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ECHO SUPPRESSOR

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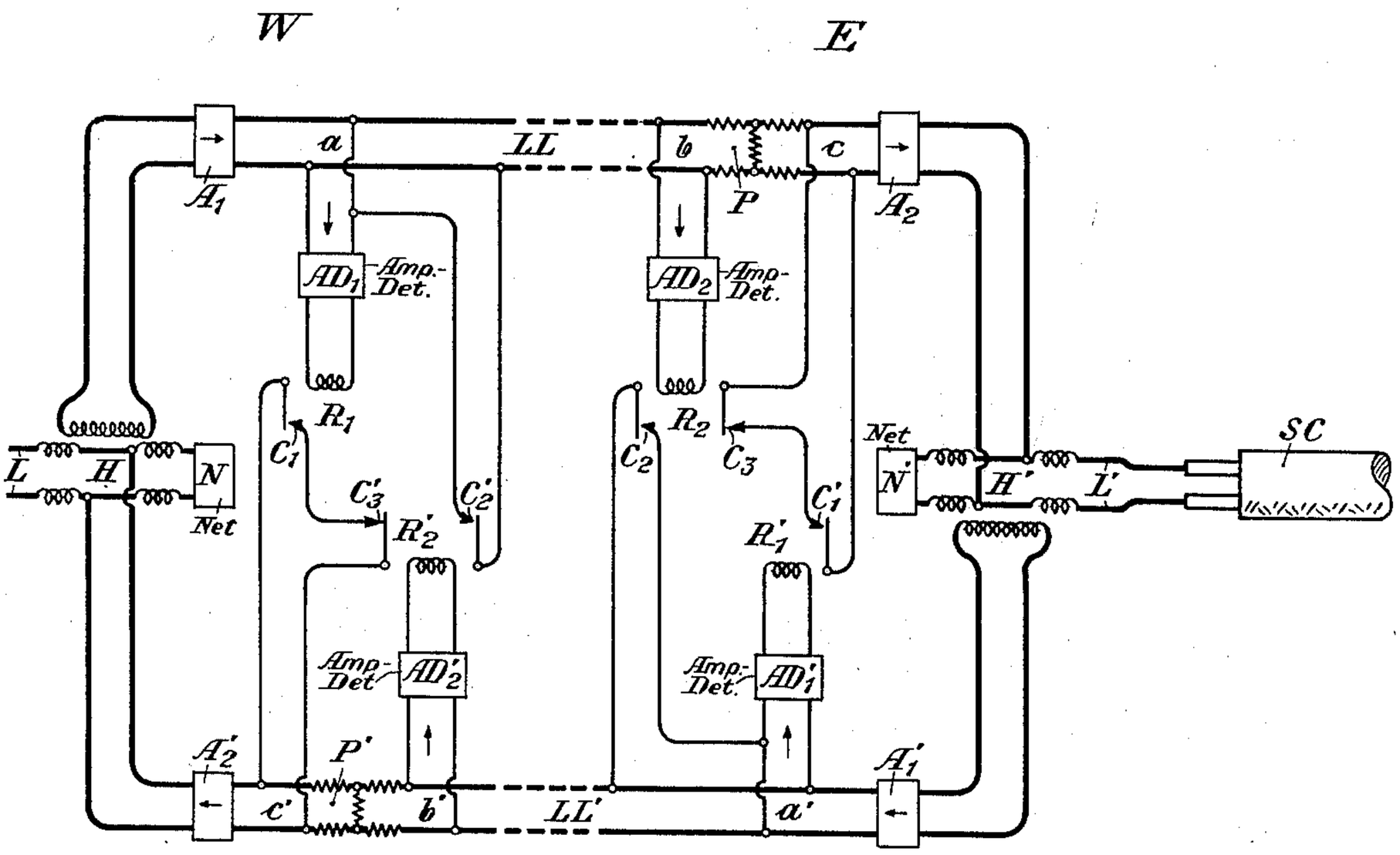

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ECHO SUPPRESSOR

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10 Claims. (Cl. 179—170)

This invention relates to two-way telephone systems, and more particularly to methods of and means for suppressing echoes in such systems.

The apparatus for the suppression of echoes which is used at present on many types of two-way telephone circuits is disclosed in its essentials in United States Patent No. 1,434,790, granted November 7, 1922 to John Mills, and in an article by A. B. Clark and R. C. Mathes, entitled "Echo suppressors for long telephone circuits", appearing in the Journal of the American Institute of Electrical Engineers, June 1925, pages 618 et seq.

The present invention is one of those made to solve the various problems of transmission control and echo suppression which arise as the principle disclosed in the above identified patent and article is applied—or as it is attempted to apply it—to the various types of communication systems or in connection with other devices for the improvement of long distance telephony.

Reference may be had to United States Patent No. 1,826,196, granted October 6, 1931 to the applicant in which there is disclosed the so-called "terminal echo suppressor". That arrangement was aimed at the substantial reduction of the "breaking time" and the lessening of the chance of mutual lockout, and has as one of its principal novel features the placing of the echo suppressor devices at the terminals of the circuit to which they are applied.

The present invention is designed to retain some of the advantages of the terminal echo suppressor—in particular, the reduction of the time required for one party to take control of the circuit after the other has stopped talking—and at the same time to provide proper suppression of echoes arising at intermediate points on the circuit, as will be more fully discussed hereinbelow.

This invention is applicable to many different types of two-way circuits. For instance, it is applicable to a four-wire circuit which is extended at one end by a land two-wire line and at the other end by a submarine cable circuit. Again, the four-wire circuit to the terminals of which the echo suppressor apparatus is directly applied may include sections intermediate to which are hybrid coils, no intermediate echo suppressor apparatus being applied.

In general, the applicant associates echo suppressor apparatus with each end of the four-wire circuit and arranges this apparatus so that voice waves which pass the apparatus at the talker's end of the circuit will reach the listener's end without fail and will disable the opposite path at the listener's end, and echoes from intermediate points on the four-wire circuit of voice waves traveling from either end thereof will be suppressed while the party at the end of origin continues to talk without interruption.

The invention will be clearly understood when the following detailed description of one desirable embodiment of the invention is read with reference to the accompanying drawing, the single figure of which shows diagrammatically and in part schematically the applicant's novel echo suppressor apparatus applied to the terminals of a four-wire circuit.

With reference to the details of the drawing, there is shown a four-wire circuit extending between a point W at the left and a point E at the right. This circuit is extended at its left end by a two-wire line L, which may be taken to be a land line. This connection is made through the hybrid coil H and the line L is balanced by the artificial network N. At the right end the four-wire circuit is extended by the two-wire line L′, which may be the circuit of a submarine cable SC. The connection to this extending circuit is made through the hybrid coil H′ and the network N′ balances the line L′, it being understood that any other suitable connection between the four-wire circuit and the two wire line may be utilized.

The four-wire circuit extending between points W and E comprises the two-wire path LL adapted for transmission from W to E, and the two-wire path LL′ adapted for transmission from E to W. It will be noted that the lines representing these two-wire paths are broken over the intermediate portion lying between the two sets of echo suppressor apparatus. It will be understood that the four-wire circuit may be very long and may have in its intermediate section hybrid coils or other arrangements which may produce unbalances. A circuit is contemplated which has no echo suppressor apparatus applied to it between the points W and E.

In the case of a long four-wire circuit such as that indicated above and suggested by the disclosure of the drawing, unbalances, temporary or otherwise, may produce what may be termed intermediate echoes; in other words, due to the unbalances, voice waves passing over one of the paths LL and LL′ may be reflected toward the talker. These unbalances or the equivalents may be produced by crosstalk between the two paths, by monitoring on the four-wire circuit and by

the application of hybrid coils without intermediate echo suppressors, for instances.

As indicated above, one of the principal objects of the present invention is the suppression of the intermediate echoes caused by unbalances produced between the points W and E.

In the path LL are the one-way amplifiers A_1 and A_2 at the ends W and E, respectively, and in the path LL' are the one-way amplifiers A'_1 and A'_2 at the ends E and W, respectively. Connected across the path LL at the point *a*, which, it is understood, is at or near the left terminal of the four-wire circuit, is the amplifier-detector AD_1 which has included in its output circuit the winding of a relay R_1. At the right end of the path LL at a point *b* there is connected the amplifier-detector AD_2, controlling a relay R_2. Similarly, the path LL' has connected across it at the point *a'* near its right end, an amplifier-detector AD'_1, controlling a relay R'_1; likewise, at the left end of the path LL' there is connected at the point *b'* an amplifier-detector AD'_2, controlling a relay R'_2. Relay R_1 controls a contact C_1, normally open; the relay R_2 controls a contact C_2, normally open, and a contact C_3, normally closed; relay R'_1 controls a contact C'_1, normally open; and relay R'_2 controls a contact C'_2, normally open, and a contact C'_3, normally closed. It will be noted that contacts C_1 and C'_3 are in series in a circuit connected across the path LL' at point *c'*, and that contacts C'_1 and C_3 are in series in a circuit connected across the path LL at point *c*.

The further details of the arrangement of the echo suppressor apparatus will be best understood from the following description and discussion of the operation of the circuit.

Let it be assumed first that the subscriber connected to the line L starts to talk and that the subscriber connected to the cable circuit L' is for the moment silent. The voice waves from the line L pass from W to E over the one-way path LL. At the point *a*, a portion of the energy of the voice wave is diverted and operates the amplifier-detector AD_1, which in turn causes the operation of relay R_1. The contact C_1 is now closed, and since the contact C'_3 remains closed, a short-circuit is placed on the transmission path LL' at the point *c'*. Because of this short-circuit any intermediate echoes arising as reflections of the voice wave passing from W to E over the path LL are suppressed at the point *c'* on the path LL'. When the voice wave traveling from W to E reaches the point *b* at the right end of the four-wire circuit, a portion of the energy is diverted to operate the amplifier-detector AD_2. This operation causes the operation of relay R_2, the closing of contact C_2 and the opening of contact C_3. The closing of contact C_2 short-circuits the transmission path LL' at its right end. This short-circuiting operation cuts off echoes tending to travel from E to W over the path LL' and prevents the response of amplifier-detector AD'_1 to waves in the path LL'. The opening of contact C_3 prevents the short-circuiting of the path LL at the point *c* in the case of the undesired operation of amplifier-detector AD'_1 and the closing of contact C'_1. Thus, it is seen that if the voice wave from the talker connected to line L reaches the right end of the four-wire circuit, it is enabled to pass on through the right terminal of the circuit to the line L'.

If, now, the subscriber at the right end of the system talks over line L' and the subscriber at the other end has paused long enough to allow the release of contact C_2, the voice wave from L' will pass from E to W over the line LL' of the four-wire circuit. The energy diverted at point *a'* operates amplifier-detector AD'_1 and relay R'_1 and contact C'_1 is closed, short-circuiting the path LL at point *c*. The voice wave in LL' passes on to the left end of the four-wire circuit and further energy is diverted at the point *b* to operate amplifier-detector AD'_2 and relay R'_2. Contact C'_2 is closed, whether the subscriber connected to line L has in the meantime resumed his talking or not. Likewise, whether or not this subscriber connected to line L is talking, the contact C'_3 is opened and the voice waves in LL' pass on to the left terminal of the four-wire circuit and over the line L.

It will be understood by those skilled in the art that amplifier-detector AD_2 or AD'_2 should be adjusted as to sensitivity (by means well known in the art) so that it will not operate in response to noise waves but will operate in response to comparatively weak speech.

It is seen from the above discussion that with the applicant's present arrangement of echo suppressor apparatus once a voice wave from the line L or L' has passed the echo suppressor at the near end of the four-wire circuit, it cannot be prevented from reaching the distant end. If, however, one talker takes control of the entire circuit and continues talking, voice waves in the opposite direction are cut off by a short-circuit. For instance, if the subscriber connected to line L takes control of the echo suppressor apparatus at W and the voice wave reaches E before the subscriber connected to line L' starts to talk, the voice wave from L will reach the right end of the circuit and the voice from L' is suppressed. If the voice wave from L' reaches point *a'* before the voice wave from L reaches the point *b*, then each voice wave passes on to its destination but succeeding waves may be cut off. It will be noted further that as long as one subscriber has control of both ends of the circuit echoes of his voice arising at intermediate points are cut off in the opposite transmission path.

A pad P is shown connected in the line LL between points *b* and *c*. The purpose of such a pad is to permit the amplifier-detector AD_2 to be operated by the voice wave from L even if a short-circuit has been applied at the point *c* through the operation of relay R'_1 and the closure of contact C'_1. Likewise, the pad P' shown in the line LL' between points *b'* and *c'* serves to permit the operation of amplifier-detector AD'_2 in spite of the temporary closure of contacts C_1 and C'_3. The pad P or the pad P' or both may be so constructed as to introduce a delay, serving to avoid clipping of the incoming speech and to prevent the escape of fast echoes. Reference may be had to United States Patent No. 1,607,687 to Nyquist.

While the invention has been disclosed in a specific embodiment which is deemed desirable for some systems, it is to be understood that its scope is not limited thereby but is determined by the appended claims.

Furthermore it is to be noted that, while the echo suppressing apparatus shown at one end of the four-wire circuit is described in combination with like apparatus at the other end of the circuit, and will be so employed on some systems, it is capable of use at one end of a two-way circuit to the other end of which there is applied a different arrangement of voice-operated apparatus. For instance, in the system

shown, comprising a four-wire circuit extended at W by a land line and at E by a submarine cable, the echo suppressor apparatus at W may be substantially as disclosed while the voice-operated arrangements at E are of a different type. It is to be understood that the duplicate showing of the echo suppressor apparatus applied to the four-wire circuit does not limit the invention, which resides as well in the use of such apparatus at one terminal—or in combination with different apparatus at the distant terminal.

What is claimed is:

1. In a two-way telephone circuit including paths adapted for transmission in opposite directions, the method of transmission control and echo suppression which consists in causing the incoming voice waves near either end of the circuit to disable the outgoing path, causing the outgoing voice waves near either end of the circuit to disable the incoming path, provided said path is not carrying voice waves of earlier arrival, and causing the incoming voice waves near either end of the circuit to prevent the disabling of the incoming path or, if said path be already disabled, immediately to restore it to operative condition.

2. In a two-way telephone circuit including paths adapted for transmission in opposite directions, apparatus relatively near each end of the circuit comprising means whereby the outgoing path will be disabled in response to voice waves in the incoming path, means whereby the incoming path will be disabled in response to voice waves in the outgoing path of earlier arrival than waves in the incoming path, and means responsive to voice waves in the incoming path for preventing the subsequent disabling of said path and for restoring the same to operative condition if it be already disabled.

3. In a two-way telephone circuit including paths adapted for transmission in opposite directions, echo suppressor apparatus associated with each end of the circuit and so arranged that voice waves which pass the apparatus at the talker's end will reach the listener's end and will at all times disable the opposite path, and echoes from intermediate points on the circuit of voice waves traveling from the talker's end thereof will be suppressed before they reach said talker's end while the party at the end of origin continues to talk without interruption.

4. In a two-way telephone circuit including paths adapted for transmission in opposite directions, echo suppressor and associated apparatus near each end of the circuit, said apparatus comprising means responsive to voice waves in the outgoing path for closing a circuit designed to short-circuit the incoming path, means responsive to voice waves in the incoming path for at all times disabling the outgoing path without substantial delay, and means responsive to voice waves in the incoming path for opening the circuit designed to short-circuit said path.

5. In a two-way telephone circuit including paths adapted for transmission in opposite directions, the method of transmission control and echo suppression which consists in causing the incoming voice waves near one end of the circuit to disable the outgoing path, causing the outgoing voice waves near said end of the circuit to disable the incoming path, provided said path is not carrying voice waves of earlier arrival, and causing the incoming voice waves near said end of the circuit to prevent the disabling of the incoming path, or if said path be already disabled, immediately to restore it to operative condition.

6. In a two-way telephone circuit including paths adapted for transmission in opposite directions, apparatus near one end of the circuit comprising means whereby the outgoing path will be disabled in response to voice waves in the incoming path, means whereby the incoming path will be disabled in response to voice waves in the outgoing path of earlier arrival than waves in the incoming path, and means responsive to voice waves in the incoming path for preventing the subsequent disabling of said path and for restoring the same to operative condition if it be already disabled.

7. In a two-way telephone circuit including paths adapted for transmission in opposite directions, voice operated control apparatus associated with each end of the circuit, said apparatus at a certain near end of the circuit being so arranged that voice waves which pass the apparatus at the distant end will reach said near end and will at all times disable the opposite path at said near end, and echoes from intermediate points on the circuit of voice waves originating at the talker's end thereof will be prevented from reaching said talker's end while the party at the end of origin continues to talk without interruption.

8. In a two-way telephone circuit including paths adapted for transmission in opposite directions, echo suppressor and associated apparatus near one end of the circuit, said apparatus comprising means responsive to voice waves in the outgoing path for closing a circuit designed to short-circuit the incoming path, means responsive to voice waves in the incoming path for at all times disabling the outgoing path without substantial delay, and means responsive to voice waves in the incoming path for opening the circuit designed to short-circuit said path.

9. In a two-way telephone system, a four-wire circuit having paths adapted for transmission in opposite directions; apparatus near one end of said four-wire circuit comprising means whereby the outgoing path will be disabled in response to voice waves in the incoming path, means whereby the incoming path will be disabled in response to voice waves in the outgoing path of earlier arrival than waves in the incoming path, and means responsive to voice waves in the incoming path for preventing the subsequent disabling of said path and for restoring the same to operative condition if it be already disabled; a two-wire line connected in extension of said four-wire circuit at one end thereof, and a submarine cable circuit connected in extension of said four-wire circuit at the other end thereof.

10. In a two-way system for the transmission of energy, comprising two separated stations connected by two paths adapted for transmission in opposite directions, the method of transmission control which consists in causing the energy in one of said paths to disable the opposite path at both of said stations, and causing the energy received at one of said stations over said opposite path to prevent said path from being disabled at said station by energy in the first mentioned path, or if it be already disabled, immediately to restore it to operative condition.

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