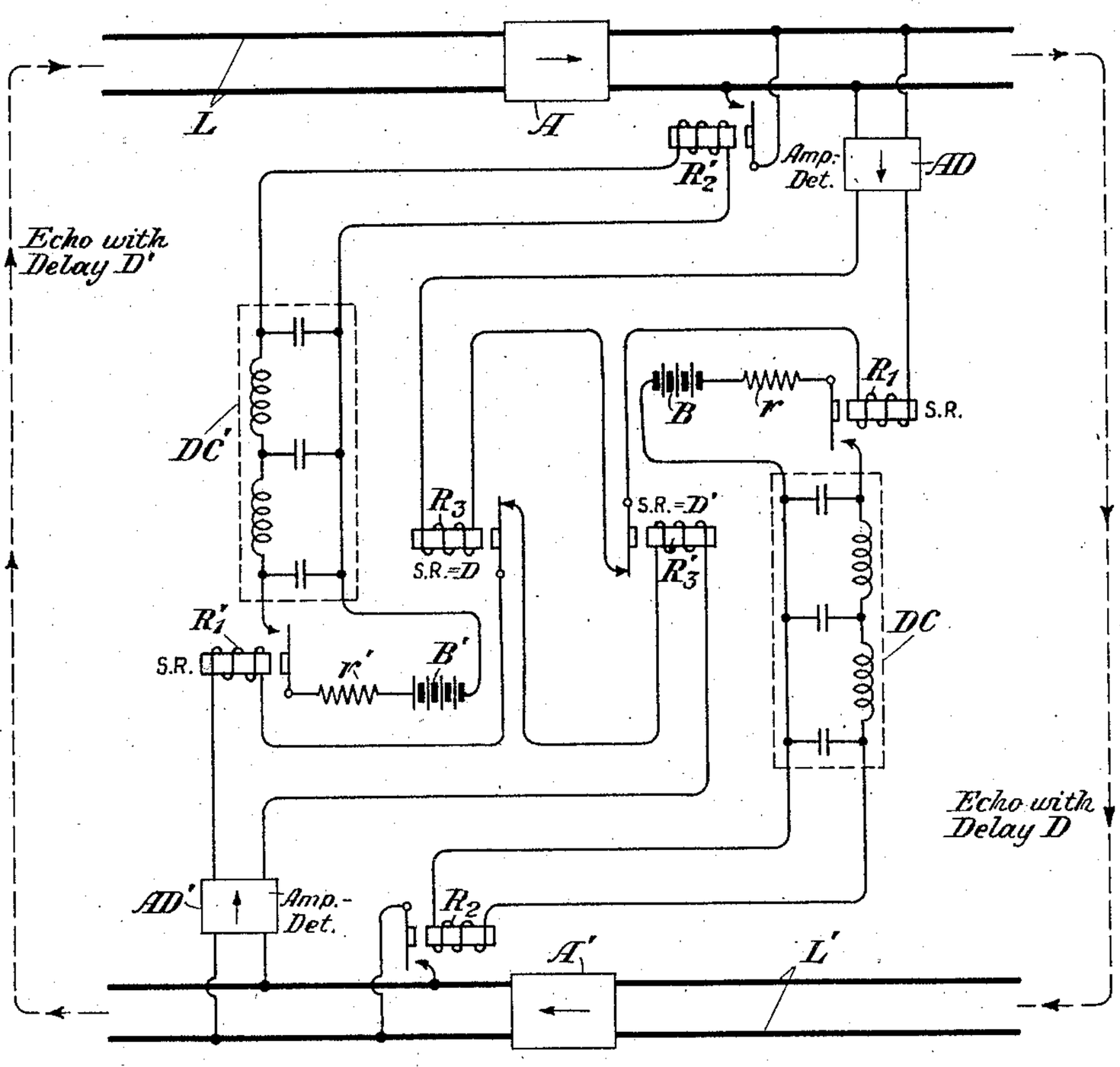
Aug. 12, 1930. D. MITCHELL ET AL 1,772,552

ECHO SUPPRESSOR

Filed Feb. 20, 1929



INVENTORS

D. Mitchell and J. Herman

BY

J E Foe

ATTORNEY

Patented Aug. 12, 1930 1,772,552

UNITED STATES PATENT OFFICE

DOREN MITCHELL, OF NEW YORK, N. Y., AND JOSEPH HERMAN, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

ECHO SUPPRESSOR

Application filed February 20, 1929. Serial No. 341,544.

This invention relates to two-way transmission circuits, and more particularly to four-wire circuits and the apparatus often associated therewith for suppressing echoes.

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.

It is often necessary, especially in long two-way circuits, to provide a hang-over or slow release period of considerable length for a transmission circuit blocking relay of the echo suppressor in order to provide full echo suppression and to prevent false operation of the opposite blocking relay. This hang-over period may render it difficult for the "listener" to interrupt the speaker. The time during which the return path is blocked may be greatly reduced and breaking made easier if a delay is introduced in the echo suppressor circuit such that a transmission circuit is blocked only while an echo is actually present in the system. If a delay is introduced in the echo suppressor circuit ahead of the amplifier-detector a voice frequency delay circuit is required, and such a device is quite expensive.

The object of the present invention is to introduce the desired delay in the echo suppressor circuit without the requirement of the expensive voice frequency delay circuit.

In attaining this object the applicants take the voice energy from one side of the usual four-wire circuit, detect this energy, delay the transmission through the echo suppressor circuit of the direct current component and then apply the delayed current to block the opposite side of the four-wire circuit.

The invention will now be clearly understood when the following detailed description of one suitable system for accomplishing the desired result is read with reference to the accompanying drawing, which shows diagrammatically, and in part schematically, the echo suppressor circuits applied.

With reference to the details of the drawing, there is shown a section of a four-wire circuit having a two-wire line L adapted for transmission from west to east, for instance, and a second two-wire line L′ adapted for transmission from east to west. One-way amplifiers A and A′ are included in the lines L and L′, respectively. It is to be understood that the echo suppressor is so located with respect to the ends of the four-wire circuit that transmission over line L may produce an echo which returns to the echo suppressor point in line L′ with a delay D, while transmission over line L′ may produce an echo returning to the echo suppressor point in line L with a different delay D′.

An amplifier-detector AD is connected across the line L, as shown in the drawing. This amplifier-detector functions ultimately to operate a relay R_2 which places a short-circuit on the line L′. It is the applicants' purpose to delay the operation of relay R_2 so that the relay will not operate until the instant when the echo from the east end of the circuit reaches the echo suppressor point in line L′. If the necessary delay is obtained in the voice range by means of an electrical delay circuit the device introduced in the echo suppressor system will be cumbersome and costly. An acoustic delay device might be employed, but such a device also is cumbersome. No mechanical delay device has yet been developed which would be reliable for the present purpose. Accordingly, the applicants employ the following novel circuit arrangement whereby a low frequency delay circuit may be used.

The amplifier-detector AD operates, in response to waves in line L, a relay R_1 and also a relay R_3, to be discussed hereinafter. The relay R_1 upon operation closes a circuit through a battery B, a resistance r, a low frequency delay circuit DC, and the winding of relay R_2. The delay circuit DC is made up of condensers and standard coils of very high inductance, and can be constructed quite cheaply. This delay circuit has a very low cut-off frequency, 10 or 20 cycles, perhaps. The delay circuit is adjusted to give the required delay in the operation of relay R_2; that is, the low frequency component re-

sulting from the detection in the device AD is held up over a period of time such that the operation of relay R_2 will occur just at the instant that the echo of delay D reaches the echo suppressor point in line L′. It will be noted that relay R_1 is slow releasing. In the absence of this slow release feature of relay R_1 short impulses of speech, which might cause serious echoes, would not hold relay R_1 long enough to send a current through the delay circuit DC and the echo suppressor would fail to operate relay R_2. If, however, a proper hangover is provided for the relay R_1, even a very short speech impulse will cause this relay to transmit through the delay circuit DC an impulse of sufficient length to operate the shorting relay R_2. The slow release period should be such that the impulses transmitted through the delay circuit will have a duration of approximately $\frac{1}{fc}$ at least, where *fc* is the cut-off frequency of the delay circuit DC.

On the other side of the four-wire circuit the amplifier-detector AD′ responds to waves in line L′ and causes the operation of relay R'_1 and a second relay R'_3. Relay R'_1 upon operation closes a circuit through a battery B′, a resistance *r′*, the delay circuit DC′, and the winding of relay R'_2, which is the shorting relay for line L. The delay circuit DC′ corresponds to the delay circuit DC described above and introduces a delay of the low frequency component corresponding to the delay of the echo returning from the west end of the four-wire circuit over line L to the echo suppressor point. In order that even a very short impulse may cause the proper operation of relay R'_2, the relay R'_1 has a delayed release such as that described above in connection with relay R_1.

If the talker at the west end of the four-wire circuit begins to speak over line L, and immediately thereafter the talker at the east end begins to speak, the original voice waves in line L′ may operate amplifier-detector AD′ and tend to operate relay R'_1, which would cause false operation of relay R'_2. In order to prevent such false operation the relay R_3, which is controlled by the amplifier-detector AD, is given a slow release period equal to D, the delay of the echo returning from the east end of the circuit over line L′. The relay R_3 thus serves to disable the suppressor operated from L′ and thus prevent false operation of relay R'_2 in response to delayed energy in the echo suppressor by breaking the circuit through relays R'_1 and R'_3. Likewise, relay R'_3, having a slow release period equal to D′, is associated with amplifier-detector AD′ and serves to prevent false operation of shorting relay R_2 by delayed energy through the breaking of the circuit through relays R_1 and R_3.

The above expedients are resorted to in order that the talker whose waves first reach the suppressor may take complete control of the device and suffer no interruption due to the later talker. This does not, of course, prevent the other talker from speaking between the pauses of the first talker.

Proper attention must be given, of course, to the termination of the delay circuits DC and DC′, with a view to the matching of impedances. The resistances *r* and *r′* shown in series with batteries B and B′, respectively, or the resistance of the relays R_2 and R'_2 may be adjusted to effect the proper impedance matching.

While the invention has been disclosed in one embodiment which is deemed desirable, it is to be understood that this specific disclosure is for the purpose of illustration and does not limit the scope of the invention, which is to be determined from the appended claims.

What is claimed is:

1. In an echo suppressor designed to operate in response to voice waves in one side of a two-way circuit to block the opposite side of the circuit, the method of obtaining delayed action of the suppressor which consists in taking the voice energy from one side of the circuit, detecting said energy, delaying the transmission through the suppressor of the direct current component, and then applying the delayed current to block the opposite side of the circuit.

2. In a two-way circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, an amplifier-detector associated with the first path, means controlled thereby for blocking the second path, and a low frequency delay circuit interposed between the output of said amplifier-detector and said blocking means for delaying the operation of said blocking means in response to waves in the first path.

3. In a four-wire circuit having one path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, an amplifier-detector connected across each of said paths, switching means associated with each path for placing a short-circuit thereon, said switching means being controlled by the amplifier-detector connected across the opposite path, a low frequency delay circuit interposed between the output of each amplifier-detector and the short-circuiting switching means controlled thereby, and means responsive to the operation of each amplifier-detector for preventing the short-circuiting of the path associated therewith.

In testimony whereof, we have signed our names to this specification this 18th day of February, 1929.

DOREN MITCHELL.
JOSEPH HERMAN.