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ECHO SUPPRESSOR

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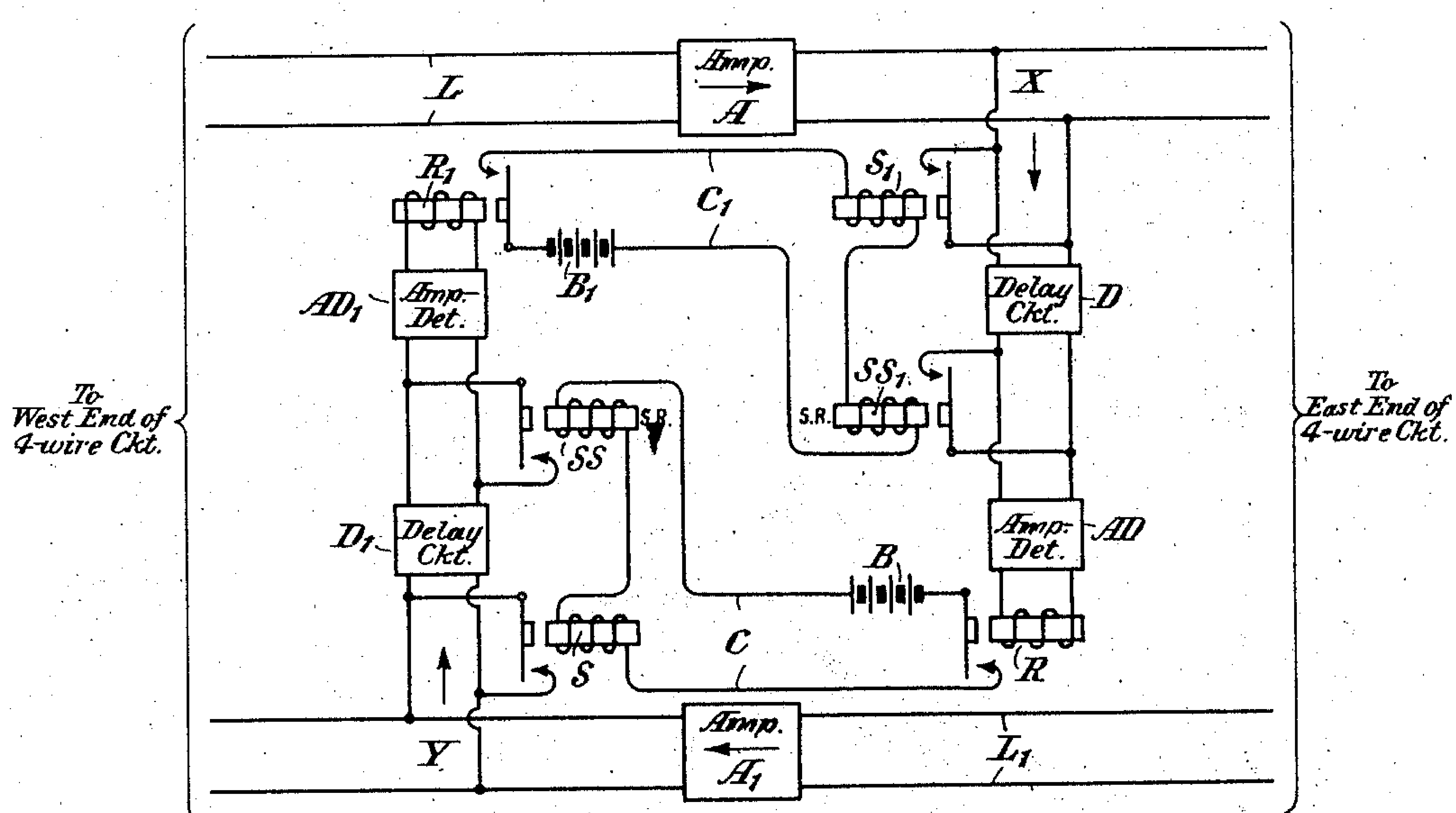
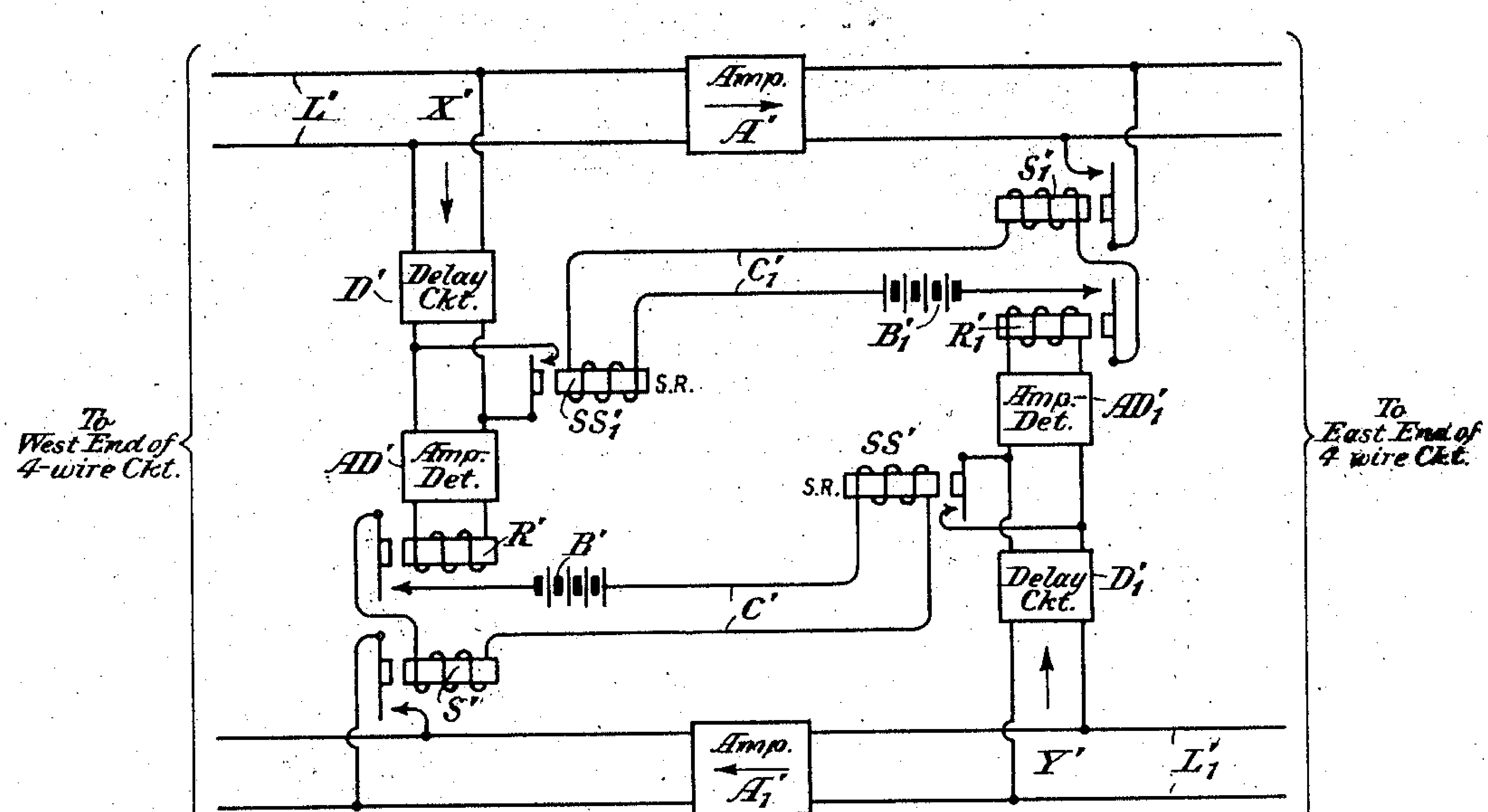


Relays R, S, R_1, and S_1 have practically no hangover. Relays SS and SS_1 have hangover equal to delay of D or D_1.

Fig. 1



Relays R', S', R_1', and S_1' have practically no hangover. Relays SS' and SS_1' have hangover equal to delay of $D' + D_1'$.

Fig. 2

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ECHO SUPPRESSOR

Application filed February 20, 1929. Serial No. 341.540.

This invention relates to four-wire transmission circuits, and more particularly to means for suppressing echoes in such circuits.

For a discussion of some of the fundamental problems connected with the presence of echoes in two-way transmission circuits and for a description of echo suppressing devices which are among those better known in the art, reference may be had to an article by A. B. Clark and R. C. Mathes, Journal of the American Institute of Electrical Engineers, June, 1925, pages 618–626.

In a four-wire circuit, the echo suppressor—which includes two amplifier-detectors, each having its input connected across one of the two-wire transmission paths and each operating a relay or a plurality of relays to block the opposite transmission path and to prevent false operation of the opposite amplifier-detector—may be located approximately at the middle of the four-wire circuit. In this case, the relays controlling the short-circuiting of the transmission paths must have a slow release period equal to the time required for a wave to go from the echo suppressor point to either end of the circuit, plus the time required for the echo to return to the suppressor point; accordingly, the transmission path is blocked for a period of time considerably greater than that during which the echo is present in the system, especially if the circuit is a long one.

In accordance with another arrangement, the amplifier-detectors and the relays controlled by them are separated, one amplifier-detector and its associated relays being located at each end of the four-wire circuit. In this case, the hang-over of the relays which short-circuit the two-wire paths may be reduced to a very short period of time, and accordingly the transmission circuit is blocked only while an echo is actually present in the system. However, with this arrangement, if the talker at the west end of the circuit, for instance, and the talker at the east end of the circuit begin to speak at practically the same time, both amplifier-detectors will be operated, and as a result, speech will be completely blocked in both transmission paths. This serious disadvantage is overcome if telegraph circuits are employed, one in association with each amplifier-detector to operate a relay at the distant end for the purpose of disabling the distant amplifier-detector when the near-end talker begins to speak. The necessarily long and extremely fast operating telegraph circuits are, however, very expensive, and thus the arrangement will, in many cases, be impracticable.

The object of the present invention is to provide an echo-suppressing arrangement which combines the above-mentioned advantages without the requirement of fast operating and expensive telegraph circuits. More specifically, the invention aims to secure in an economical fashion the satisfactory suppression of echoes while avoiding excessively long blocking of one transmission path and the likelihood of complete blocking of speech in both paths.

In general, the applicants, in attaining the above stated object, provide a voice-operated device connected across each of the two-wire paths of the four-wire circuit—approximately at the midpoint of the circuit, for instance—means responsive to the operation of each voice-operated device for blocking the opposite transmission path and disabling the voice-operated device connected across that path, and means associated with the input of each voice-operated device for delaying the operation of the device over the period of time required for a wave to travel from the point of connection in one transmission path to the corresponding point in the opposite transmission path.

The invention will be clearly understood when the following detailed description is read with reference to the accompanying drawing. Figure 1 of the drawing shows diagrammatically, and in part schematically, one desirable form of the invention, while Fig. 2 shows in like manner a slightly modified form.

With reference, first, to Fig. 1 of the drawing, there is shown the mid-section of a four-wire transmission circuit, the ends of this circuit being designated for convenience "West" and "East". The upper two-wire path L is adapted for transmission from west to east and includes the one-way amplifier A. Similarly, the lower two-wire path L_1 is adapted for transmission from east to west and includes the one-way amplifier A_1. An amplifier-detector AD is connected across the transmission path L at a point X through a delay circuit D. A relay R is connected in the output of the amplifier-detector AD and is designed to close a circuit through a battery B and the windings of relays S and SS. The latter relay is slow releasing. The short connecting circuit, which provides for the control of relays S and SS in response to the operation of relay R, is designated C.

An amplifier-detector AD_1 is connected across the transmission path L_1 at a point Y through a delay circuit D_1. The amplifier-detector AD_1 controls a relay R_1 which, in turn, is designed to close a circuit through a battery B_1 and relays S_1 and SS_1. The relay SS_1 is slow releasing. The short circuit connecting the relay R_1 with the relays S_1 and SS_1 is designated C_1. It is to be noted that the relay S_1, upon operation, places a short-circuit across the branch path from the point X in line L at a point ahead of the delay circuit D, while the relay SS_1 is designed to short-circuit the branch path between the delay circuit D and the input of the amplifier-detector AD. It will be noted further that the functions of these two relays correspond to the functions of relays S and SS, respectively, on the other side of the echo suppressor circuit.

The delay introduced by the delay circuit D or by the delay circuit D_1 is equal to the period of time required for a wave to travel from the point of connection of the echo suppressor in one transmission path to the corresponding point in the opposite transmission path. More specifically, D introduces a delay of the time required for a wave to travel from X in path L to the east end of the two-way circuit and back (as an echo) to the point Y in path L_1, while D_1 introduces a delay equal to the time required for a wave to travel from Y to the west end of the two-way circuit and back (as an echo) to the point X.

The operation of the circuits of Fig. 1 will now be described.

Let it be assumed that the talker at the west end of the two-way circuit wishes to take control and that there is no speech coming at the moment from the east end of the circuit. The voice currents pass over the two-wire line L through the amplifier A and on to the east end of the circuit where they may be reflected back over the path L_1 as echoes. A part of the currents in L will be drawn off at X into the branch path toward the amplifier-detector AD. In response to the operation of AD, the relay R closes the circuit C and causes the operation of relay S and the operation of relay SS. Since relays R and S are quick-operating, a short-circuit will be placed on the line L_1 at Y practically immediately in response to the operation of the amplifier-detector AD. The delay circuit D, however, delays the operation of the amplifier-detector over a period of time equal to that required for the currents to flow from X to the east end of the circuit and back to Y. Therefore, the short-circuit is placed on line L_1 at Y just at the time when the echo from the east end of the circuit arrives at Y. Assuming that there is no circuit of considerable length connected to the east end of the four-wire circuit, no hang-over of the relay S will be required, and the path L_1 will be blocked only for the time required to cut off the echo. It will be seen hereinafter that the connection to the four-wire circuit of a two-wire circuit, or of a combination of two-way circuits, calls for a short hang-over.

It is, of course, possible that immediately after the talker at the west end of the circuit has started to speak, the talker at the east end may attempt to take control of the circuit. In this case, the voice currents in the line L_1 would reach the point Y before the echoes of the voice currents originating at the west end and traveling over the line L. The voice energy passed into the branch path at Y may be stored up in the delay circuit D_1 and would eventually cause the operation of the amplifier-detector AD_1. The short-circuit placed on the branch path from Y by the relay S disables the amplifier-detector AD_1 and also places a short-circuit on the input of the delay circuit D_1. This relay S, however, does not operate until after the delay introduced by the circuit D. Accordingly, it becomes necessary to prevent the delayed operation of the amplifier-detector AD_1 and the resultant false blocking of the path L by the currents stored up in the circuit D_1 as a result of the speech from the east end of the circuit. The prevention of this false operation of amplifier-detector AD_1 is the function of relay SS. This relay is given a hang-over long enough to hold the short-circuit on the input of amplifier-detector AD_1 until the delayed currents have passed through the delay circuit D_1. This slow release period would, of course, be approximately equal to the delay introduced by the delay circuit D_1.

The operation of the echo suppressor circuits in response to voice currents from the east end of the two-way circuit is of course similar to the operation responsive to voice currents in the line L. The amplifier-detector AD_1 is operated, but only after the delay introduced by the delay circuit D_1. The amplifier-detector operation causes the operation of relays R_1, S_1, and SS_1. Relay S_1 places a short-circuit on the transmission line L at

X and also shorts the input to the delay circuit D. Relay SS_1 functions to prevent the false operation of amplifier-detector AD by voice currents in line L which have passed through to the circuit D before the operation of relay S_1 and have been stored up in the delay circuit.

As indicated above, circuits connected to the ends of the four-wire circuit, if of considerable length, introduce the requirement of a certain hang-over in the release of relay S or relay S_1. In a long circuit, the time required for a wave to pass from the midpoint of the four-wire circuit to an end of the two-way circuit and back to the echo suppressor point, may be .2 second or greater. If the transmission path is blocked for a period of .2 second or longer, it becomes difficult for a talker to break the control from the opposite end and take control himself. In a very long four-wire circuit having circuits connected to its ends of considerable length, the use of the ordinary type of echo suppressor would require a hang-over for the two-wire blocking relays of about .35 second. This long hang-over of course would cause difficulty in breaking between the two talkers. However, assuming that the delay time of the four-wire circuit is .25 second, and the additional delay of .1 second is required by the connected circuits, it is evident that if the applicants' improved echo suppressor is employed, the necessary hang-over of the relays S and S_1 may be reduced from .35 second to .1 second.

A further advantage of the applicants' arrangement is found in the fact that since the delay circuits are used only in the branch paths for the control of the echo suppressor and not in the main transmission paths, a relatively inexpensive type of mechanical or accoustic delay circuit may be employed in place of the delay circuits often used in the transmission paths.

The arrangements of echo-suppressor circuits shown in Fig. 2 of the drawing are somewhat similar to those shown in Fig. 1 but differ from the circuits of Fig. 1 in that the functions of actually suppressing echoes in the transmission path and preventing false operation of the opposite echo suppressor devices are separated. The various elements of Fig. 2 are designated by the same reference letters as the corresponding elements of Fig. 1 except that the letters of Fig. 2 are primed. It is believed that the circuits of Fig. 2 will be understood with sufficient clarity from the following brief description of their operation.

If the talker at the west end is the first to speak, the amplifier-detector AD′ is operated after the delay introduced by the delay circuit D′. Relay R′ closes the circuit C′ through the battery B′ and relays S′ and SS′. Relay S′ places a short-circuit on the line L'_1 at a point near the mid-point of the four-wire circuit, for instance, and relay SS′, which is slow-releasing, prevents the operation of amplifier-detector AD'_1 and the echo suppressor relays controlling the line L′.

Similarly, voice currents in the line L'_1 cause the delayed operation of amplifier-detector AD'_1, which operation closes the circuit C'_1 through battery B'_1 and relays S'_1 and SS'_1. Relay S'_1 shorts line L′ and relay SS'_1 prevents the false operation of amplifier-detector AD′ and the relays controlled thereby.

Relays SS′ and SS'_1 should each have a hang-over equal to the delay of D″ plus the delay of D'_1.

While the invention has been disclosed in two specific embodiments which are deemed desirable, it is to be understood that its true scope is not limited thereby but is to be determined from the appended claims.

What is claimed is:

1. In a four-wire circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, a voice-operated device connected across each of said paths, means responsive to the operation of each of said voice-operated devices for blocking the opposite transmission path and disabling the voice-operated device connected across said opposite path, and means associated with each of said voice-operated devices for delaying the operation thereof over a period of time not greater than that required for a wave to travel from the point of connection in one transmission path to the corresponding point in the opposite transmission path.

2. In a four-wire circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, a voice operated device connected across each of said paths, means responsive to the operation of each of said voice-operated devices for blocking the opposite transmission path and disabling the voice-operated device connected across said opposite path, means associated with each of said voice-operated devices for delaying the operation thereof over a period of time not greater than that required for a wave to travel from the point of connection in one transmission path to the corresponding point in the opposite transmission path, and means associated with each of said voice-operated devices for holding the device in its disabled condition to prevent false operation thereof.

In testimony whereof, I have signed my name to this specification this 18th day of February, 1929.

DOREN MITCHELL.

In testimony whereof, I have signed my name to this specification this 13th day of February, 1929.

HAROLD C. SILENT.