Sept. 8, 1931. A. B. CLARK 1,821,928

TELEPHONE ECHO SUPPRESSOR

Filed Aug. 24, 1928

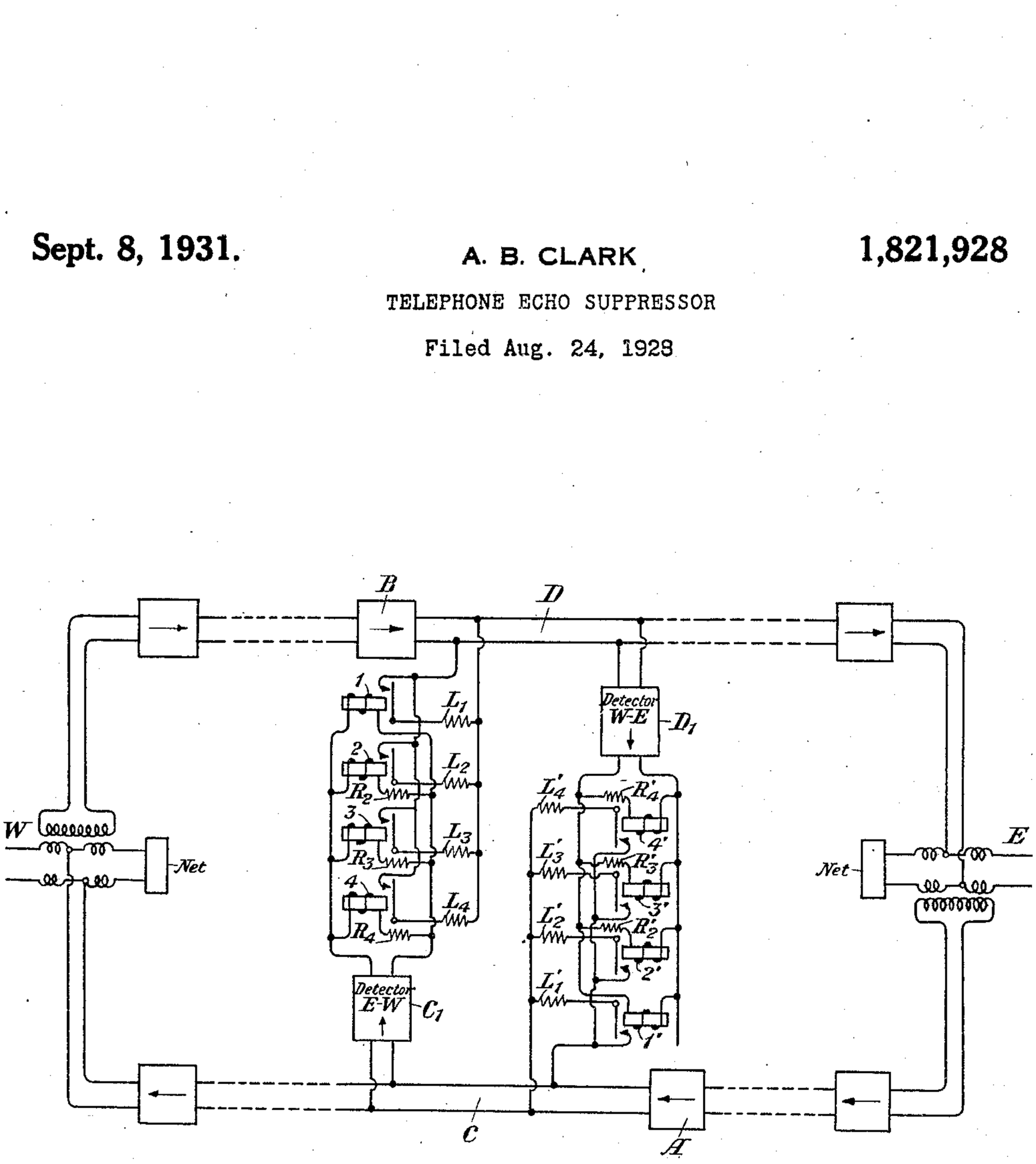


Fig. 1.

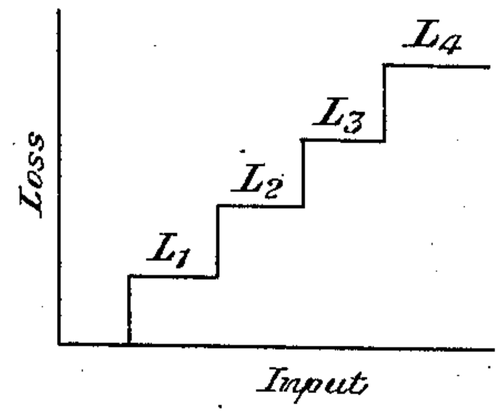


Fig. 2

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# UNITED STATES PATENT OFFICE

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## TELEPHONE ECHO SUPPRESSOR

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This invention relates to a method and means for suppressing echo effects in telephone transmission lines, and, more particularly, relates to increasing the sensitivity of such voice-operated suppressors in spite of the presence of noise on the transmission lines, which might otherwise cause operation of the suppressors.

The sensitivity of the present echo suppressors for four-wire telephone circuits, in which a relay short circuits the echo path, is limited by the noise currents from lines or from rooms in which the telephone transmitters are located. If the sensitivity of such a device could be increased, the echoes would be suppressed more effectively, but occasional noise currents would cause the device to lock up in one direction, thereby rendering the circuit useless for two-way talking.

An object of this invention is to permit operation at increased sensitivity and to provide that when the circuits are noisy, two-way conversations can still take place in spite of the action of the noise.

The invention will be better understood by reference to the following specification taken in connection with the accompanying drawings, in which Figure 1 shows a four-wire circuit embodying this invention, and Fig. 2 shows the manner in which loss may be built up in a line.

Referring more particularly to Fig. 1, there is shown a four-wire circuit consisting of one pair of wires C for transmitting speech from east to west, and a second pair D for transmitting speech from west to east. These lines are associated at their ends with the usual hybrid coil and networks, from which a pair of wires leads to the subscribers' stations, one pair going to the subscriber at the west, and one to the subscriber at the east. Each of these lines may be provided with a plurality of amplifiers, and, at the outputs of a pair of these amplifiers, such as A and B, an echo suppressor is connected. This echo suppressor comprises two units. These units are identical in their operation, and it will therefore be necessary to describe but one of them. Bridged across the output of the amplifier A, for example, there is an amplifier-detector unit $C_1$ which is operated by voice currents coming over the line C and whose direct current output operates a number of relays 1, 2, 3 and 4, connected in parallel. These relays are made to have different sensitivities either by differences in their construction or by connecting resistances $R_2$, $R_3$ and $R_4$ in series with their windings. Relay 1, which has zero resistance in series with its winding, is most sensitive, and relay 4 is least sensitive of the group. Relay 1 is adjusted so as to be operated by very weak currents passing through the line C. Relay 2, on the other hand, may be adjusted to be operated by currents which are, say, five t. u. stronger than those operating relay 1. So, also, each successive relay may be adjusted to be operated by currents which are successively five t. u. stronger, although it is to be understood that this five transmission units is given as an example, only, and that obviously any other desired difference in sensitivity between the successive relays may be adopted.

The operation of relay 1 connects a resistance $L_1$ in parallel with the line D, and, at the same time, in parallel with the input of the amplifier-detector $D_1$ of the other unit of the suppressor. The telephone current passing through the line C would, in due course, be subject to reflection at various points in the line, such as at the hybrid coil or the subscriber's station, and might be sufficiently great to cause operation of the amplifier-detector $D_1$. The resistance $L_1$, however, is so proportioned as to attenuate this echo enough to prevent it from being objectionable to the subscriber and also to prevent the operation of the detector $D_1$. If the telephone currents on the line C are stronger, the echo effects will also be stronger, but their tendency to cause operation of the detector $D_1$ is prevented by the operation of the relays 2, 3 and 4 in proper succession as the current increases, connecting other resistances $L_2$, $L_3$ and $L_4$ in parallel with the original resistance $L_1$ and thereby causing greater losses to the echo. In this

way, the necessary additional protection is provided against the echoes which are more objectionable at the subscribers' stations and also against the greater tendency to cause false operation of the detector $D_1$.

The unit of the suppressor comprising the detector $D_1$ bridged across the line D is symmetrical in every respect to the unit already described and includes the relays 1′, 2′, 3′ and 4′ with their resistances $R'_2$, $R'_3$, $R'_4$ for graduating the sensitivity. These relays control the shunt resistances $L'_1$, $L'_2$, $L'_3$, $L'_4$ to modify the loss introduced in the line C, all in the manner described in connection with the first unit of the suppressor. In both cases, as the successive relays are operated, the loss introduced into one line or the other is increased step by step in the manner indicated in Fig. 2.

The advantage of this arrangement is that the relays may be made sensitive enough to suppress echoes on very weak parts of the subscriber's speech. This increased sensitivity, however, will also render them sensitive to operation from noise currents of a kind which has heretofore limited the increase in sensitivity of the suppressors. Assume, for example, that a noisy line is connected to the east terminal of the four-wire circuit, the volume of the noise on the line being sufficient to operate both relays 1 and 2 inserting losses $L_1$ and $L_2$ in the line D. If, now, the subscriber at W begins talking, his voice currents will first undergo the same attenuation as the echo currents from the noise due to the losses $L_1$ and $L_2$. If, however, W talks strongly enough, his voice currents will do two things. They will first cause operation of relay 1′, thereby introducing loss $L'_1$ and reducing the noise reaching the input of the detector $C_1$, thus releasing relay 2. As soon as relay 2 is released, the voice currents from W are increased at the echo suppressor D′ so that it is possible for relay 2′ to operate, thus further reducing the noise coming from the line C and allowing relay 1 to release and eliminate loss $L_1$ from the line D. Thus W's voice currents will be received at E at their full strength, and, if he continues to talk before relays 1 and 2 are again operated by the noise, his speech will be received at E as well as if there were no noise actuating the device.

While the building up of W's voice currents in steps gives rise to a fluctuation in amplitude of the initial speech as received by E, it is apparent that this can in part be overcome by making the steps of the successive losses as small as desired and using a correspondingly larger number of such steps and relays to control them.

While this invention has been described in the specific circuit of Fig. 1, it is to be understood that it is not limited to such a specific form of four-wire circuit, but might be applied equally well to the two-wire circuit which is supplied with repeaters of the 22-type. It is also to be understood that many other variations may be introduced without departing from the spirit of this invention.

What is claimed is:

1. In a telephone signaling system, a transmission line, an echo suppressor comprising a voice-operated detector unit, a plurality of control circuits in the output of the unit, and a plurality of loss elements adapted to be connected in parallel with each other across the transmission line, the connection being controlled by the said control circuits.

2. In a telephone signaling system, an echo suppressor comprising a voice-operated detector unit, a plurality of control circuits in the output of the unit, and a plurality of parallel resistance shunts each controlled by one of said circuits.

3. In a telephone signaling system, an echo suppressor comprising a voice-operated detector unit, a plurality of control circuits of different sensitivities in the output of the unit, and a plurality of loss elements of different values adapted to be connected in parallel across the transmission lines, the connection being controlled by said control circuits.

4. In a signaling system, a four-wire transmission circuit, an amplifier in each line of the four-wire circuit, an echo suppressor associated with each line of the four-wire circuit for controlling the loss in the other line, comprising an amplifier-detector unit, a plurality of relays of different sensitivities in the output circuit of the unit, and a plurality of resistance elements adapted to shunt the other line, each of said resistance shunts being controlled by one of said relays.

5. In a signaling circuit, a four-wire transmission circuit, an amplifier in each line of the four-wire circuit, an echo suppressor associated with each line of the four-wire circuit, comprising an amplifier-detector unit, and means associated with each of said units for introducing variable loss step by step on the other line in accordance with the intensity of the incoming signal.

6. In a signaling system, a four-wire transmission circuit, an amplifier in each line of the four-wire circuit, an echo suppressor associated with the lines and comprising two amplifier-dectector units, one associated with each line and a plurality of loss elements for each line adapted for control by the detector units, the two units reacting on each other to decrease the loss in the line over which signals are coming and increase the loss in the other line.

7. In a four-wire signaling system subject to noise disturbances and provided with

an echo suppressor, the method of permitting increased sensitivity of the suppressor, which consists in reducing the echo in one line from the noise originating in the other, reducing the loss step by step in the first named line and increasing it step by step in the second line when signals come over the first line.

8. In a signaling system a four-wire transmission circuit, an amplifier in each line of the four-wire circuit, an echo suppressor associated with each line of the four-wire circuit for controlling the loss in the other line, each suppressor comprising an amplifier detector unit, a plurality of parallel relays of different sensitivities in the output circuit of the unit, and a plurality of resistance elements adapted to shunt the other line, each of said resistance shunts being controlled by one of said relays.

9. In a signaling system a four-wire transmission circuit, an amplifier in each line of the four-wire circuit, an echo suppressor associated with one line of the four-wire circuit for controlling the loss in the other line and comprising a detector unit, a plurality of shunt elements associated with the other line, and means controlled by the detector unit for connecting and disconnecting one or more of said shunt elements.

In testimony whereof, I have signed my name to this specification this 17th day of August, 1928.

ALVA B. CLARK.