

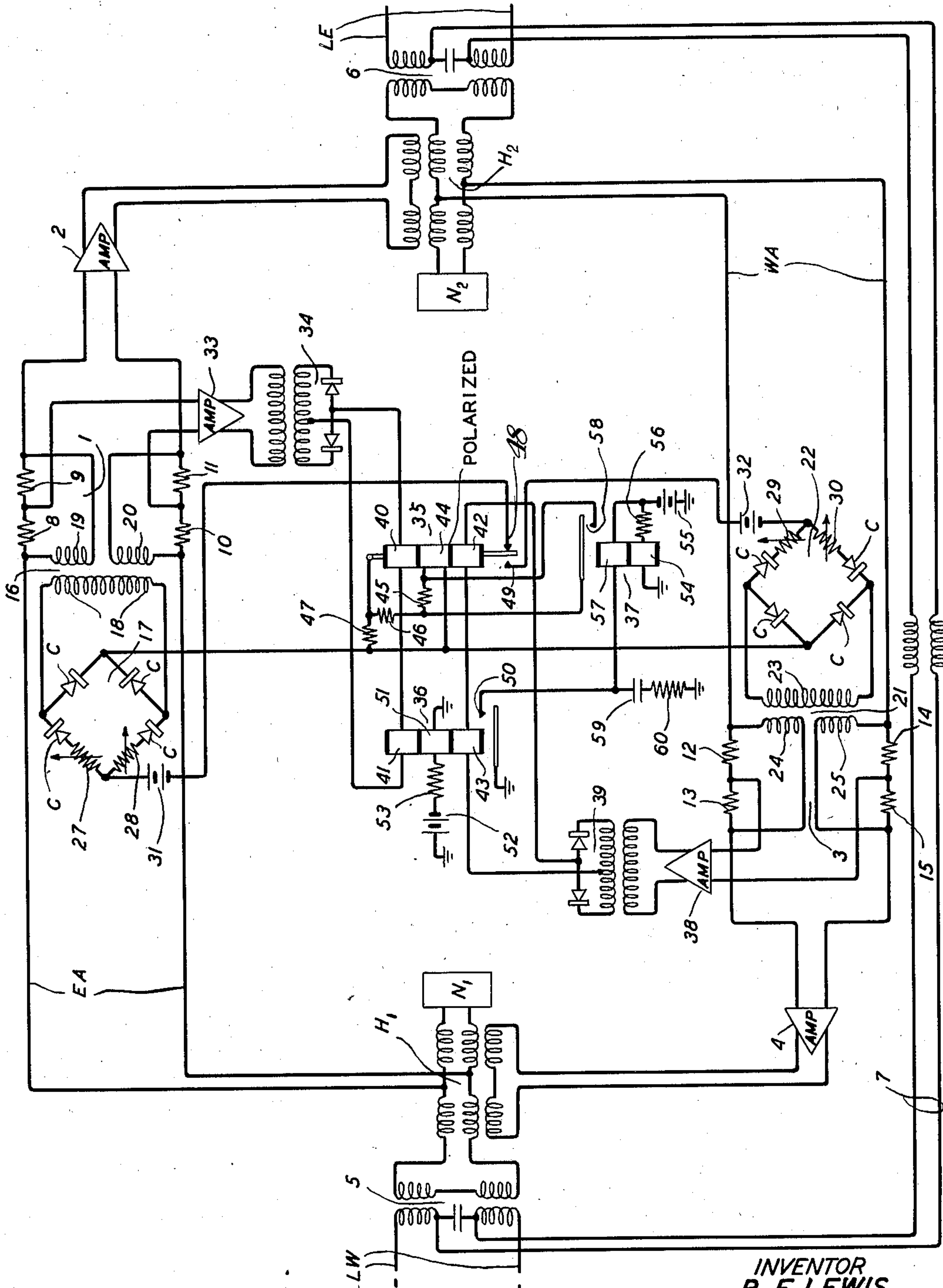
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TRANSMISSION CONTROL IN SIGNALING SYSTEMS

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TRANSMISSION CONTROL IN SIGNALING SYSTEMS

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This invention relates to signal transmission systems and particularly to circuits for regulating transmission in such systems.

An object of the invention is to improve the operation of such circuits.

The invention is more specifically directed to regulating circuits employing as control elements devices which have a non-linear resistance-direct current voltage characteristic, such as copper-oxide rectifiers.

In one embodiment the invention comprises a voice-operated telephone repeater of the 22-type. Copper-oxide rectifying devices are connected effectively in parallel with series loss elements in each repeating path and a single master relay is responsive to initiation of speech signal transmission in either path to apply or remove biasing voltages to control the resistance values of the copper-oxide rectifying devices in such manner that the loss elements are short-circuited thereby in the path transmitting signals and remain effective in the other path. Thus while transmitted speech receives the normal gain there is at all times an additional loss in the singing path of the repeater. The additional loss controlled in this manner enables the use of higher gains than would be permitted by the balances obtainable between the lines with which the repeater would be used and their respective balancing networks.

A feature of the invention is the use of adjustable resistances in a bridge configuration with the copper-oxide rectifying elements, used for control, for the purpose of reducing "click" disturbances in the signal transmission path resulting from the application to and removal from the rectifying elements of the biasing direct currents.

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, the single figure of which shows schematically the invention embodied in a two-way telephone repeater.

The two-way telephone repeater circuit as shown in the drawing comprises a transmission path EA including the loss pad 1 and the one-way amplifying device 2, for repeating telephone signals in the direction from west to east between the west two-way line section LW and the east two-way line section LE, and a transmission path WA including the loss pad 3 and the one-way amplifying device 4, for repeating signals in the direction from east to west between the line sections LE and LW, through the repeating coils 5 and 6. The oppositely-directed one-way repeating paths EA and WA are connected in substan-

tially conjugate relation with each other and in energy transmitting relation with the line sections LW and LE by the hybrid coil transformers H₁ and H₂ and associated balancing networks N₁ and N₂ in well-known manner. A circuit 7 for transmitting direct current signals around the repeater in both directions connects the line sections LW and LE.

The loss pad 1 in the repeating path EA comprises the two impedance elements 8 and 9 connected in series with the upper conductor of the path EA and the two impedance elements 10 and 11 connected in series with the lower conductor of path EA. Similarly, the loss pad 3 in the repeating path WA comprises the two impedance elements 12 and 13 connected in series with the upper conductor path WA and the two impedance elements 14 and 15 connected in series with the lower conductor of the path WA. The impedance elements 8, 10, 12 and 14 are preferably of equal value and the impedance elements 9, 11, 13 and 15 are preferably of equal value.

A transformer 16 is utilized for connecting the copper-oxide rectifier bridge 17 effectively in shunt with loss pad 1. The primary winding 18 of transformer 16 is connected across one diagonal of the bridge 17, and the two equal secondary windings 19 and 20 of the transformer 16 are respectively connected across the impedance elements 8 and 9 in series and the impedance elements 10 and 11 in series. Similarly, the transformer 21 is utilized for connecting the copper oxide rectifier bridge 22 effectively in shunt with the loss pad 3 in the path WA. The primary winding 23 of transformer 21 is connected across one diagonal of the bridge 22 and the two equal secondary windings 24 and 25 of transformer 21 are connected, respectively, across the impedance elements 12 and 13 in series and the impedance elements 14 and 15 in series.

The rectifier bridges 17 and 22 have in each of their four arms a copper-oxide rectifier unit C comprising one or more stacked copper-oxide discs the number used depending on the magnitude of the impedances in the loss pads 1 and 3. The adjustable resistance units 27 and 28 are connected respectively in one of two of the arms of bridge 17, and the adjustable resistance units 29 and 30 are connected respectively in one of two of the arms of the bridge 22. These adjustable resistance units are adjusted to compensate for variations in the impedance values of the copper-oxide rectifier units in the several arms and thus to improve the balance of the bridges. Each copper-oxide rectifying unit C in the bridge 17 is

so poled in the arm of the bridge in which it is connected that when biased by current from the associated direct current source 31 poled as indicated, it has an impedance of very low value, and, when unbiased, it has an impedance of very high value, due to the unidirectional characteristics of the copper-oxide devices. It will be seen, therefore, that when the source 31 is connected to the rectifier bridge 17 as indicated, biasing current from the battery flows through the copper-oxide units in such direction as to reduce their impedances to a low value so that the bridge provides a low impedance across the primary winding 18 of transformer 16. The series impedance elements 8 and 9, 10 and 11 of loss pad 1 in the path EA are therefore effectively short-circuited through the low impedance secondary windings 19 and 20 of transformer 16, respectively, and the loss pad 1 is effectively removed from the path EA. Also, it will be seen that when the direct current source 31 is effectively disconnected from the rectifier bridge 17 the copper oxide units therein provide a high impedance across the primary winding 18 of transformer 16, and, therefore, the secondary windings 19 and 20 of transformer 16 provide a very high impedance across the series impedances 8 and 9, 10 and 11 of loss pad 1 in the path EA so that these impedances are effective to insert loss in the repeating path EA.

Similarly, each copper-oxide unit C in the bridge 22 is so poled that when biased by direct current from the associated direct current source 32 poled as indicated, it has a very low impedance, and, when unbiased, it has a very high impedance. Thus, when the source 32 is connected to supply current to the bridge 22, the bridge provides a low impedance across the primary winding 23 of transformer 21. The secondary windings 24 and 25 then provide very low impedance paths shunting the series impedance elements 12 and 13, 14 and 15, respectively, in the loss pad 3, and pad 3 is effectively removed from the path WA. Also, when the direct current source 32 is effectively disconnected from the bridge 22, the copper-oxide rectifying units C therein form a very high impedance across the primary winding 23 of transformer 21, and, therefore, the secondary windings 24 and 25 form high impedance shunts around the series impedance elements 12 and 13, 14 and 15, respectively, in loss pad 3 so that the series elements in the pad are effective to insert loss in the path WA.

Connected across repeating path EA at the junctions of the series impedance elements in loss pad 1 is the input of a voice-operated control circuit comprising in order a one-way amplifier 33, a rectifier 34 and a chain of mechanical relays comprising relay 35, relay 36 and relay 37. Relay 35 is a polarized relay and relays 36 and 37 are of neutral type. Similarly, connected across the repeating path WA at the junctions of the series impedance elements in the loss pad 3 is the input of a second voice-operated control circuit comprising, in order, the one-way amplifier 38, the rectifier 39, and the same chain of mechanical relays comprising relay 35, relay 36, and relay 37 as in the first control circuit. These control circuits operate to disconnect and connect the direct current biasing sources 31 and 32 from the copper-oxide rectifier bridges 17 and 22 and to produce other results to provide proper directional control of signal transmission in the repeater as will be described below.

The amplifiers 2 and 4 in the repeating paths

and the amplifiers 33 and 38 in the control circuits may be of any of the well-known types, for example, of the type employing three-electrode amplifying vacuum tubes. The rectifiers 34 and 39 in the control circuits also may be of any of the well-known types for example, as shown, of the full-wave type employing two copper-oxide rectifying units connected in push-pull relation.

One winding 40 of relay 35 and one winding 41 of relay 36 are connected in series directly in circuit with the output of rectifier 34 in the control circuit associated with the path EA. A second winding 42 of relay 35 and a second winding 43 of relay 36 are connected in series directly in circuit with the output of rectifier 39 in the control circuit associated with the path WA.

Relay 35 has a third winding 44 shunted by the resistances 45, 46 and 47 in series, the function of which winding is to shift bias from one direction to the other. When the armature of relay 35 is on contact 48, current flows over a circuit extending from the positive terminal of battery 31 through the copper-oxide rectifier bridge 17, resistance 47, armature and back contact 48 of relay 35 to the negative terminal of battery 31. The voltage drop in resistance 47 applies a biasing potential to the winding 44 in such direction as to tend to hold the relay armature on contact 48. When the armature of the relay is on contact 49, current flows from battery 32 through contact 49 and armature of relay 35, resistance 47 and the copper oxide bridge 17 in the opposite direction, the voltage drop in resistance 47 applying bias in the opposite direction to the relay winding 44 tending to hold the relay armature on contact 49. Thus, the voltage drop in resistance 47 controls the amount of bias supplied to the master relay 35.

The winding 40 of relay 35 is so wound that when energized by rectified speech from the output of rectifier 34, it will operate to hold the relay armature more firmly on contact 48 or shift it from contact 49 to contact 48, whereas the winding 42 is oppositely wound so that when energized by rectified speech from the output of rectifier 39, it will operate to hold the relay armature on contact 49 or to shift it from contact 48 to contact 49. It will be seen, therefore, that the effect of the biasing winding 44 on relay 35 is to hold the relay armature in the position corresponding to the transmission of speech from one direction until telephonic energy from the opposite direction causes the armature to be transferred; then winding 44 tends to hold the armature in the other position.

The windings 41 and 43 of relay 36 are wound so that energization of either, respectively, in response to the rectified speech from the output of rectifier 34 or from the output of rectifier 39 tends to attract the armature of the relay to its contact 50. The relay 36 has a third winding, the biasing winding 51, which is continuously supplied with biasing current from the battery 52 through the resistance 53. This winding is so wound as to oppose the action of winding 41 or winding 43. The normal bias applied to winding 51 of relay 36 is made greater than the normal bias on the master relay 35, so that the former relay will operate to close contact 50 only in response to the strong peaks of the rectified speech current supplied to either of its operating windings, whereas relay 35 will be operated by the applied rectified speech currents of low level as well as the speech peaks.

Relay 37 has two windings, a biasing winding

54 supplied with biasing current by battery 55 through resistance 56, and an oppositely wound operating winding 57 which is normally deenergized and is adapted to be energized by current from battery 55 through the closed armature and contact 50 of relay 36 when the latter relay is operated. When relay 37 operates, its armature and contact 58 close a short circuit around the resistance 45 in the circuit normally shunting the biasing winding 44 of relay 35, thus effectively increasing the bias applied to that relay and making it less sensitive by an amount corresponding to the increase in bias. When relay 36 operates to close its armature and contact 50, the condenser 59 normally charged by current from battery 55 through the winding 57 of relay 37 and resistance 60, discharges to ground through closed contact 50 and armature of relay 36 and resistance 60. When the relay 36 releases with cessation in the supply of sufficient energizing current to an operating winding, its armature will fall back and open contact 50 thereby breaking the energizing circuit for the operating winding 57 of relay 37 from battery 55 and removing ground from the condenser 59 through that contact. The relay 37 will not release immediately, however, but will be maintained operated for the additional time interval required for condenser 59 to be charged to the potential of battery 55 through the winding 57 and resistance 60. The functions of the two relays 36 and 37 will be explained more fully in connection with the description of the operation of the repeater.

35 The operation of the system as a whole will now be described.

It will be assumed that in the idle condition of the repeater circuit, that is, when no speech waves are being received from line section LW or line section LE, the circuit connections are as shown in the drawing. In that case, polarizing current is being applied to the copper oxide bridge circuit 17 from battery 31 through the armature and back contact 48 of relay 35, and resistance 47. The current flowing through the bridge 17 is in such direction as to reduce the impedance of the copper oxide rectifying elements C therein in shunt to the primary winding 18 of transformer 16 to a low value and the series impedance elements 8, 9, 10 and 11 of loss pad 1 are short-circuited through the resulting low impedance secondary windings 19 and 20 of the transformer. Thus, the loss pad 1 inserts little or no loss in the transmission path EA. No direct current flows through the copper oxide rectifier bridge 22 due to the break in the circuit for battery 32 at the front contact 49 of the master relay 35. Because of the resultant high impedance condition of the copper oxide rectifying elements C in bridge 22, the impedance across the primary winding 23 of transformer 21 is high and the series impedance elements 12, 13, 14 and 15 in loss pad 3 in repeating path WA are shunted effectively by very high impedances through the secondary windings 24 and 25 of the transformer. The series impedance elements in loss pad 3 are therefore normally effective to insert loss in the repeating path WA. The values of the impedances in each loss pad 1 or 3 are selected so that when the impedances are in the path EA or WA the total loss introduced is sufficient to prevent singing or excessive regenerative effects.

Now, let it be assumed that speech signals from the west subscriber are received at the repeater over the line LW and at that time no speech

signals are being received at the repeater over the line LE from the east subscriber. The received speech signals will be impressed by the hybrid coil transformer H₁ on the path EA, and, the loss pad 1 being effectively removed from that path, the main portion will be transmitted with little attenuation to the amplifier 2. The amplified signals in the output of the amplifier 2 will be impressed by the hybrid coil transformer H₂ on the line LE and will be transmitted over that line towards the east subscriber.

A portion of the west-to-east speech signals at the midpoints of pad 1 in the path EA will be diverted into the control circuit associated with that path and will be amplified by the amplifier 33 and rectified by the rectifier 34 therein. The rectified speech currents will be supplied to the operating winding 49 of relay 35 and the operating winding of relay 36 in series. As the armature of relay 35 is on contact 48, the effect of the rectified speech currents is only to hold the armature more firmly on contact 48 and loss pad 1 remains effectively removed from path EA and loss pad 3 remains effective in the path WA to prevent singing and excessive regenerative effects.

The normal bias on relay 36 is greater than the bias on the relay 35 and such that the latter relay will be operated only in response to the strong peaks of the rectified speech supplied to the operating winding 41. When such peaks are received, the relay operates to attract its armature to contact 50, thereby closing an energizing circuit from battery 55 for the operating winding 57 of relay 37 causing the operation of the relay and causing the discharge of the normally charged condenser 59 through ground and resistance 60. Relay 37 operates to attract its armature to contact 58, thereby closing a short circuit around resistance 45 in the circuit normally shunting the biasing winding 44 of the master relay 35. This removal of the portion of the shunting resistance reduces effectively the bias applied to relay 35 and makes that relay less sensitive to operation by rectified telephonic currents from the east line which may be impressed on the operating winding 42 of the master relay. As long as the west subscriber's speech currents are substantially continuously received, the relay 37 will be maintained substantially continuously in the conditions described, as a result of the hangover arrangement and echoes of his speech currents will be unable to reverse relay 35. Relay 36 will be continuously operating on successive strong speech impulses. The east subscriber can interrupt and seize control of the switching circuit by talking loudly enough to overcome the additional bias on the master relay.

When the west subscriber pauses relay 36 will release and its contact 50 will fall back, opening the energizing circuit for the operating winding 57 of relay 37 from battery 55, and removing ground from condenser 59 through the contact 50 and armature of the relay 36. Relay 37, however, will not immediately release but will be maintained operated for an additional hangover interval while the condenser 59 is being again charged to the potential of battery 55 through the winding 57 and the resistance 60. The armature of relay 37 will be maintained on contact 58, causing the resistance 45 shunting the biasing winding 44 of the master relay 35 to be maintained short-circuited and thus the relay 35 to be maintained less sensitive to the energy from the path WA for this additional interval of time.

Relay 36 and relay 37 produce two effects: (1) they provide protection against false operation of the switching circuit by delayed echoes of the west subscriber's speech currents in the path WA, which if not suppressed, might cause reversals of relay 35 and result in speech clipping. They act to desensitize relay 35 when the stronger parts of speech are transmitted and the lower sensitivity is maintained for a length of time sufficient in practically all cases to allow for the return of the most delayed echo. The reduced sensitivity prevents reversal of relay 35 by the echoes if they return when weak speech sounds are being transmitted or during intersyllabic intervals; and (2) they provide protection against noise in that by maintaining relay 35 at reduced sensitivity for the hangover time interval, they reduce possibility of false operation by noise during pauses in speech. The relays 36 and 37 operate similarly to prevent reversal by delayed echoes and false operation by noise during pauses in speech transmission when the east subscriber has obtained control of the switching circuit.

At the end of the hangover interval, the relay 37 releases opening contact 53, removing the short circuit around the resistance 45 in the circuit shunting the biasing winding 44 of relay 35 and, therefore, removing the bias in favor of the west subscriber. All the relay circuits are now again in the condition indicated in the drawing.

Now, if while the circuits are in this condition, speech currents from the east subscriber are received at the repeater over the line LE, and none of the west subscriber's speech currents are being simultaneously received over the west line LW, the operation will be as follows:

The east subscriber's speech waves will be impressed by hybrid coil transformer H₂ on the path WA and will be transmitted thereover to the loss pad 3 therein. The initial portion of the received speech will be transmitted through the pad and will be attenuated greatly therein due to the normal high loss condition of the copper oxide rectifier units C in the rectifier bridge 22. This attenuated part of the west subscriber's speech waves will be amplified by amplifier 4 in the output of the repeating path WA and the amplified waves will be impressed by hybrid coil transformer H₁ on the west line LW over which they will be transmitted to the west subscriber. As relay 35 operates very quickly, only a small portion of the first syllable will be attenuated by the loss pad.

Meanwhile, a portion of the east subscriber's speech currents will be diverted into the control circuit at the midpoints of loss pad 3, and will be amplified by amplifier 38 and rectified by rectifier 39 therein. The rectified speech currents will be supplied to the operating winding 42 of relay 35 and the operating winding 43 of relay 36 in series. The more sensitive master relay 35 will operate quickly to shift the armature of the relay from contact 48 to contact 49. The opening of contact 48 will break the circuit of the battery 31 and direct current therefrom will cease to flow through the copper-oxide rectifier units C in bridge 17. These copper-oxide rectifying units will thus be changed from the low impedance to the high impedance condition, thus putting a high impedance across the primary winding 18 of transformer 16 and producing high impedance paths in parallel to the series impedance elements 8, 9, 10 and 11 of loss pad 1 through the secondary windings 19 and 20 of the transformer 16. The series impedance

elements 8, 9, 10 and 11 of the loss pad 1, therefore, are effective to insert loss in the path WA sufficient to prevent singing or excessive regenerative effects.

The closing of contact 49 of master relay 35 in the manner which has been previously described connects the direct current battery 32 to the bridge circuit 22 and the polarizing current therefrom flows through the copper-oxide rectifying units C therein in such direction as to change them to the low impedance condition. The series impedance elements 12, 13, 14 and 15 in loss pad 3 are short-circuited by the resulting very low impedance paths through the secondary windings 24 and 25 of transformer 21, causing loss pad 3 to be effectively removed from the path WA as regards inserting any loss to the signals transmitted thereover. As soon as this condition is effected, the east subscriber's speech currents are transmitted over the path WA with little attenuation and amplified by the amplifier 4 therein. The amplified speech waves are impressed by hybrid coil H₁ on the line LW and transmitted thereover to the west subscriber.

As stated previously, the bias of relay 36 provided by biasing winding 51 is such as allows operation of the relay only by the strong peaks of rectified speech applied to its operating windings. When the rectified speech received from rectifier 39 is of this nature, relay 36 will operate to close its contact 50. This in the manner previously described in the case of signal transmission in the opposite direction, will result in the operation of relay 37 to close its contact 58 short-circuiting the resistance 45 in the circuit shunting the biasing winding 44 of the master relay.

The previous opening of contact 48 and the closing of contact 49 of relay 35 besides causing the reversal of the loss condition in the two paths EA and WA, as described, disconnects battery 31 from the resistance 47 in the circuit shunting the biasing winding 44 of the master relay 35 and connects the battery 32 thereto. The current from battery 32 flows through the shunting resistance 47 in the opposite direction causing the bias applied by the winding 44 to the relay to be also in the reverse direction, tending to cause the relay armature to be attracted towards contact 49 instead of toward contact 48 as before.

Therefore, when resistance 45 which is in series with resistances 46 and 47 in the circuit shunting winding 44 is short-circuited through the closed armature and contact 58 of relay 37, the effect is to increase the amount of bias on the winding 44 of relay 35 in such direction as to make the relay less sensitive to operation by the speech from the path EA.

A hangover in the operation of the relay 37 for a suitable interval of time after the east subscriber ceases talking is produced in a manner similar to that previously described for the opposite direction of speech transmission.

After cessation in the east subscriber's speech transmission, the armature of master relay 35 will remain on contact 49 until it is shifted to contact 48 in response to the west subscriber's speech circuits received over the line LW.

During the travel time of the armature of the relay 35 from one contact to the other, no polarizing direct current will flow through either loss-controlling rectifier bridge 17 or 22, and the loss pads 1 and 3 are each effective to insert loss in the path in which connected.

As stated above, the values of the adjustable resistance units 27 and 28 in two of the arms of the copper-oxide rectifier bridge 17 and the adjustable resistance units 29 and 30 in two of the arms of the copper-oxide rectifier bridge 22 are adjusted to compensate for differences in the resistance values of the copper-oxide rectifier units C in the several arms of the bridges so as to obtain a better balance. It has been found that without their use, in spite of the bridge configuration of rectifier units, the closing and opening of the contacts 48 and 49 of relay 35 in connecting the polarizing direct current source 31 and 32 to the respective bridges and disconnecting them from the bridges will result in the transmission of excessive "click" disturbances over the voice circuits, which are quite annoying. A large reduction in the magnitude of these clicks and in some cases complete elimination is attained by the use of the adjustable resistance units to improve the balance.

Many changes in the details of the repeater circuits which have been illustrated and described within the spirit and scope of the invention will occur to persons skilled in the art. The invention is only to be limited within the scope of the appended claims.

What is claimed is:

1. In combination, a signal transmission line, a loss circuit of bridge configuration including non-linear resistance elements in the arms thereof, having one diagonal coupled to said line, a source of polarizing voltage, contact means adapted to be operated to connect said source across the other diagonal of the bridge and to disconnect it therefrom, and means for preventing the transmission of a disturbing impulse due to operation of said contact means, into said line, comprising linear resistance means in certain of said bridge arms for balancing the bridge to make the diagonal including said contact means conjugate with respect to the diagonal coupled to said line.

2. In combination, a line for transmitting signals, a control circuit coupled to said line and including a copper oxide rectifier circuit, means normally polarizing said rectifier circuit so that said control circuit provides one loss condition in said line, contact means operating to apply a polarizing voltage to said rectifier circuit to cause said control circuit to provide a different loss condition in said line, and means for preventing the transmission of an impulse into said line from the operation of said contact means comprising a bridge configuration of the elements in said rectifier circuit and a balancing resistance for making the circuit of said contact means conjugate with respect to the circuit associating said rectifier circuit with said line.

3. In a signal transmission system, a signal transmission line, a control circuit connected thereto and including a copper oxide rectifying circuit and a source of polarizing voltage therefor, said control circuit causing a certain loss condition in said line when said source of voltage is connected to said rectifying circuit and a different loss condition in said line when said source is removed from said rectifying circuit, said source being normally associated with said rectifying circuit so that one of the two loss conditions is provided in said line, contact means to shift said source to provide the other loss condition in said line, and means for preventing the transmission of a disturbing impulse into said line when said contact means operates comprising

a bridge configuration of the elements of said rectifying circuit and a balancing resistance in one of the arms of the bridge to make the contact means conjugate with respect to the circuit connecting said bridge to said line.

4. In combination, two oppositely directed one-way circuits for transmitting alternating signals in opposite directions between stations, a loss pad in each circuit comprising one or more series impedance elements of such values as to offer a high loss to transmitted signals, one or more copper oxide rectifying units connected effectively in shunt with the impedance elements in the loss pad in each circuit, and means comprising a single relay responsive to initiation of signal transmission in either of said circuits to control the direct current bias on said copper oxide rectifying units so that those associated with the pad in the circuit transmitting signals offer a low resistance to the transmitted signals, and those associated with the pad in the other circuit offer a larger resistance to transmission thereover.

5. In a two-way signal wave transmission system, two oppositely-directed one-way circuits for transmitting signal waves in opposite directions between stations, one or more loss elements in each of said circuits, means normally making the loss elements in one of said circuits substantially ineffective to introduce loss in that circuit and the loss elements in said other circuit effective to introduce loss therein, a single mechanical relay responsive to initiation of signal wave transmission in either circuit to make or maintain the loss elements ineffective therein and to make or maintain the loss elements in the other circuit effective, and means responsive to signal wave transmission in the circuit in which first initiated to reduce the sensitivity of said relay as regards operation by waves in the other path with respect to the sensitivity of the relay as regards operation by waves in the first circuit.

6. In combination, two oppositely-directed one-way circuits for transmitting alternating current signals in opposite directions between stations, a loss pad in each circuit comprising one or more series impedance elements of such values as to offer substantial loss in said line and one or more copper oxide rectifying units effectively in shunt with the impedance elements in the loss pad in each circuit and effectively in series relation with the circuit, a mechanical relay responsive to initiation of signal transmission in either one-way circuit to control the direct current bias on the copper oxide rectifying units in the loss pads in both circuits so that the pad in the circuit transmitting signals offers a low loss to the transmitted signals and the pad in the other circuit offers a high loss therein, and means responsive to the signals in the circuit in which first initiated for reducing the sensitivity of said relay to operation by waves in said other circuit with respect to the sensitivity of the relay as regards operation by waves in the first circuit.

7. In a two-way telephone transmission system, two two-way lines, a four wire repeater therebetween comprising two oppositely directed one-way two-wire circuits for repeating the speech signals in opposite directions between said lines, and means for directionally controlling signal transmission between said lines through said repeater comprising a loss pad in each one-way circuit, consisting of one or more impedance elements in series with the circuit and of said values as to offer a substantial transmission loss therein, one or more copper-oxide rectifying units

effectively in shunt with the series impedance elements in each pad and effectively in series with the circuit in which the pad is connected, the rectifying units associated with the pad in one
5 of said circuits being normally biased so as to offer a very low impedance to the signals and thus effectively removing the pad from the circuit, and the rectifying units associated with the pad in the other circuit being normally biased to offer
10 a very high impedance to the signals so that the pad is effective to insert loss therein, a mechanical relay responsive to the initiation of signal transmission in said one circuit to maintain the normal bias on the rectifying units associated
15 with both pads, and responsive to initiation of signal transmission in the other circuit in the absence of prior signal transmission in said one

circuit to reverse the bias on the rectifying units associated with the two pads, means for biasing said relay so that it tends to remain in the operated condition initiated by signals in the circuit in which signal transmission last took place, 5 means responsive to the peaks of speech signals only in either repeater circuit after said relay has been operated in response to signal transmission in one circuit to reduce the sensitivity of said relay to operation by subsequent signals in 10 the other repeating circuit with respect to its sensitivity to operation by signals in the first circuit, and means for maintaining the relay at said reduced sensitivity for a desired interval of time after cessation in the supply of controlling signal 15 energy to said relay from said first circuit.

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