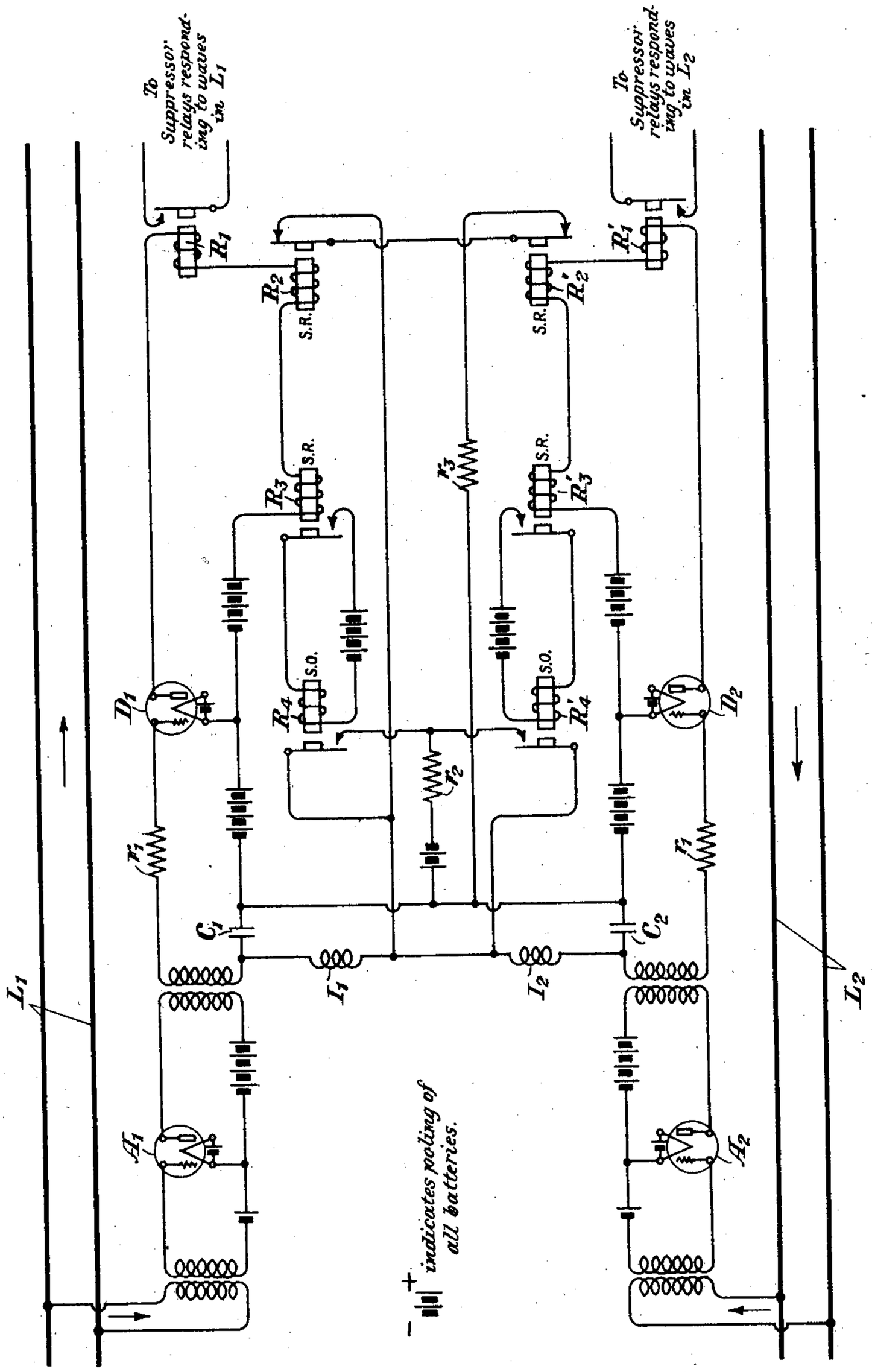
July 14, 1931. D. MITCHELL 1,814,052

ECHO SUPPRESSOR

Filed Feb. 20, 1929



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Patented July 14, 1931

1,814,052

UNITED STATES PATENT OFFICE

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ECHO SUPPRESSOR

Application filed February 20, 1929. Serial No. 341,543.

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.

The applicant's invention is applicable to voice-operated echo suppressors such as that disclosed in the above identified article. The principal object of the invention is to prevent false operation of the echo suppressor relays by noise without excessive reducing the sensitivity of the echo suppressor.

In attaining the above stated object, the applicant in general associates with the detector tubes means responsive to noise in the transmission circuit for raising the threshold of operation of the detector to a degree just sufficient to prevent operation by the noise, along with means for producing the necessary lowering of the threshold when the noise is decreased.

The invention will be clearly understood when the following detailed description of one desirable embodiment thereof is read with reference to the accompanying drawing, which shows diagrammatically the circuits of the improved echo suppressor.

With reference to the details of the drawing, there is shown a section of a four-wire circuit having the upper two-wire line L_1 adapted for transmission from west to east, for instance, and the lower two-wire line L_2 adapted for transmission from east to west.

Connected across the line L_1 is a vacuum tube amplifier A_1 which has its output associated with the input of a three-electrode vacuum tube detector D_1. In the grid-filament circuit of the detector D_1 are a condenser C_1 which is preferably of several microfarads, and a resistance r which may have a value of several hundred thousand ohms.

Three relays R_1, R_2, R_3 have their windings connected in series in the plate circuit of detector D_1. Relay R_1 controls the circuit to the usual echo-suppressor relays directly controlling the blocking of line L_2 in response to the waves in line L_1, this apparatus being fully disclosed and discussed in the above identified article by Clark and Mathes. Relays R_2 and R_3 are slow releasing. It is important that these three relays have the proper relative sensitivities. The most sensitive of the three relays is the slow-release relay R_2. Next in order, with respect to sensitivity, is relay R_3 which, as indicated above, is slow releasing and controls a slow operating relay R_4, as indicated in the drawing. Relay R_1, which may be termed the "echo suppressor relay", is made slightly less sensitive than relay R_3. As will appear more clearly hereinafter, relay R_4 controls in part the charging circuit of condenser C_1.

While it is quite feasible to utilize relays R_2, R_3, and R_4 to control the sensitivity of the opposite echo suppressor, as well as the sensitivity of the apparatus now under discussion, by suitable connection of extra windings of relays R_2 and R_3, such an arrangement has one disadvantage, as will appear hereinafter, and accordingly these relays are duplicated on the opposite side of the circuit.

Connected across the line L_2 is the amplifier-detector arrangement A_2—D_2. A condenser C_2 and a resistance r'_1 in the input of the detector D_2 correspond to the elements C_1 and r_1 on the other side of the circuit. In the plate circuit of the detector D_2 are relays R'_1, R'_2, and R'_3, this last relay controlling a relay R'_4. Relays R'_2 and R'_3 are slow releasing, while relay R'_4 is slow operating. As is the case on the opposite side of the circuit, relay R'_2 is the most sensitive of the three relays in the detector plate circuit, with relay R'_3 somewhat less sensitive and the echo suppressor relay R'_1 slightly less sensitive than relay R'_3.

It is believed that an understanding of the invention will be best advanced by the

following description of the operation of the circuits.

If a talker at the west end of the circuit produces waves traveling from left to right in line L_1, it is of course desired to block the opposite transmission path L_2 in order to cut off the returning echoes and to effect certain other switching operations, for a discussion of which reference may be had to the above identified Clark and Mathes article.

Futhermore, it is of course desirable that the echo suppressor apparatus should have considerable sensitivity in order that all appreciable echoes may be suppressed. However, if the echo suppressor has a fixed sensitivity, it will readily be understood that operation may result from noise currents in the transmission path and that false blocking of the four-wire circuit will thus be effected. Accordingly, it is desired to provide some means for reducing the sensitivity of the echo suppressor when noise currents flow in the four-wire circuit, without, however, rendering the suppressor insufficiently sensitive to voice currents. With the applicant's arrangement, the apparatus for suppressing echoes is normally in the condition of maximum sensitivity. The bias on the grid of the detector tube D_1, for instance, is of normal value since the condenser C_1 is in a completely discharged condition, a circuit being closed through the armature of relays R_2 and R'_2 and resistance r_3. Accordingly, if voice waves pass over line L_1, for instance, the relay R_1 will operate in the normal way to cut off the echoes in line L_2. It should be borne in mind that relay R_1 is slightly less sensitive than relay R_3 and considerably less sensitive than relay R_2. Accordingly, normal voice waves in line L_1 will, through the detector D_1, operate not only relay R_1 but also relay R_2 and relay R_3. Since there is no charge on condenser C_1, this operation of relay R_2 is immaterial. Likewise for normal amplitude of voice waves, the operation of relay R_3 will not be sufficiently long to cause the operation of relay R_4 which is slow operating. Thus it is seen that the bias on the detector tube D_1 remains substantially normal during ordinary speech.

Occasional peaks of speech, however, may cause the flow of some grid current in detector D_1, and condenser C_1 will be charged so as to increase momentarily the negative bias on the detector tube. The result, of course, is a slight reduction of the sensitivity of the echo suppressor. This slight reduction is, for practical purposes, unobjectionable, since it is caused only by speech sufficiently loud to insure full operation of the echo suppressor apparatus. The irregular sensitivity reduction effect, however, can be minimized if the resistance r_1 in the grid circuit of detector D_1 is made sufficiently large. The effect of making this resistance very large is that any grid current resulting from the speech peaks will be so small that practically no charging of condenser C_1 will be caused, it being borne in mind that the capacity of this condenser is quite high.

If, now, noise currents are present in line L_1 of sufficient amplitude to cause false operation of relay R_1 and the relays controlled thereby, relay R_2 will be operated and will break the short-circuit on condenser C_1. Likewise relay R_3 will operate. If the noise is of a fairly steady nature and holds relay R_3 in operated condition for a sufficiently long period, the slow operating relay R_4 will be operated and a circuit will be closed through condenser C_1, a battery, resistance r_2, and inductance I_1. The result will be additional negative grid bias on the detector tube D_1. This additional negative bias causes, of course, a reduction of the sensitivity of the echo suppressor by raising the threshold of operation of the detector D_1, and this threshold increase will obtain as long as the plate current due to the steady noise is sufficient to operate relay R_3. When the plate current in the detector is reduced below the point at which relay R_3 operates, the relay of course releases and the charging of condenser C_1 is interrupted. Since relay R_2, however, is more sensitive than relay R_3, the noise continues to hold it operated and thus the condenser C_1 cannot discharge through the armature of relay R_2. Since the capacity of this condenser is large, the loss of the condenser charge will be very slow and accordingly the threshold of operation of the detector tube D_1 will remain practically constant. There may, however, be slight readjustments from time to time, as will be readily understood, offsetting any condenser leakage that may occur.

If, now, the noise in line L_1 ceases or decreases greatly, relay R_2 will release and condenser C_1 will be discharged through resistance r_3, this discharge being somewhat slow. If there is no return to great amplitude of noise current, the discharge of the condenser will be completed and the system will be returned to the normal condition. That is, the condenser discharge will continue until the discharge circuit is again broken by the operation of relay R_2.

It is apparent that the proper reduction of echo-suppressor sensitivity is accomplished in response to noise on either side of the circuit. As indicated above, it will be possible to connect the amplifier-detector A_2—D_2 and the condenser C_2 with relays R_2 and R_3 through extra windings of those relays, but this introduces the disadvantage that, if noise occurs on both sides of the circuit there is excessive reduction of sensitivity since the plate currents of the two detectors D_1 and

D_2 would be added in the relays R_2 and R_3. Accordingly it is highly desirable to use separate relays, as shown in the drawing. It will be readily understood, of course, that, in response to noise currents in line L_2 the apparatus shown in the lower half of the drawing operates to charge condenser C_2 through inductance I_2, resistance r_3, and the armatures of relays R_2 and R'_2, causing additional bias on detector D_2, and that when the noise decreases to the point of release of relay R'_2, the condenser will be discharged slowly and the detector bias removed.

It is to be noted that in the applicant's echo suppressor, reduction of sensitivity is obtained which is just sufficient to prevent the operation by noise currents of the echo suppressing relays, no matter what may be the load characteristic of the detector tubes; thus battery variations etc., have no effect on the device. It is to be noted further that a margin of safety is provided through the adjustment of relay R_3 to be slightly more sensitive than relay R_1, for instance, which controls the suppressor relays proper.

Interaction between the two sides of the echo suppressor is prevented through the filtering action of condensers C_1 and C_2 and inductances I_1 and I_2.

While the invention has been disclosed in one specific embodiment which is deemed desirable, it is to be understood that this description 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 a system for suppressing echoes in a two-way circuit, a detector associated with each side of the circuit and responsive to waves therein, means controlled by each detector for blocking the opposite side of the circuit, and means associated with each detector and appreciably responsive only to sustained noise in the circuit for raising the threshold of operation of the detector.

2. In a system for suppressing echoes in a two-way circuit, a detector associated with each side of the circuit and responsive to waves therein, means controlled by each detector for blocking the opposite side of the circuit, and means associated with each detector and appreciably responsive only to sustained noise in the circuit for raising the threshold of operation of the detector to a degree just sufficient to prevent operation by the noise.

3. In a system for suppressing echoes in a two-way circuit, a detector associated with each side of the circuit and responsive to waves therein, means controlled by each detector for blocking the opposite side of the circuit, means associated with each detector and appreciably responsive only to sustained noise in the circuit for raising the threshold of operation of the detector to a degree just sufficient to prevent operation by the noise, and means associated with each detector for lowering its threshold of operation in response to decrease of the noise.

4. In a system for suppressing echoes in a two-way circuit, a three-electrode vacuum tube detector associated with each side of the circuit and responsive to waves therein, means controlled by each detector for blocking the opposite side of the circuit, a condenser in the grid-filament circuit of each detector, said condenser being normally without biasing charge thereon, means for preventing the charging of said condenser in response to voice waves or normal noise in the circuit, means associated with each detector and responsive to sustained noise in the circuit for charging the condenser to place a negative voltage on the detector grid, and means associated with each detector for discharging the condenser in response to a decrease of the noise.

5. In a system for suppressing echoes in a two-way circuit, a three-electrode vacuum tube detector associated with each side of the circuit and responsive to waves therein, means controlled by each detector for blocking the opposite side of the circuit, a condenser in the grid-filament circuit of each detector, said condenser being normally without biasing charge thereon, means for preventing the charging of said condenser in response to voice waves or normal noise in the circuit, means associated with each detector and responsive to sustained noise in the circuit of sufficient strength to operate said controlled means for charging the condenser to place a negative voltage on the detector grid, and means associated with each detector for discharging the condenser in response to a decrease of the noise.

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

DOREN MITCHELL.