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ECHO SUPPRESSOR CIRCUITS

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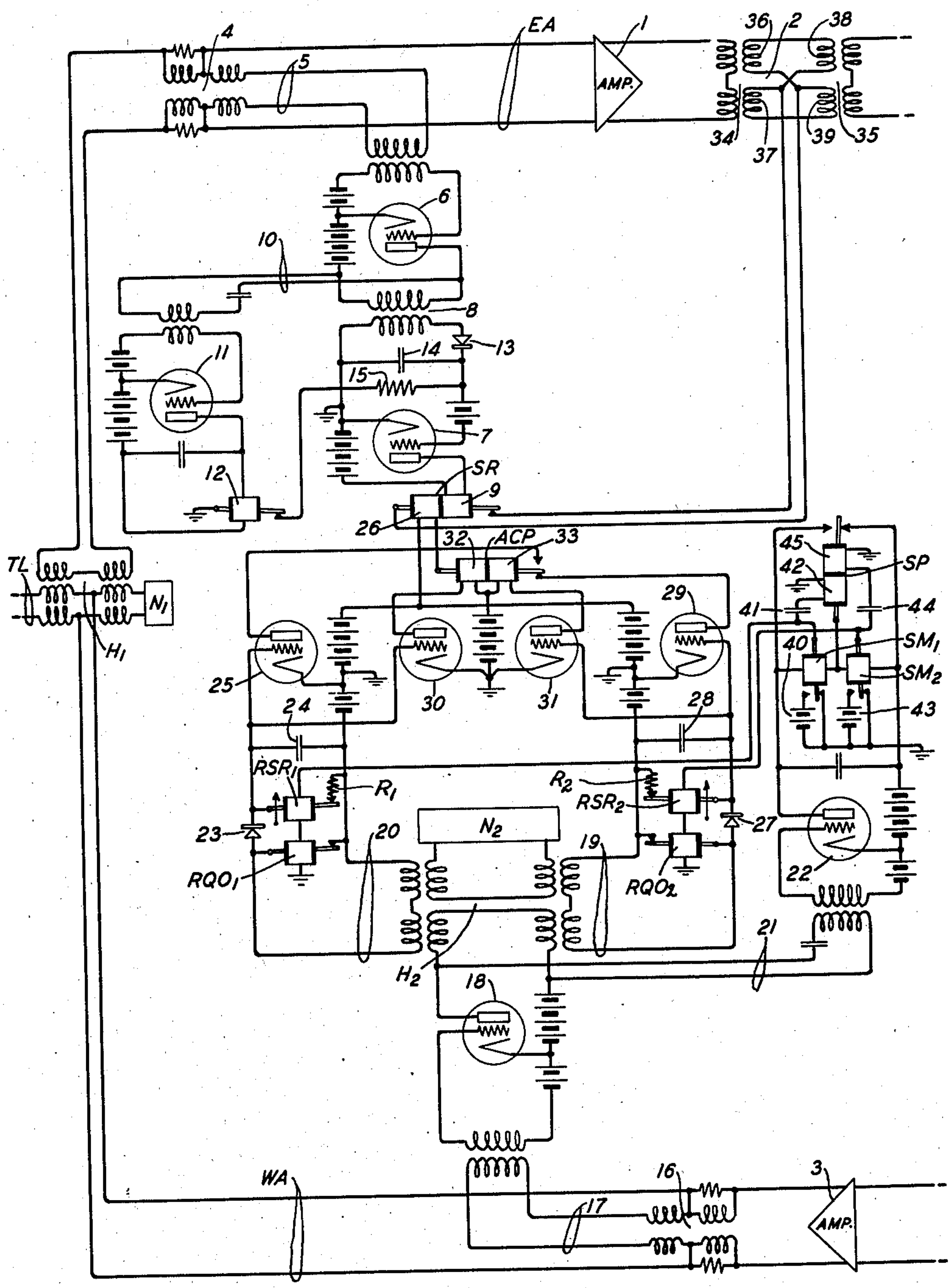

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ECHO SUPPRESSOR CIRCUITS

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The invention relates to two-way signaling systems and particularly to the circuits employed for directionally controlling signal transmission in such systems.

An object of the invention is to improve the operation of a long two-way signal transmission system employing therewith signal-operated apparatus for suppressing echoes.

To obtain proper operation of a long two-way telephone system including over at least a portion of its length, a four-wire circuit comprising oppositely directed one-way paths for the signals in opposite directions, it has been found necessary in the past to employ therewith voice-operated switching apparatus to insure that only one of these paths is operative at a time. This is to prevent echoes of the transmitted voice signals from being carried back to the transmitting end of the system and causing a disturbance. The voice-operated switching apparatus when located at the terminals of the four-wire circuit are known as terminal echo suppressors.

The invention is particularly concerned with terminal echo suppressors of the differential type. These echo suppressors usually comprise at each terminal, a polar relay having one winding adapted to be energized in response to wave energy in the outgoing one-way path by a control circuit connected thereto, and an opposing winding adapted to be energized in response to wave energy in the incoming path of the terminal by a control circuit connected to that path, the relay tending to operate in one direction or the other depending on which winding carries the stronger current. In one system of this type in the prior art, the outgoing path at each terminal is normally operative and is maintained operative by the relay in response to stronger signals in that path, but is disabled by operation of the relay when the signals in the incoming path are stronger.

The invention is specifically directed to improvements in such differential type terminal echo suppressors, the improvements consisting in the provision of means for facilitating break-ins by a listening party after a talking party has obtained control of the switching circuit, and without decreasing the efficiency of the circuit as regards the suppression of echoes. This is accomplished mainly by a receiving control circuit operating on alternate syllables of incoming voice signals to apply a bias against break-ins to the transmitting control circuit proportional to the amplitude of the stronger of successive syllables, which is applied quickly enough to prevent false operation thereof by the initial echo of the incoming signals, and is prolonged just sufficiently to prevent false operation by the terminal echo.

A more complete understanding of the invention with its various objects and features will be had from the detailed description thereof when read in connection with the accompanying drawing, the single figure of which shows schematically one terminal portion of a four-wire toll telephone system equipped with a terminal echo suppressor in accordance with a preferred form of the invention.

The four-wire toll telephone circuit of the drawing comprises a one-way signal transmission path EA for repeating telephonic currents in the direction from west to east and a one-way transmission path WA for repeating telephonic currents in the direction from east to west. The input of the path EA and the output of the path WA are coupled at the west terminal of the four-wire circuit in conjugate relation with each other and in energy transmitting relation with the two-way telephone line TL by the hybrid coil H_1 and associated balancing network N_1 in well-known manner. The transmission path EA includes near the west terminal the one-way amplifying device 1 and the loss network 2, and the transmission path WA includes near the west terminal the one-way amplifying device 3.

Connected across the path EA in front of the amplifying device 1 through the directional network 4 is the input of the transmitting control circuit 5 of the terminal echo suppressor. The directional network 4 may be of any suitable type which will allow transmission from the incoming portion of the path EA into the control circuit 5 while preventing substantially transmission from the outgoing portion of the path EA into the control circuit 5. The particular network illustrated is a special bridge transformer such as is disclosed and claimed in Crisson Patent 1,755,743 issued April 22, 1930.

The transmitting control circuit 5 comprises a main portion including the three-electrode vacuum tube amplifier 6, a three-electrode vacuum tube detector 7, the input of which is coupled to the output of the amplifier 6 by transformer 8, and the polarized suppressor relay SR, one winding 9 of which is connected in the plate-cathode circuit of the detector tube 7. Connected across the plate circuit of the vacuum tube amplifier 6 is an auxiliary circuit 10 including the three-electrode vacuum tube detector 11 and a polarized relay 12 having its winding connected in series with the plate-cathode circuit of the detector tube

11. Connected in the grid-cathode circuit of the detector tube 7 in series with the secondary winding of the transformer 8 is the copper-oxide rectifying device 13, and connected across the grid-cathode circuit of tube 7 in shunt with the secondary winding of transformer 8 and the rectifying device 13 in series, is the control condenser 14. The condenser 14 is normally shunted by the resistance 15 through the normally closed contact and armature of the polarized relay 12.

Connected across the path WA in the output of the amplifying device 3 through the directional network 16, similar to the network 4, is the input of the receiving control circuit 17 of the terminal echo suppressor. The receiving control circuit 17 includes the three electrode vacuum tube amplifier 18 and the two operating channels 19 and 20, the inputs of which are coupled in conjugate relation with each other and in energy transmitting relation with the output of the amplifier 18 by the hybrid coil network H_2 and associated balancing network N_2. The operating channels 19 and 20 are so connected to enable either channel to be blocked without affecting the input of the other.

The receiving control circuit 17 also includes a selector circuit 21, the function of which is to direct alternate incoming speech syllables received from the path WA into the proper receiving channel. The selector circuit 21, the input of which is connected across the plate-cathode circuit of the amplifier 18 in front of the hybrid coil H_2 includes a three-electrode vacuum tube detector 22, the selector master relays SM_1 and SM_2, the windings of which are connected in series across the plate-cathode circuit of the detector tube 22, one of the latter windings being always shorted, which control the operating channels 19 and 20 in the manner which will be described later, and a differentially-connected selector polarized relay SP which alternately conditions the relays SM_1 and SM_2 for operation.

The operating channel 20 includes a series copper-oxide rectifying device 23 for charging the condenser 24 connected in shunt with the channel, and a three-electrode vacuum tube detector 25 having its input electrodes connected across the condenser 24, and the output circuit of which is connected or adapted to be connected under control of the amplitude comparor polarized relay ACP, across the other winding 26 of the suppressor relay SR. The winding 26 of the suppressor relay SR is wound in opposing relation to the winding 9 thereof controlled by the transmitting control circuit 5.

The receiving channel 19 includes a series copper-oxide rectifier 27 for charging the condenser 28 connected in shunt with the channel, and a three-electrode vacuum tube detector 29 having its input circuit connected across the condenser 28 and its output circuit connected or adapted to be connected by the relay ACP across the winding 26 of the suppressor relay SR as will be explained.

The receiving channel 20 is normally short-circuited in the input of the rectifier 23 through the normally closed armature and contact of the quick-operating channel control polarized relay RQO_1, and is normally short-circuited in the output of the rectifier 23 through the normally closed armature and contact of the polarized slow-release channel control relay RSR_1 and its series resistance R_1. Similarly, the operating channel 19 is normally short-circuited in the input of rectifier 27 through the normally closed armature and contact of the quick-operating polarized channel control relay RQO_2, and is normally short-circuited in the output of the rectifier 27 through the normally closed armature and contact of the slow-release polarized channel control relay RSR_2 and the series resistance R_2. The relays RQO_1, RSR_1 and RQO_2, RSR_2 are controlled from their respective selector relays SM_1 and SM_2 as will be explained later in connection with the description of operation of the whole circuit.

The receiving control circuit 17 also includes another portion, which consists of the two three-electrode vacuum tube detectors 30 and 31 the cathode-anode circuits of which are differentially connected to the amplitude comparor polarized relay ACP through the two opposing windings 32 and 33 thereof. The grid-cathode circuits of the detectors 30 and 31 are respectively connected across the condenser 24 in operating channel 20, and across condenser 28 in operating channel 19, so that if the charge on condenser 24 in receiving channel 20 is larger than the charge on condenser 28 in the receiving channel 19, the relay ACP operates in the upward direction, and if the charge on condenser 28 is larger than the charge on condenser 24, the relay ACP operates in the downward direction.

The loss network 2 in the path EA may be of any suitable type which will normally provide a low loss to transmitted waves and which is adapted to be changed to the high loss condition by operation of a mechanical relay. The particular type of network illustrated is disclosed and claimed in H. C. Silent Patent 1,749,851 issued March 11, 1930. As indicated, it comprises the two transformers 34 and 35 connected in tandem in the circuit EA. The transformer 34 has one primary winding and two secondary windings 36 and 37, and the transformer 35 has two primary windings 38 and 39 and one secondary winding. The upper terminals of the windings 36 and 38 are connected together and likewise the lower terminals of the windings 37 and 39. The lower terminal of the winding 36 is connected to the upper terminal of the winding 39, and the lower terminal of the winding 38 is connected to the upper terminal of the winding 37. These connections, taken by themselves, are such that the windings 36, 38, 37, 39 would oppose each other in such manner as to prevent transmission over the path EA through the transformer network 2. However, as indicated a normal cross-connection made through the normally closed armature and contact of the suppressor relay SR ties together the lower terminals of the windings 36 and 38 and the upper terminals of the windings 37 and 39, so that, in effect, two series aiding circuits are established through transformers 34 and 35, and transmission through the network 2 over the path EA is normally permitted. When the suppressor relay SR operates to open its armature and contact, the normal cross-connection is removed and the windings 36, 38, 37, 39 are connected in opposing relation so that transmission through the transformer network 2 is substantially prevented.

Echo suppression apparatus identical with that just described is associated with the output of the path EA and the input of the path WA at the east terminal (not shown) of the four-wire circuit, the transmitting control circuit corresponding to the transmitting control circuit 5 at the west terminal being connected to the input of the path WA and a receiving control circuit corresponding to the receiving control circuit 17 at the west terminal being connected to the output of the transmission path EA. The operation of the elements of the circuits just described as well as that of other elements therein, not previously referred to, in controlling transmission over the four-wire circuit will be clear from the following description of operation of the entire system.

Operation

In the unoperated condition of the circuit, that is with no speech waves being transmitted in either direction and with only the usual line noise in the transmission paths EA and WA, the sensitivities of the transmission control circuits 5 and 17 are arranged so that the suppressor relay SR is unoperated and its armature and contact are closed, as indicated in the drawing, and thus the loss network 2 in the path EA is in the low loss condition. The transmission control circuits at the east terminal of the four-wire circuit (not shown) will be in similar condition, so that the paths EA and WA will both be operative to transmit.

In the operation of the echo suppressor circuits of the invention there are three distinct cases to be considered: (1) operation on transmitted speech only; (2) operation on received speech only; and (3) operation on both transmitted and received speech.

Transmitted speech only

Speech waves for transmission in the direction from west to east arriving over the telephone line TL will be impressed by the hybrid coil H_1 on the input of the path EA. The main portion of these waves will be impressed upon the input of the amplifier 1 and the amplified waves in the output thereof, the loss pad 2 being in the low loss condition, will be transmitted therethrough and over the outgoing portion of the path EA to the east terminal of the four-wire circuit from which it will be transmitted to an east subscriber.

Part of the transmitted speech waves will pass through the directional network 4 into the input of the transmitting control circuit 5. These waves will be amplified by amplifier 6, and the amplified waves will be divided between the input of the circuit 10 and the input of the detector 7. The initial portion of the waves transmitted to the input of the detector 7 through transformer 8 will be rectified by rectifier 13 and the rectified waves will produce an RI drop in the resistance 15 connected across the input of the detector tube 7.

The portion of the amplified speech waves diverted into the circuit 10 will be detected by the detector tube 11 and the detected waves in the output thereof will cause operation of the relay 12 to open its normally closed armature and contact thereby effectively disconnecting the resistance 15 from in shunt of the control condenser 14 in the main portion of control circuit 5. This will allow the rectified speech in the output of rectifier 13 to charge up the control condenser 14 to a voltage corresponding to the peak syllabic amplitudes, which charge will remain on the condenser 14 until the relay 12 releases to reconnect the resistance 15 in shunt with the control condenser 14 when the charge will leak off through this resistance.

No appreciable hang-over is applied to the control circuit 10 so that the control relay 12 will release, discharging control condenser 14, as soon as the speech wave has passed. The charge on the control condenser 14, as long as it remains, is applied to the input of the detector tube 7 and causes the operation of the tube to apply energizing current to the winding 9 of the suppressor relay SR in such direction as to tend to hold the relay armature more firmly on its contact thus retaining the loss network 2 in the path EA in the low loss condition, and biasing the relay SR against operation by the receiving control circuit 17 in proportion to the amount of current in the winding 9.

The transmitting control relay 12 is made slow operating so that the resistance 15 is not immediately removed from in shunt of the condenser 14 in response to impressed wave energy. This prevents the transmitting control condenser 14 from receiving a charge from an echo in the path EA of the first syllable of speech energy to be received over the path WA and thus permits the receiving control circuit 17 to operate the suppressor relay SR quickly in response to received speech. Fast operation of the suppressor relay SR is necessary in order to minimize initial echoes.

Received speech only

The operation of the suppressor apparatus at the east terminal of the four-wire circuit in response to the speech waves transmitted from the west terminal over the path EA will be clear from the following description of operation of the suppressor apparatus at the west terminal in response to speech waves received from the east terminal over the path WA.

The speech waves received over the path WA will be amplified by the amplifier 3. The main portion of the amplified waves will be transmitted out over the outgoing portion of the path WA and will be impressed by the hybrid coil H_1 upon the two-way telephone line TL over which it will be transmitted to the west subscriber.

A portion of the speech waves transmitted through the hybrid coil H_1 to the two-way line TL will return and be transmitted into the input of the path EA in the form of an echo. The initial echo, due to the first part of the received speech syllables will build up a voltage across condenser 14 which will be small due to the parallel resistance 15. Thus it will not be effective to apply a full bias against the operation of the receiving side of the suppressor before the suppressor relay SR has been operated by the receiving side, due to the slow operation of transmitting control relay 12, as described above.

Meanwhile, the portion of the amplified received speech waves diverted into the receiving control circuit 17 will be amplified by the amplifying device 18 therein.

First, let it be assumed that the receiving control circuit is of the usual type with only one channel. In that case, in actual conversation the received speech syllables would follow each other so closely that the receiving control circuit relay with the usual hang-over (about 0.1 seconds) would very frequently not fall back between syllables. As a result, a weak syllable following a strong one which had caused operation of the suppressor relay SR, might maintain the voltage on the control condenser produced by the strong syllable. The current in the winding 26 of the suppressor SR, which acts as a bias against break-ins, will then tend to be unnecessarily high, and since in a normal conversation at constant volume the peak syllabic amplitudes can vary over a 30-decibel range, this effect would be considerable.

For remedying this tendency towards excessive bias against break-ins, utilization is made of two or more similar receiving channels operating one after the other on successive signals, for controlling the suppressor relay, the number of channels being such that each particular channel will have been returned to normal before the next operating syllable comes along. The number of channels required depends on the rate at which signals are being transmitted and the hang-over period of the holding currents. For the usual speech signals, two channels, as illustrated, will be sufficient to produce satisfactory operation. The operation of the receiving channels will now be described.

A portion of the amplified speech waves in the output of amplifier **18** will be divided between the input of the receiving channels **19** and **20**. Another portion will be diverted into the selector circuit **21**. It will be assumed that when the first syllable is received, the receiving control circuits are in the condition indicated in the drawing with the armature of the relay SP on its right-hand contact so that the winding of the relay SM_2 is short-circuited, and with the armature of relay ACP on the lower contact so that the output of detector **29** is connected to the winding **26** of relay SR and the output of detector **25** is open.

The first syllable of the received speech waves in the output of amplifier **18** will be diverted into control circuit **21** and will be detected by the detector **22** therein. The detected current will pass through the winding of the relay SM_1 causing operation of that relay to shift its armature from the right-hand contact to the left-hand contact. When this happens, a voltage is applied from battery **40** to the windings of the relays RSR_1 and RQO_1 in series through the left-hand contact and armature of relay SM_1, thereby causing operation of the former relays to break their armatures and contacts. This will remove the short-circuiting connections across the receiving channel **20** and allow the speech impulse diverted into that channel to charge condenser **24** through rectifier **23** to the maximum voltage of the rectified wave. This rectified voltage is supplied to the grid of the detector tube **30** and the resulting detected current passing through the winding **32** of relay ACP will cause operation of that relay to shift its armature from the lower to the upper contact. This disconnects the output of rectifier **29** in receiving channel **19** from the winding **26** of the suppressor relay SR and connects the output of the detector **25** in receiving channel **20** thereto. This will allow the output current of the detector **25** to build up in the winding **26** of the relay SR sufficiently to cause operation of that relay to break its armature and contact, thereby changing the loss network **2** in the path EA from the low loss to the high loss condition and effectively suppressing echoes of the received speech current in that path.

The charge produced on condenser **14** in the transmitting control circuit by the echo of the received speech current in the path EA, will produce a bias on the opposing winding **9** of the suppressor relay SR in the manner previously described but this bias will not be sufficient to cause that winding to prevail over the winding **26** controlled by the received speech current through the receiving control circuit because of the difference in amplitude between the received speech and its echo. Relay SR therefore will be maintained operated to suppress the echo in the path EA.

When the relay SM_1 operates in the manner which has just been described, in response to a received speech syllable, the condenser **41** associated with relay SP will be charged by current from the battery **40** through the left-hand contact and armature of relay SM_1, but the charging current is so directed through the winding **42** of relay SP that the armature thereof is held more firmly on its right-hand contact. At the end of the syllable (i. e. when the syllable amplitude has fallen below the operate point of the selector detector **22**) the relay SM_1 will release practically immediately. The condenser **41** will then be discharged through the winding **42** of the relay SP causing the relay to shift its armature from the right-hand to the left-hand contact, thereby shorting the winding of relay SM_1 and removing the short from the winding of the relay SM_2.

Also, at the end of the speech syllable, with the release of SM_1, the relay RQO_1 will immediately release reconnecting the normal short circuit across that channel through the contact and armature of that relay. The relay RSR_1, however, due to its slow-releasing characteristic, will stay operated for a short hang-over interval of time so that the suppressor relay SR will maintain the high loss in the path EA until the last part of the echo has been dissipated.

The portion of the second received speech syllable diverted into the selector circuit **21** will be detected by the detector **22** therein and will cause operation of the relay SM_2 to shift its armature from the right-hand to the left-hand contact. This will cause energizing current from battery **43** to be supplied in series to the windings of the relays RSR_2 and RQO_2 associated with the receiving channel **19**, causing their operation to open the normal short-circuits across that channel in the input and the output of rectifier **27**. This will allow the other portion of the second received speech syllable in the output of amplifier **18** to start to build up a voltage across condenser **28** in receiving channel **19** through rectifier **27**.

If the second speech impulse is stronger than the preceding speech impulse the voltage built up on condenser **28** will exceed the voltage previously built up by the latter impulse on condenser **24** in receiving channel **20**. In that case, the rectified voltage on condenser **28** acting through the detector tube **31** of the differential detector will produce a current of such magnitude in the winding **33** of the amplitude comparor relay ACP as to cause the armature of that relay to be thrown to its lower contact thereby disconnecting the output of detector **25** in the receiving channel **20** from the receiving winding **26** of the suppressor relay SR and connecting the output of the detector **29** in the receiving channel **19** thereto. The latter detector will transmit current to the winding **26** of the suppressor relay SR in such direction as to tend to hold that relay operated to maintain the network **2** in the path EA in the high loss condition. The current in winding **26** will build up to a level which is proportional to the strength of the second received speech impulse, which will be just sufficient to prevent the release of relay SR on the echo of the second speech syllable in EA operating through the transmitting control circuit **5**.

If the second received speech impulse were weaker than the first so that the voltage on condenser 28 in receiving channel 19 does not exceed the voltage on the condenser 24 in receiving channel 20, the armature of the relay ACP would be maintained on its upper contact and the current in the winding 26 of the suppressor relay SR will be maintained at a magnitude corresponding to the charge on condenser 24. Thus, it will be seen that the bias on relay SR through the receiving winding 26 of that relay will always be held at a value proportional to the stronger of each two succeeding received speech syllables for time intervals just sufficient to prevent false operation of the relay SR by the echo of the stronger syllable to change the network 2 in the path EA from the high loss to the low loss condition.

At the end of the second syllable, relay SM_2 will release practically immediately and the condenser 44, which was charged by current from battery 43 during the period in which the relay SM_2 was maintained operated, will discharge through the winding 45 of the SP relay causing the armature of the latter relay to return to its right-hand contact, thereby short-circuiting the winding of the relay SM_2, and removing the short from the relay SM_1. Also, with the release of relay SM_2, the relay RQO_2 associated with the receiving channel 19 will release reblocking the input of channel 19 by the resulting short-circuit through the armature and contact of the latter relay. The relay RSR_2 will remain operated for a small interval of time after relay SM_2 has released, due to its slow releasing characteristic, so that the relay SR will be maintained operated to maintain the path EA blocked until the echo has returned to the suppressor point.

If a weak syllable follows the preceding strong syllable, the relay SM_1 will be operated by it in the manner previously described, followed by operation of the relays RQO_1 and RSR_1 associated with the receiving channel 20. The voltage on condenser 24 will then build up, but not to as high a value as that on the condenser 28 associated with the receiving channel 19. Therefore, the armature of the relay ACP will stay on its lower contact until, and only as long as, the relay RSR_2 is held operated by its hangover, after which the armature of the ACP relay will be thrown to the upper contact causing the charge on the condenser 24 to control the winding 26 of the suppressor relay SR.

Operation on both transmitted and received speech

When speech waves from the subscriber associated with the west terminal of the four-wire circuit and the subscriber associated with the east terminal of the four-wire circuit are present simultaneously in the input of the path EA and the output of the path WA, respectively, there are three possible conditions of operation of the suppressor apparatus: (A) speech arriving at the receiving side first; (B) speech arriving at the transmitting side first; and (C) speech arriving at both sides simultaneously.

In condition (A), considering the west terminal of the four-wire circuit, the successive syllables of the received speech waves from the path WA, in the receiving control circuit 17 alternately produce proportional charges on the condenser 24 in the receiving channel 20 and condenser 28 in the receiving channel 19, which, in the manner previously described, produces a current in the winding 26 of the suppressor relay SR proportional to the stronger of the syllables, and causing the operation of the relay SR to condition the loss network 2 in the path EA to provide a large loss therein in the manner which has been previously explained in detail. The portion of the outgoing speech waves later received by the transmitting control circuit 5 subsequently produces a charge on the control condenser 14 therein in the manner which has been previously described. Each charge is proportional to the peak power of the input waves.

If the charge on the transmitting control circuit condenser 14 is greater than that on the receiving circuit condenser 24 or 28 due to the west subscriber talking more strongly than the east subscriber, the winding 9 of the suppressor relay SR will prevail over the winding 26 of that relay causing the relay to release and thereby conditions the loss network 2 in the transmitting path TA to permit the transmitted speech to pass. But, if the charge on the receiving condenser 24 or 28 is sufficiently greater than the charge on the transmitting condenser 14, the suppressor relay SR will not be released, the path EA will remain suppressed and the received speech will retain control of the suppressor circuits.

In condition (B), the portion of the transmitted speech diverted into the transmitting control circuit 5 from the path EA will produce a charge on the transmitting control condenser 14. This will bias the detector 7 so that a proportional current will be produced in the winding 9 of the suppressor relay SR in its output which will be in such direction as to tend to hold the relay armature more firmly on its contact, whereby the loss network 2 in the path EA will be maintained in the normal low loss condition. Speech arriving later on the receiving side and diverted from the path WA into the receiving control circuit 17 will place a proportional charge on the receiving control condenser 24 or 28, as previously described. The latter charge will not cause the suppressor relay SR to operate to change the loss network 2 in the path EA to the large loss condition unless this charge is sufficiently greater than that on the transmitting condenser 14.

In condition (C) charges are placed on both the transmitting and receiving control circuit condensers by the west subscriber's and the east subscriber's speech currents, respectively, at the same time. If the charge on the receiving circuit condenser is sufficiently greater than that on the transmitting circuit condensers, the receiving side controls the suppressor relay, otherwise the transmitting side controls the suppressor relay.

It will be apparent from the above description of operation of the receiving control circuit, that by using the two similar receiving channels operating on successive syllables for insuring that the amount of current in the receiving winding of the suppressor relay is proportional for the required time to the stronger of the received successive signals, the bias against false operation of the suppressor relay by echoes will only be just sufficient to prevent false operation by the echoes of these stronger signals. Because the bias produced by the receiving side on the suppressor relay at any time is only just the minimum amount necessary, break-ins by either party is facilitated, while at the same time echoes are satisfactorily suppressed.

It is to be understood that the invention is not limited to the precise details of the circuits illustrated and described, for it is apparent that numerous modifications thereof could be made by those skilled in the art within the spirit and scope of the invention.

What is claimed is:

1. In a two-way signal wave transmission system comprising at each terminal a one-way signal transmitting path and a one-way signal receiving path, a differential type echo suppressor associated with the signal transmitting and signal receiving paths at each terminal of the system for directionally controlling signal transmission therein, and means for insuring that the bias against break-ins applied to the transmitting side of each echo suppressor by the receiving side thereof is always proportional to the amplitude level of the stronger of successive signal impulses in the signal receiving path.

2. In a two-way signal wave transmission system including a four-wire signal repeating circuit, an echo suppressor of the differential type associated with the outgoing and incoming two-wire paths at each terminal of said four-wire circuit for directionally controlling signal transmission over said four-wire circuit, the one portion of the echo suppressor controlled from the incoming two-wire path operating to bias the other portion controlled from the outgoing two-wire path against operation, said one portion of said echo suppressor including means for comparing the amplitude level of successive signal impulses received from the incoming two-wire path, and for utilizing the stronger of the compared impulses to exclusively produce a bias on said other portion of said echo suppressor, proportional to its amplitude until its termination.

3. In a two-way telephone transmission system comprising at least near the terminals thereof oppositely directed one-way transmission paths for the speech wave signals transmitted in opposite directions, an echo suppressor unit at a terminal of the system comprising wave-controlled differential means which when operated in one direction disables one of the one-way paths near that terminal and when operated in the opposite direction tends to prevent said one one-way path from being disabled, control circuits respectively connected to said one one-way path and the other one-way path near said terminal, for transmitting controlling wave energy therefrom to said differential means, said control circuits being responsive to stronger speech signal waves received from said other one-way path than from said one one-way path to cause operation of said differential means in said one direction and responsive to stronger speed signal waves received from said one one-way path than from said other one-way path to cause operation of said differential means in said opposite direction, and means in the control circuit connected to said other one-way path for insuring that the amount of controlling wave energy transmitted thereby to said differential means is proportional for a definite period to the amplitude level of the stronger of successive syllables of the speech signal waves received from said other one-way path.

4. In a two-way telephone transmission system comprising at least near the terminals thereof oppositely directed one-way transmission paths for the speech signal waves transmitted in opposite directions, an echo suppressor unit at each terminal of the system comprising wave-controlled differential means which when operated in one direction disables the outgoing one-way path at the terminal, and when operated in the opposite direction tends to prevent said outgoing one-way path from being disabled, a transmitting and a receiving control circuit respectively connected to the outgoing one-way path and the incoming one-way path at the terminal, for transmitting controlling wave energy therefrom to said differential means, the control circuits being responsive to stronger speech signal waves received from said incoming one-way path than from said outgoing path to cause the operation of said differential means in said one direction and responsive to stronger speech signal waves received from said outgoing path than from said incoming path to cause operation of said differential means in said opposite direction, and means for facilitating break-ins by a listening party when the speech signal waves of one talking party have obtained control of said echo suppressor unit comprising means in said receiving control circuit for comparing the amplitude levels of successive syllables of the speech wave energy received thereby, and for utilizing the stronger of the compared syllables to exclusively control the operation of said differential means in said one direction.

5. The system of claim 4, in which said means in said receiving control circuit comprises a plurality of receiving channels connected in parallel to the incoming one-way path, means for directing successive syllables of the received speech signal waves alternatively into said channels, means for comparing the amplitude levels of the syllables in the several channels, and means for selecting the strongest of the syllables in the several channels, and utilizing it to control the differential means in proportion to its amplitude level.

6. The system of claim 4, in which said differential means includes a differential relay having two opposing windings energized from the transmitting and receiving control circuits, respectively, and said means in said receiving control circuit comprises a plurality of receiving channels connected to said incoming path, means for directing successive impulses of the speech waves received from said incoming path into said receiving channels alternately, means continuously comparing the amplitude levels of the impulses in the several channels and means responsive to the amplitude level of the strongest impulse in the several channels to supply a corresponding amount of energizing current to the receiving circuit winding of said differential relay.

7. The system of claim 4 in which said differential means includes a differential relay having two opposing windings respectively connected to the transmitting and the receiving control circuit, and said means in said receiving control circuit comprises a plurality of receiving control channels, means for directing successive syllables of the speech signal waves received from said incoming path alternately into said channels, means responsive to the first speech syllable received through the channel in which directed, to cause energizing current of proportional amplitude to be supplied to the receiving circuit winding of said differential relay, means to compare the amplitude of said first syllable with the amplitude of the second received syllable in another channel, means responsive to the second speech syllable, only if stronger than the first syllable, to cause energizing current of proportional amplitude to be supplied to said receiving circuit winding in place of the energizing current due

to the first syllable, and means to repeat these steps for the succeeding syllables of the signal waves in the other channels.

8. The system of claim 4 in which said differential means includes a mechanical relay with two opposing windings respectively connected to the output of the transmitting and receiving control circuits, and said means in said receiving control circuit comprises a plurality of control channels, means to direct the first syllable of the received speech signals into one of said control channels, means responsive to the energy of said first syllable in said one channel to supply energizing current of proportional amplitude to the receiving winding of said relay, means to direct the next syllable of the received speech syllables into another of said control channels, means responsive to a greater amplitude level of said next syllable in said other channel than the level of said one syllable diverted into said one channel, to cause the energizing current supplied to the receiving winding of said relay to become proportional in amplitude to the amplitude level of said next syllable, and responsive to a greater amplitude level of the syllable in said one channel than that of said next syllable in said other channel to maintain the energizing current in the receiving winding of said relay at the previous value.

9. The system of claim 4 in which said differential means comprises a differential relay with its two opposing windings respectively connected to the transmitting and receiving control circuit, and said means in said receiving control circuit comprises a plurality of parallel control channels each including a vacuum tube detector, the output of one of said detectors being connected through the contacts of a second relay to the receiving circuit winding of said differential relay, and the outputs of the other detectors being adapted to be connected thereto in place of the output of the first detector through other contacts of said second relay, means for diverting the first syllable of the received speech signals from said incoming path into one of said control channels, means responsive to the wave energy of said first syllable in said one channel for controlling said second relay to connect said one control channel, or maintain it connected if already connected, to the receiving circuit winding of said differential relay so that the detected current in said one control channel will control said differential relay in accordance with its amplitude, means for diverting subsequent signals of the received speech signals respectively into other control channels, and means responsive to the wave energy in one of said other channels if stronger than that in said one channel to control said second relay to connect the output of said one other channel to the receiving winding of said differential relay in place of the output of said one channel so that the differential relay will be controlled by the amplitude of the strongest received speech syllable.

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