receiving circuit RE in the east terminal of the system comprises the usual transmission apparatus including the antenna tuning means 5, which may include some fixed gain, the radio amplifier 6, the detector 7, the automatic gain control 8 for the radio amplifier 6, controlled by the received carrier from the output of detector 7, for regulating the sensitivity of the receiving circuit RE to compensate for variations in received signal volume, and the audio amplifier 9. The automatic gain control 8 may be of any of the types well known in the art.

Associated with the receiving circuit RE of the east terminal is the Codan circuit 10 of the invention. As indicated, it comprises two control circuits in tandem, the first consisting of the variable gain amplifier 11 having its input connected across the receiving circuit RE in front of the radio amplifier 6, and a backward-acting circuit 12 comprising the filter F_1 and rectifier 13 for controlling the gain of amplifier 11; and the second consisting of a forward-acting circuit comprising the two parallel filters F_2 and F_3 fed from the output of the amplifier 11, and a detector 15 in the output thereof which, when operated, renders the output of the receiving circuit RE, normally disabled at the point 16 as indicated by the separated arrowheads, operative at that point.

The filter F_1 in the backward-acting control circuit 12 is designed to exclude the carrier and side-band frequencies generated by the oscillator 2 associated with the radio transmitter at the west terminal, and to pass all other frequencies received from the output of amplifier 11. The two filters F_2 and F_3 in the forward-acting control circuit 14 are similar in characteristic except that the filter F_2 passes the carrier frequency generated by the carrier oscillator 2 at the west terminal of the system, and filter F_3 excludes that carrier frequency and side-bands.

The transmitting circuit TE at the east terminal of the radio telephone system of Fig. 1 contains transmission and control apparatus similar to that used in the transmitting circuit TW at the west terminal of the system, as indicated by the use of similar characters for identifying the corresponding pieces of apparatus, except that in the circuit TE the characters are followed by a prime (′) mark. Also, the receiving circuit RW at the west terminal of the radio telephone system contains transmission and control apparatus similar to that used in the receiving circuit RE at the east terminal, including a Codan circuit, as indicated by the use of the same characters for identifying the corresponding pieces of apparatus in the receiving circuit at each terminal, except that these characters in the case of the apparatus in the receiving circuit RW are followed by a prime (′) mark. However, the carrier frequency generated by the carrier oscillator 2′ in the transmitting circuit TE at the east terminal may be different from the carrier frequency generated by the carrier oscillator 2 at the west terminal, in which case the filters in the Codan circuit 10′ at the west terminal corresponding to the filters F_1, F_2 and F_3 in the Codan circuit 10 at the east terminal, may have frequency pass ranges determined by the particular value of frequency selected for the carrier oscillator 2′ at the east terminal.

For the purpose of giving exclusive control of the switching apparatus at both terminals to the particular subscriber associated with the telephone line LW or LE, who first starts to talk, additional switching apparatus is provided at both terminals as follows. Operation of the control circuit (amplifier-detector) 4 in response to telephone signals in the circuit TW, in addition to rendering the latter circuit operative at the point 3, also disables the normally operative output of the Codan circuit 10′ at the same terminal, as indicated. Similarly, operation of the control circuit (amplifier-detector) 4′ at the east terminal in response to signals in the transmitting circuit TE disables the Codan circuit 10 at the same terminal in its output as indicated. Also, the Codan circuit 10 at the east terminal when operated, if its output is operative, causes the control circuit (amplifier-detector) 4′ controlling the transmission of carrier from the east terminal, to be disabled in its input, and operation of the Codan circuit 10′ at the west terminal, when its output is operative, causes the control circuit (amplifier-detector) 4 controlling the transmission of carrier from that terminal, to be disabled in its input, as indicated.

The system of Fig. 1 operates as follows:

When no speech signals are being received by the radio telephone system from the telephone line LW, associated with the west radio terminal, or by the telephone line LE, associated with the east radio terminal, the control circuits at the two radio terminals are in the condition indicated in the figure, with both transmitting circuits TW and TE disabled in their outputs at the points 3 and 3′, respectively, so that no carrier waves can be radiated to the other terminal, and with the receiving circuits RE and RW blocked in their outputs at the points 16 and 16′, respectively. The latter prevents, when signals are not being transmitted, noise currents from being transmitted through to the subscriber associated with each terminal and being fed back through the transmitting circuit to the switching apparatus for controlling the transmission of carrier from that terminal. The action of the automatic gain control in each receiving circuit is to adjust the latter to maximum sensitivity during non-signaling intervals, so it is apparent that the noise currents, if they are allowed to go through, may be of sufficient amplitude to greatly annoy the subscriber and to cause false operation of the carrier control apparatus at the terminal.

Now, let it be supposed that speech waves are being received in the transmitting circuit TW of the west radio terminal from a subscriber associated with the telephone line LW. The main portion of these waves will be impressed on the input of the radio transmitter 2 and will modulate the carrier frequency from the associated carrier oscillator 2 therein in well-known manner. A portion of the speech waves in the input of the radio transmitter 1 will be diverted therefrom and will be impressed upon the control device 4 causing its operation to remove the disability at the point 3 in the output of the transmitted circuit TW, so as to allow the speech signal modulated carrier, as well as the unmodulated carrier waves, to be radiated by the transmitting antenna TAW to the east terminal of the radio telephone system.

The operation of the control circuit 4 also disables the output of the Codan circuit 10′ associated with the receiving circuit RW at the west terminal thereby preventing the disability at the point 16′ therein from subsequently being removed by carrier waves received from the east terminal.

At the east terminal of the radio telephone system, the carrier waves and signal-modulated carrier will be picked up by the receiving antenna RAE and selected by the antenna tuning device 5. The selected waves will divide between the input of the radio amplifying device 6 and the input of the amplifier 11 in the Codan circuit 10.

The speech signal-modulated carrier waves in the output of the amplifier 6 will combine in the detector or demodulator 7 with the unmodulated carrier to produce the speech waves in well-known manner. Also, a portion of the rectified waves will be fed back from the detector 7 through the connection 8 to adjust the gain of radio amplifier 6 in accordance with the amplitude level of the received waves in well-known manner. The detected speech signal waves in the output of the detector 7 will then be amplified by audio amplifier 9.

The portion of the waves fed into the Codan circuit 10 from the output of the antenna tuning device 5 in receiving circuit RE will include the signal-modulated carrier and the unmodulated carrier received from the east terminal, as well as the interfering waves (static) picked up by the receiving antenna RAE from the radio link of the system. These combined waves will be impressed on the variable-gain amplifier 11, which is tuned to transmit efficiently a wider frequency band than is necessary for carrier and side-band alone. A portion of the amplified waves in the output of amplifier 11 is fed into the backward-acting control circuit 12. The filter F_1 in that control circuit suppresses the carrier and side-bands, and the remaining frequencies including the amplified static, are fed into the rectifier 13, the rectified output of the latter being used to control the gain of the amplifier 11 in such manner as to make its gain decrease for increases in input level and to increase for decreases in the input level.

The combination comprising the amplifier 11 and the backward-acting control 12 including filter F_1 and rectifier 13, for controlling its gain, would be inherently slow in operation, since a particular peak of static must have passed through the amplifier before that peak begins to control the amplifier gain. By proper selection of the time constants of the constituent elements, the operation of the combination is slowed up still more and made to function only on the long time static power, or more simply, on the long time rectified average of the static applied thereto. This means that the combination will be effective to suppress slow changes of static level, but the static peaks of varying amplitudes, such as sudden crashes, will go through the device practically unchanged in relative size. Such a backward-acting device can easily be made to function over a static amplitude range of 50 decibels, and to hold the long-time rectified average of the static to as close limits as desired.

The control circuit 14 connected in tandem with the backward-acting device, constituting a forward-acting desensitized detector operating on peaks and having substantially no speed limitation, is used to supplement the former device over the range of fast varying static. Such a device would not be satisfactory as a Codan, if used alone, since it would be extremely difficult to build a control that would function over the complete static range of approximately 70 decibels, but a control which will take care of the smaller range, about 20 decibels, of the fast variations in static, may be easily made.

The amplified waves in the output of amplifier 11, from which the slowly varying static variations have been removed are transmitted into the control circuit 14 and are impressed on the parallel filters F_2 and F_3 therein. As previously stated, the two filters F_2 and F_3 are similar in characteristic, except that one, F_2, passes the carrier frequency whereas the other, F_3, does not.

The outputs of the two filters F_2 and F_3 are fed into the input of detector 15, which would preferably comprise two rectifiers the outputs of which are connected in phase opposition, which detector, when operated, removes the disability from the receiving circuit RE at the point 16. This forward-acting device works on the principle that steep wave fronts applied to two similar filters separated slightly as to their frequency pass ranges, will produce disturbances at the outputs of the two filters having very similar envelopes. Thus, the outputs of the two rectifiers in detector 15 tend to neutralize each other since they are in phase opposition, as described more fully later in connection with Fig. 2.

The carrier frequency, however, passed by the filter F_2 is applied to the input of detector 15 in such manner as to cause its operation to remove the disability at the point 16 in the output of the receiving circuit RE, thereby allowing the amplified speech waves in the output of the audio amplifier 9 to be transmitted out over the output of the circuit RE through the hybrid coil H_2 to the line LE over which it will be transmitted to the telephone subscriber. The detector 15 is designed to have a small time constant so that it will operate quickly in response to the applied carrier to make the receiving circuit RE operative and thus to prevent any speech energy from being lost in the circuit RE.

It should be noted that the amount of carrier at the detector of the forward-acting control device 14 necessary to operate depends on the amplitude of the static peaks received and that the carrier needed at the receiving antenna RAE to cause operation of the backward-acting control device of the Codan 10 depends also on the long-time average rectified static. When large noise peaks are present, the sensitivity of the detector 15 to carrier is decreased accordingly, but this sensitivity is a maximum for the amount of static present.

Operation of the detector 15 in response to the applied carrier, in addition to removing the disability at the point 16 in the output of the receiving circuit RE, also causes the control circuit (amplifier-detector) 4′ associated with the transmitting circuit TE at the terminal, to be disabled in its input, thus preventing it from being falsely operated thereafter by any energy which may be transmitted through the hybrid coil H_2 from the output of RE to the input of TE, to make the latter circuit operative to radiate that energy as well as the carrier from the source 2′.

When speech waves applied from the line LW to the west radio terminal cease, the control device 4 associated with the transmitting circuit TW will release, redisabling the output of the circuit TW at the point 3, and thereby preventing carrier oscillations from the oscillator 2 from being radiated thereafter to the east terminal of the system, and rendering the output of the Codan 10′ at the west terminal operative. The detector 15 in the Codan circuit 10 at the east terminal will also release on cessation of the supply of carrier waves thereto, causing the receiving circuit RE at the east terminal to be redisabled at the point 16 in its output, and the disability to be removed from the input of control circuit 4′ at the east terminal. The control devices at the two terminals may be given suitable hang-overs in operation by methods well-known in the art, so that "clipping" of the speech waves by premature release of the control devices will be minimized.

A schematic circuit of one type of detector which may be used for the detector 15 in the system of the invention in Fig. 1, is shown in Fig. 2. As indicated, this detector includes a two-element rectifier tube 17 in series with a resistance 18 and a condenser 19 in parallel, coupled across the output of the filter F_2, and a two-element rectifier 20 in series with the resistance 21 and condenser 22 in parallel, coupled across the output of the filter F_3. The two resistances 18 and 21 are connected in series across the control grid-cathode circuit of the screen grid direct current amplifier tube 23, and the winding of a mechanical relay 24 is connected in the plate-cathode circuit of the tube 23.

With these connections, the static outputs of the filters F_2 and F_3, having substantially the same envelopes, which are the static peaks not suppressed by the preceding backward-acting control circuit, produce opposing substantially equal opposing voltage drops in the series resistances 18 and 21 in the grid circuit of the tube 23, and, therefore, are substantially neutralized so as to prevent operation of the tube 23 by static. The operating sensitivity of the tube 23 will be decreased in proportion to the amount of voltage drop produced by the static. The carrier frequency, however, being passed by the filter F_2 only, produces a voltage drop in resistance 19 which biases the control grid of the amplifier tube 23 in the operating direction, and if the carrier energy is sufficient to overcome the reduction in sensitivity occasioned by the balancing out of the particular static peaks present at the time the carrier arrives will cause the operation of tube 23 to energize relay 24 in its output thus causing the operation of that relay. The operation of relay 24 to open its normally closed armature and contacts removes the normal disabling short-circuit across the output of circuit RE at the point 16.

By giving suitable values to the elements of the condenser-resistance combination, 19, 18 and 22, 21, the detector circuit may be made to have a small time constant and thus produce the required quick operation on applied carrier. When static and carrier are both applied to the detector tubes 17 and 20, the effective sensitivity of the detector circuit depends on the amplitude of the static peaks present, the amount of carrier necessary to operate the detector circuit depending approximately on the short-time peak factor of the static.

Fig. 3 shows schematically the circuit of one type of amplifier which may be used for the variable gain amplifier 11 in the Codan circuit 10 of Fig. 1, and Fig. 4 shows schematically one type of rectifier circuit which may be used for rectifier 13 in the system of Fig. 1 to control amplifier 11.

The amplifier 11 of Fig. 3 comprises three vacuum tube stages 25, 26 and 27, which are preferably of the pentode type as shown. A coupling network 28 in the input of the first stage 25, which in the system of Fig. 1 would couple the amplifier to the circuit RE, and the coupling networks 29 and 30 between vacuum tube stages 25 and 26, and stages 26 and 27, respectively, are designed to produce a band-pass filter effect to make the amplifier transmit efficiently to the filters F_1, F_2 and F_3 coupled to the last stage 27, a band of frequencies wider than that necessary for carrier and sidebands. The varying potential from the output of rectifier 13 (Fig. 4) transmitted by way of conductor 31 through the resistances 32, 33 respectively in the control grid-cathode circuits of tubes 25 and 26, varies the bias on the control grids of these tubes to control the gain of the amplifier.

The control rectifier circuit of Fig. 4 comprises a two-element vacuum tube rectifier 36 having its input coupled to the output of the filter F_1, and two three-electrode vacuum tube stages 37 and 38 of direct current amplification. The parallel-connected resistance 39 and condenser 40 in the output of rectifier 36 operate as a filter for the rectifier output voltage to reduce alternating current ripple, the condenser also increasing the efficiency of rectification. The input electrodes of the first vacuum tube stage 37 of the direct current amplifier are connected across the resistance 39 so that the filtered output voltage of the rectifier is impressed on the direct current amplifier.

The battery 41 through resistance 39 negatively biases the grid of tube 37. This battery is made greater than necessary to cut off tube 37 so as to give to the detector tube 36 a "trigger" effect. The more this "trigger" effect, the more constant will be the static in the output of the controlled amplifier (amplifier of Fig. 3 corresponding to amplifier 11 of Fig. 1). Plate current is supplied from plate battery 42 to the plate of tube 37 through the resistance 43. A condenser 44 is connected in shunt with resistance 43 for the purpose of giving further control of the operate and release times of the circuit.

The input electrodes of the second vacuum tube amplifier stage 38 are connected across condenser 44. Plate current is supplied to the plate of tube 38 from battery 45 through the large series resistance 46. A condenser 47 connected between the plate and cathode of tube 38 is provided for giving further control of the operate and release times of the circuit. One terminal of the condenser 47 is connected through conductor 31 and the filtering resistances 32 and 33 in parallel respectively to the control grid-cathode circuits of the amplifier tubes 25 and 26 of Fig. 3.

Connection 31 includes the battery 48 for producing a desired normal negative bias on the control grids of amplifier tubes 25 and 26.

The circuit of Fig. 4 operates to control the gain of the amplifier of Fig. 3 in the following manner:

The waves in the output of the filter F_1, which will include all frequencies in the output of the amplifier of Fig. 3 except the carrier and side-band frequencies suppressed by that filter, will be rectified by rectifier 36, the time constant of resistance 39 and condenser 40 governing how long an average rectified static is used for control. The rectified voltage will be impressed on the amplifier tube 37 in such manner as to oppose the negative bias on the control grid of that tube.

When the control grid of tube 37 becomes sufficiently less negative, its plate impedance decreases causing the condenser 44 in its plate-cathode circuit to become charged because of the current flowing through the resistance 43. As condenser 44 charges, more and more negative bias is applied to the grid of the amplifier tube 38.

The plate impedance of the tube 38 increases as the grid voltage becomes more negative, and the voltage drop in the resistance 46 in its plate circuit, due to the output current of tube 38, decreases, causing a slowly increasing negative bias to be applied to the grids of the tubes 25 and 26 in the amplifier of Fig. 3, through connection 31 and the resistances 32 and 33 in the respective control grid-cathode circuits of the two tubes. The time constants of the circuit of Fig. 4, by proper selection of the values of the various condensers and resistances therein, are made such that the gain of the amplifier of Fig. 3 will be a function of the average rectified static, so that the long-time average of static at its output will be held nearly constant. The gain will decrease relatively slowly for sudden increases in static and will increase faster when the static suddenly decreases. Thus the slow variations in static level will be suppressed in the controlled amplifier of Fig. 3, but static crashes will pass through that amplifier practically unchanged, and will be supplied with the carrier to the forward-acting control circuit 14 of the Codan 10 of Fig. 1. The latter operates in a manner which has been previously described in detail in connection with Fig. 2, to suppress the fast variations in static also, while allowing the carrier waves to operate the Codan relay 24 quickly, and thus to remove the disability at the point 16 in the receiving circuit of the radio terminal during periods of signal transmission.

Various modifications in the circuits which have been illustrated and described which are within the spirit and scope of the invention will be apparent to persons skilled in the art. For example, the filter F_1 in the backward-acting control circuit of Fig. 1 may be eliminated if the input of the rectifier 13 controlling the gain of amplifier 11, is connected across the output of the filter F_3 in the forward-acting control circuit 14, instead of directly across the output of amplifier 11, inasmuch as the filters F_1 and F_3 both are designed to suppress the carrier frequency.

What is claimed is:

1. A receiving circuit for a carrier wave signaling system subject to static, comprising a signal demodulating path normally disabled in its output, a wave-operated switching circuit responsive to the received carrier waves to remove the disability from said path while signals are being received, and means to minimize the effect of static on the operation of said switching circuit comprising one static controlled means unresponsive to received carrier waves for suppressing from said signaling circuit the slow variations in static and another means for substantially suppressing therefrom the fast variations in static while controlling the sensitivity of said switching circuit in accordance with the applied static variations so as to maintain it at all times at maximum sensitivity to the carrier waves for the amount of static present.

2. The circuit of claim 1, in which said one means comprises means selectively responsive to applied static to automatically change the gain of said switching circuit in accordance with the slow variations in static.

3. The circuit of claim 1, in which said one means comprises an amplifier in the input of said switching circuit, the gain of which is automatically varied to maintain the average level of static in the output thereof, over a given period of time, substantially constant.

4. The circuit of claim 1, in which said one means comprises an amplifier in the input of said switching circuit, and means responsive to the long time rectified average level of the static in the output of said amplifier to adjust its gain.

5. The circuit of claim 1, in which said one means comprises a wave amplifier in the input of said switching circuit, and means for controlling its gain so that the gain increases relatively fast as the amplitude level of the waves in the input of the amplifier is decreased and the gain decreases slowly when the amplitude level of the waves in the input increases.

6. The circuit of claim 1, in which said other means comprises a forward-acting detector in said switching circuit, the sensitivity of which is varied under control of the applied static peaks in accordance with their amplitudes.

7. The circuit of claim 1, in which said other means comprises a wave operated device which when operated removes said disability from said path, two filters supplied with the received carrier waves and the received static after the slow variations have been removed therefrom, and two rectifiers respectively supplied with the outputs of said two filters, the outputs of said rectifiers being fed in phase opposition into the input of

said device, said filters being of like characteristics except that only one passes the carrier wave frequency.

8. In a signal wave transmission system comprising a signal wave transmission medium subject to variable interefering noise waves of a wide range of amplitude levels, a signal transmitting circuit coupled to the input of said medium and a signal receiving circuit coupled to its output, means normally disabling said receiving circuit in its output, means for sending out over said medium to said receiving circuit during signal transmission only, control waves of a frequency different from the signal frequencies, a wave-operated switching circuit responsive to the received control waves to remove the disability from the output of said receiving circuit, means for preventing false operation of said switching circuit by the received noise waves over a wide range of levels while continuously adjusting its sensitivity to maintain it at maximum sensitivity to said control waves for the level of noise waves present at any time, and auxiliary means for making said switching circuit quick-operating in response to applied control waves.

9. In a signal wave transmission system comprising a signal wave transmission medium subject to variable interfering noise waves of a wide range of levels, a signal transmitting circuit coupled to the input of said medium and a signal receiving circuit connected to the output thereof, means normally disabling said receiving circuit in its output, means responsive to the initiation in said transmitting circuit of signal waves for transmission, to cause control waves of a frequency different from the signal frequencies, to be transmitted to said receiving circuit, a wave-operated circuit connected to said receiving circuit so as to be supplied with the control and noise waves received thereby, switching means responsive to operation of said wave-operated circuit to remove the disability from the output of said receiving circuit, and means for substantially desensitizing said wave-operated circuit as regards operation by the received noise waves over a wide range of levels while allowing its quick and positive operation by the applied control waves.

10. The system of claim 9, in which said desensitizing means comprises means for separately removing effectively the slow and fast variations in level from the noise waves applied to said wave-operated circuit.

11. The system of claim 9, in which said desensitizing means comprises means for reducing the noise waves in the applied waves to a constant average level over a given long period of time, and means for then effectively removing from the resulting waves the noise peaks before applying them to said wave-operated circuit.

12. The system of claim 9, in which said desensitizing means includes an amplifier the gain of which is automatically controlled by the applied noise waves in such manner as to make the average noise output thereof over a long period of time substantially constant, means for separating the noise peaks and the control wave components in the output waves of said amplifier, and for utilizing the control wave components exclusively to control operation of said wave operated circuit.

13. In combination in a signal wave transmission system, a signal transmission medium subject to variable interfering noise waves, a signal receiving circuit normally disabled near its output, connected to said medium, means for sending out over said medium to said receiving circuit control waves of a frequency different from the transmitted signal frequencies, a wave-operated switching circuit responsive to the control waves received in said receiving circuit to remove the disability from the output thereof, and means for preventing false operation of said switching circuit by received noise waves comprising two control circuits in tandem in the input thereof one operating to suppress from the applied waves the slow variations in level of the received noise waves and the other operating substantially to prevent false operation of said switching circuit by the fast variations in level of the received noise waves when control waves are absent, and to vary the sensitivity of said switching circuit to prevent false operation thereof by said fast variations in static when control waves are present, the two control circuits being arranged to transmit the received control waves quickly to said switching circuit.

14. The system of claim 13, in which said one control circuit comprising an amplifier and means for controlling its gain so that the gain increases relatively fast as the input level is decreased and the gain decreases slowly when the input level increases.

15. The system of claim 13, in which said one control circuit comprises an amplifier and a feedback circuit coupling its output and input circuits for controlling its gain, including a filter for suppressing the control wave frequency and a rectifier.

16. The system of claim 13, in which said other control circuit comprises a detector, two filters connected to the output of said one control means, and feeding in phase opposition into the input circuit of said detector, said filters being similar in characteristic except that only one passes the control wave frequency, said detector having a small time constant so as to operate quickly in response to the application of said control wave thereto from the output of said one filter.

17. In a carrier telephone system comprising a transmitting and a receiving station connected by a transmission medium subject to static of widely varying level, means at the transmitting station for transmitting carrier energy over said medium to said receiving station during periods of signal transmission only, a receiving circuit at said receiving station including carrier controlled automatic gain control means and signal demodulating means, said receiving circuit being normally disabled in its output, a wave-operated switching circuit bridged across said receiving circuit in front of said automatic gain control means so as to be suppled with the received carrier energy and static therein, said switching circuit comprising an amplifier, a comparatively slow backward-acting circuit for controlling its gain in such manner that as the input level decreases the gain of the amplifier increases relatively fast and as the input level increases the gain of the amplifier decreases slowly, a detector fed from the output of said amplifier, means to suppress substantially the fast variations in static from the waves applied to said detector while allowing transmission of the carrier wave components thereto to cause operation of said detector, and means responsive to operation of said detector to cause the normal disability to be removed from the output of said receiving circuit.

18. The system of claim 13, in which said one

control circuit consists of an amplifier and a control circuit coupling the amplifier output and input and functioning on the noise waves of slowly varying level, only, to adjust the gain of the amplifier to make the average static output of said amplifier over a long time period substantially constant.

19. The system of claim 13, in which said other control circuit comprises a vacuum tube detector, two wave filters in parallel fed from the output of said one control circuit, and having their outputs fed in phase opposition into the input of said detector, said filters having substantially identical frequency pass ranges except that one only passes the frequency of said control waves, and means responsive to the control wave frequency passed by said one filter to cause operation of said detector to remove the disability from the output of said receiving circuit.

20. The system of claim 13, in which said one control circuit comprises an amplifier and a feedback circuit coupling its output and input circuits for controlling its gain, including a filter for suppressing the control wave frequency and a rectifier, said feedback circuit having such time constants that the gain of the amplifier increases relatively fast as the input level of the amplifier decreases, and decreases slowly as the input level increases.

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