

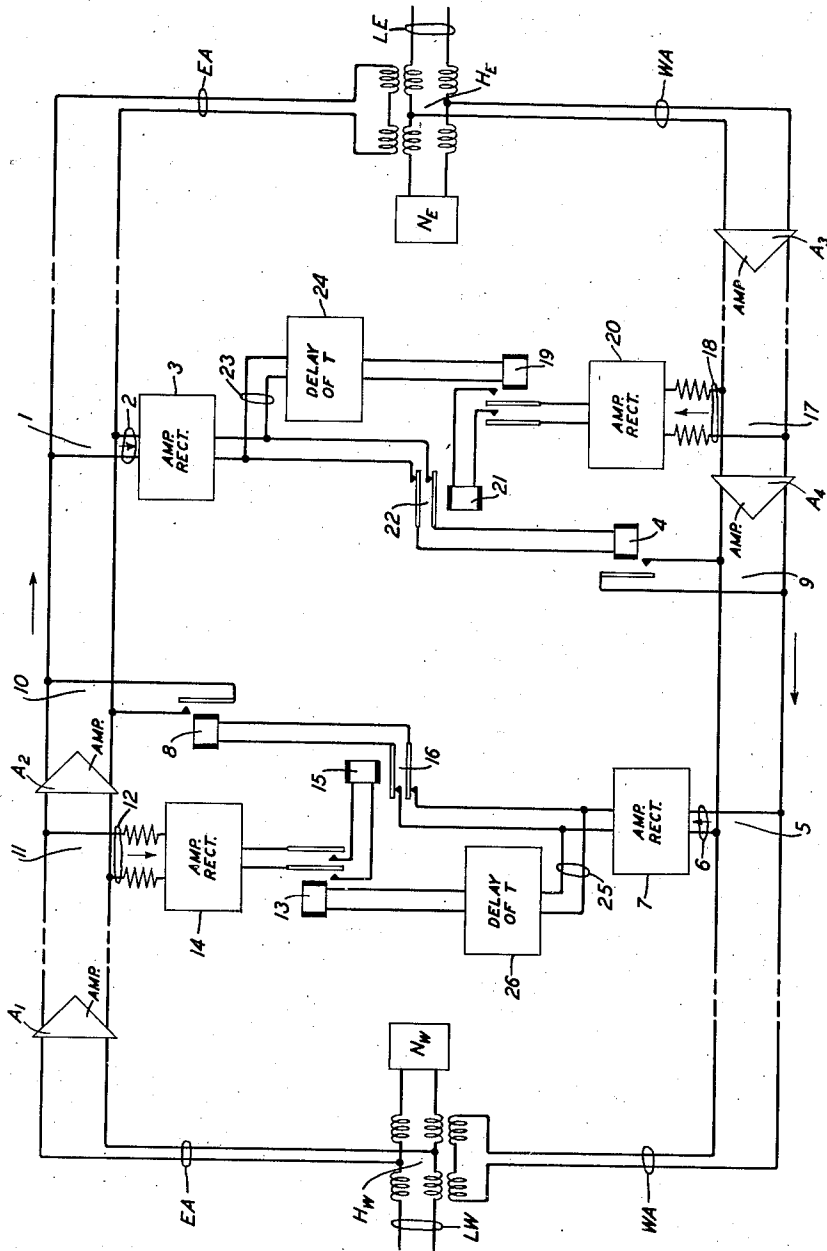
Aug. 29, 1944.

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2,356,943

TRANSMISSION CONTROL IN TWO-WAY SIGNALING SYSTEMS

Filed Aug. 29, 1942



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2,356,943

TRANSMISSION CONTROL IN TWO-WAY
SIGNALING SYSTEMS

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Application August 29, 1942, Serial No. 456,605

4 Claims. (Cl. 178-44)

The invention relates to two-way signal transmission systems and particularly to the signal-controlled switching circuits used with such systems to directionally control signal transmission therein while suppressing echoes and preventing singing.

Such signal-controlled switching circuits, commonly called echo suppressors, usually employ two switching branches respectively connected to each of the two oppositely directed one-way signal transmission paths at a terminal or intermediate point in the two-way system, each including an amplifier and a rectifier for amplifying and rectifying the portion of the signal waves diverted into the switching branch, and electromagnetic relays or other switching devices operated by the rectified signals to properly control the transmitting efficiencies of the signal transmission paths and to disable the other switching branch, so as to provide the desired directional control of signal transmission while suppressing echoes and preventing singing.

The prior patent application of Norwine and Davis, Serial No. 421,704, filed December 5, 1941, which issued as Patent 2,306,689 on December 29, 1942, discloses in combination with such an echo suppressor applied to a four-wire telephone circuit, break-in control circuits operating on an amplitude basis. These circuits enable one subscriber to break in on another who is talking and has operated his echo suppressor switching controls to seize directional control of the system, without waiting for the latter to pause and regardless of how loudly the latter is talking. This is accomplished by the use of other relatively insensitive controls respectively connected to each side of the four-wire circuit in front of the disabling point therein, operating in response to applied voice signals of a level a given amount greater than normal level to immediately disable the echo suppressor switching branch controlled from the other side of the four-wire circuit.

An object of the invention is to improve the operation of such break-in echo suppressor circuits.

A more specific object is to prevent speech signal mutilation in an echo suppressor equipped with a break-in control of the amplitude type, due to rapidly repeated interruptions of the two talkers by each other.

These objects are accomplished in accordance with the invention by making the amplitude break-in controls normally inoperative and providing auxiliary controls for causing each break-

in control to be enabled a predetermined time after operation of the echo suppressor branch which it is to disable, to provide break-in.

The various objects and features of the invention will be better understood from the following detailed description when read in conjunction with the accompanying drawing, the single figure of which shows schematically a four-wire telephone circuit equipped with an echo suppressor embodying the invention.

In the figure, the four-wire telephone circuit of the drawing includes a one-way, two-wire transmission path EA including the amplifiers A₁ and A₂, normally conditioned to transmit in the direction from west to east between the two-way line LW and the two-way line LE; and the one-way, two-wire transmission path WA including the amplifiers A₃ and A₄, normally conditioned to transmit in the direction from east to west between the two-way line LE and the two-way line LW. The transmission paths EA and WA are coupled at the west and east terminals of the four-wire circuit in conjugate relation with each other and in energy transmitting relation with the lines LW and LE by the hybrid coil H_w and associated balancing network N_w, and the hybrid coil H_e and associated balancing network N_e, respectively.

Connected across the west to east path EA at an intermediate point 1 is the input of a voice-controlled echo suppressor branch circuit 2, to be referred to hereinafter as the west echo suppressor, including the wave-controlled control device (amplifier-rectifier) 3 and the electromagnetic switching relay 4 adapted to be operatively energized by the rectified signal output of the device 3. Similarly, connected across the east to west path WA at an intermediate point 5 is the input of a voice-controlled echo suppressor branch circuit 6, to be referred to hereinafter as the east echo suppressor, including the wave controlled control device (amplifier-rectifier) 7, and the electromagnetic switching relay 8 adapted to be operatively energized by the rectified signal output of the device 7. The relay 4 in the west echo suppressor 2, when energized, operates to close a short-circuiting connection across the path WA at the point 9 in front of the point 5 to which the east echo suppressor 6 is connected, to disable that path. Similarly the relay 8 of the east echo suppressor 6, when energized, operates to close a short-circuiting connection across the path EA at the point 10 in front of the point 1 to which the west echo suppressor 2 is connected, to disable that path.

Connected across the west to east transmission path EA at a point 11 in front of the disabling point 10 is the input of a third control circuit 12, to be referred to hereinafter as the west break-in control, which control circuit as indicated by the series resistances in its input, is relatively insensitive as compared with the west echo suppressor 2. The west break-in control 12 includes a wave-operated control device (amplifier-rectifier) 14, and an electromagnetic switching relay 15 which when energized by the detected signal output of the device 14, operates to open its normally closed contacts to disable the east echo suppressor 6 at a point 16 in its output. The west break-in control 12 is normally disabled at a point between the output of the amplifier-rectifier 14 and the relay 15 by the normally open contacts of switching relay 13.

Similarly, connected across the east to west transmission path WA at a point 17 in front of the disabling point 9 is the input of a fourth control circuit 18, to be referred to hereinafter as the east break-in control, which, as indicated by the series resistances in its input, is relatively insensitive compared with the east echo suppressor 6. The east break-in control 18 includes the wave-operated control device (amplifier-rectifier) 20, and an electromagnetic relay 21 adapted to be operatively energized by the signal output of the control device 20 to disable the east echo suppressor 2 at the point 22 in its output. The east break-in control 18 is normally disabled at a point between the output of the amplifier-rectifier 20 and the relay 21 by the normally open contacts of relay 19.

Connected across the west echo suppressor 2 at a point between the disabling point 22 and the output of the amplifier-rectifier 3 is the input of a fifth control circuit 23, to be referred to hereinafter as the east break-in control enabler, including the electromagnetic switching relay 19 which when completely energized from the output of amplifier-rectifier 3, operates to close its normally open contacts to enable the east break-in control 18. As indicated by the delay circuit 24 connected between the relay 19 and the output of the amplifier-rectifier 3, the latter relay is given a delay in operation of T seconds with respect to the operation of the west echo suppressor relay 4 also controlled from the output of amplifier-rectifier 3.

Similarly, connected across the output of the east echo suppressor 6 at a point between the disabling point 16 and the output of the amplifier-rectifier 7 is the input of a sixth control circuit 25, to be referred to hereinafter as the west break-in control enabler, including the electromagnetic switching relay 13 which, when completely energized from the output of the amplifier rectifier 7, operates to close its normally open contacts to enable the west break-in control 12. As indicated by the delay circuit 26 connected in the control circuit 25 between relay 13 and the output of the amplifier-rectifier 7, the latter relay is also given a delay in operation of T seconds with respect to that of the east echo suppressor relay 8 also controlled from the output of amplifier-rectifier 7.

Break-in control enablers 23 and 25 should have the same sensitivities as the echo suppressor branches with which they are associated. Break-in controls 12 and 18 should be made as sensitive as they can be without permitting false operation on echoes of speech signals impressed on the respective opposite sides of the circuit.

Let it be assumed that a west telephone subscriber associated with the line LW starts to speak and at that time the east subscriber associated with the line LE is silent. The speech waves of the west subscriber received over the line LW will pass through the hybrid coil Hw to the west to east transmission path EA of the four-wire circuit, and over that path through the hybrid coil H_E and the line LE to the east subscriber. A portion of these speech waves will be diverted at the point 1 in the path EA into the west echo suppressor 2 causing the operation of the amplifier-rectifier 3 and thus that of the switching relay 4 in its output to disable the east to west path WA at the point 9. This also effectively disables the east echo suppressor 6 connected to the path WA at the subsequent point 5. The echoes of west's speech signals passing into the path WA through hybrid coil H_E, as well as subsequently received signals from the east subscriber, will, therefore, be suppressed at the point 9 and prevented from reaching the input of the east echo suppressor 6 to cause false operation of the latter to reverse directional control of the circuit.

T seconds after the west echo suppressor 2 has thus operated to give directional control of the four-wire circuit to the west talker, the portion of the rectified signals in the output of the amplifier-rectifier 3 of the west echo suppressor 2 diverted into the east break-in control enabler circuit 23 will have passed through the delay circuit 24 and will cause the operation of the relay 19 to enable the east break-in control 18. Up to this time, the east subscriber associated with the line LE will not be able to interrupt the west subscriber because the east break-in control 18 will be in the disabled condition. However, when the relay 19 finally operates to enable the east break-in control circuit 18, it is possible for the east subscriber to interrupt west immediately by talking loudly enough to overcome the desensitization provided by the series resistances in the input of east break-in control 18. When east does so, his speech signals diverted into the east break-in control 18 will cause operation of the amplifier-rectifier 20 and thus of the break-in relay 21 to immediately disable the west echo suppressor 2 at the point 22 in its output. The echo suppressor relay 4 will then release to remove the short-circuiting connection across the path WA at the point 9 and thus to interrupt the west subscriber's directional control of the circuit. The east subscriber's speech currents received from the line LE then will pass over the now enabled east to west transmission path WA and through the hybrid coil Hw and line LW to the west subscriber. The portion of east's speech waves diverted from the path WA into the east echo suppressor 6 will cause the operation of the amplifier-rectifier 7 and thus of the echo suppressor relay 8 in its output to close a short-circuiting connection across the path EA at the point 10. The echoes of east's speech waves passing into the path EA will therefore be suppressed at the point 10 and speech currents subsequently received from west will be prevented from passing over that path to the east subscriber, as long as east continues to hold his echo suppressor relay 8 operated. T seconds after relay 8 operates, the portion of east's rectified speech currents passing from the output of the amplifier-rectifier 7 into the west break-in control enabler branch 25 and delayed in that branch for that time interval by delay circuit 26

will operate relay 13 to enable the west break-in control 12. At any time thereafter, the west subscriber by talking loudly enough to overcome the desensitization provided by the series resistances in the input of the west break-in control 12 will be able to interrupt the east talker by operating the amplifier-rectifier 14 and thus switching relay 15 to disable the east echo suppressor 6 at the point 16. The consequent release of relay 8 will unblock the path EA, enabling west's speech currents to get through to the east subscriber and to operate the west echo suppressor 2 to regain directional control.

It will be seen from the above description of operation of the system of the drawing that a listener cannot interrupt the talker and obtain directional control of the system until a given time, T seconds, after the first talker starts to talk when the listener's break-in control is enabled under control of the first talker's speech waves. Thus in the normal course of events, a listener could reply sooner than with a conventional echo suppressor and once successful in breaking in would hold control for a reasonable time without himself being interrupted. With T in the order of, say, half a second, many of the repeated reversals that might otherwise take place should be eliminated, and both talkers should hear more intelligible interruptions.

To provide break-in that will be intelligible it has been found that break-in relays 15 and 21 should remain operated for a short time after the operating speech energy has ceased. This hangover time should be about one hundred milliseconds. This hangover may be obtained by suitable design of the relays or by the use of associated resistance-condenser hangover circuits. Break-in enabler relays 13 and 19 also should be provided with hangovers, to insure that break-in means are available as much of the time as possible excluding the time T after a talker starts talking and excluding lockup between successive speeches by the same talker. These hangovers preferably should be in the order of T seconds. Thus if delay 26 is a relay chain terminating in relay 13, the combination should operate in T seconds after speech energy arrives at point 6, and it should release in about T seconds after the speech energy ceases.

Various modifications of the circuits illustrated and described which are within the spirit and scope of the invention will occur to persons skilled in the art.

What is claimed is:

1. In combination in a two-way telephone system including two oppositely directed one-way signal transmission paths, one switching device connected to each path responsive to voice signal transmission therein, in the absence of prior voice signal transmission in the other path, to disable said other path and said one switching device connected thereto, a second relatively insensitive switching device connected to each path in front of the disabling point therein, responsive to voice signal transmission in that path of a level at least a given amount above average level to disable

said one switching device connected to the other path, means normally disabling each of said second switching devices, and means responsive to voice signal transmission in each path when that path is operative, for enabling the said second switching device connected to the other path a predetermined time after said one switching device connected to the first path has operated to disable said other path.

2. In a two-way telephone transmission system including oppositely directed one-way transmission paths for transmitting the voice signals in opposite directions, an echo suppressor device connected to each path, responsive to voice signal transmission in that path, in the absence of prior voice signal transmission in the other one-way path, to disable said other path, a normally disabled break-in control circuit connected to each path in front of the disabling point therein, which when operative is responsive to voice signal transmission in that path of a level at least a given amount above average level to disable the echo suppressor device controlled from the other path, and means responsive to voice signal transmission in each path when that path is operative to enable the break-in control circuit connected to the other path a given time after the echo suppressor device controlled from the first path operates in response to that voice signal transmission.

3. The system of claim 2 in which said given time after the echo suppressor device controlled from the first path operates is in the order of one-half of a second.

4. In combination in a two-way telephone system including two oppositely directed one-way transmission paths for respectively transmitting the voice signals of the subscribers generated at opposite ends of the system, one voice-operated switching device connected to each path, responsive to voice signal transmission over that path to disable the other path and effectively disable said one switching device connected thereto, so as to give directional control of the system to the subscriber who first starts to talk, means to enable break-in by a subscriber at either end of the system when the subscriber at the other end is talking and has obtained directional control of the system, comprising a relatively insensitive break-in control device connected to each path in front of the disabling point therein, operating only in response to applied voice signals of an amplitude level at least a given amount above normal level, to immediately disable the switching device controlled from the other path and means to prevent voice signal mutilation by reversals of directional control due to rapidly repeated interruptions of each other by the two talking subscribers, comprising means normally disabling each break-in control device and means responsive to operation of the said one switching device connected to each path to enable the break-in control device connected to the other path a given time after said other path has been disabled by that switching device.

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