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SUPPRESSION OF ECHOES AND SINGING IN FOUR-WIRE CIRCUITS

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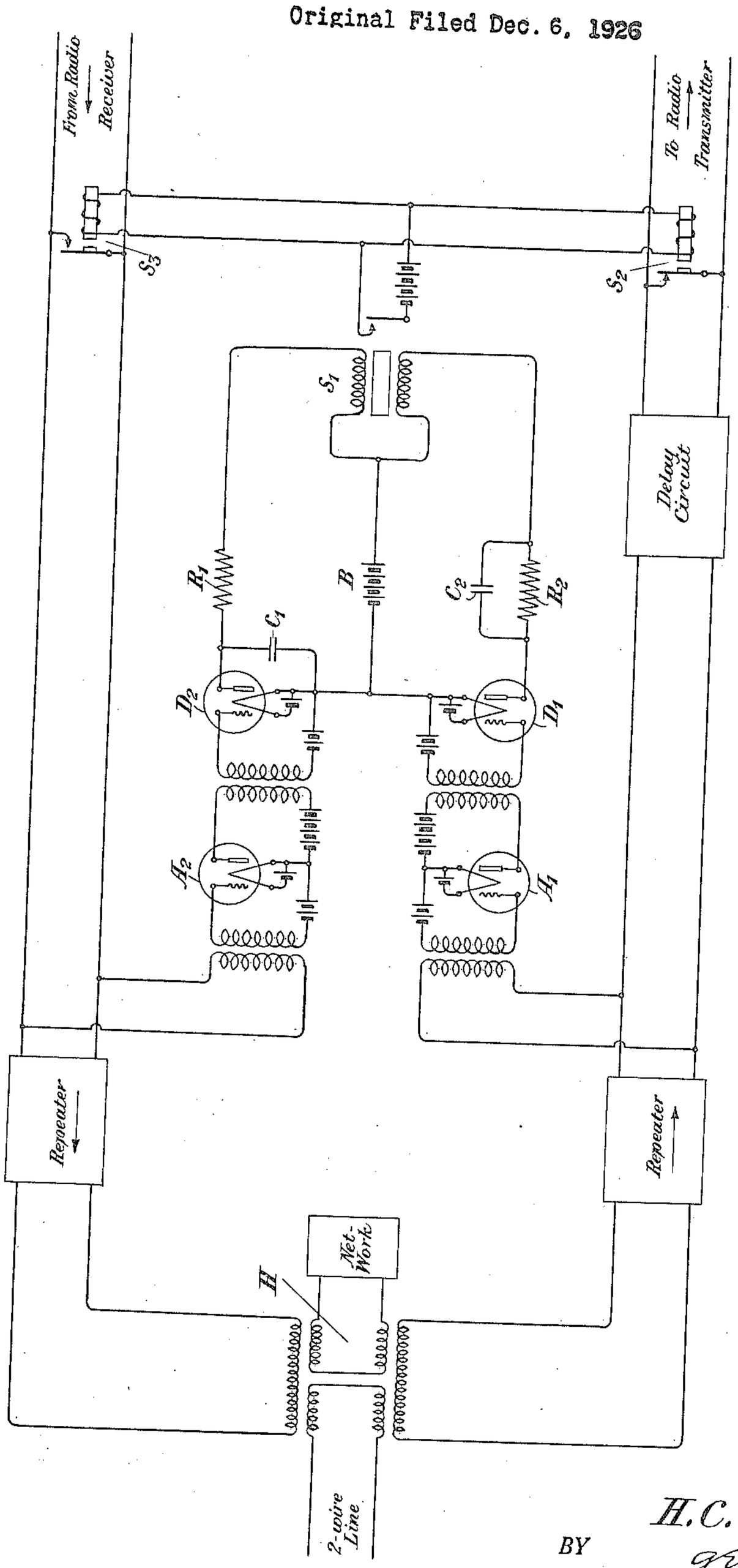

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SUPPRESSION OF ECHOES AND SINGING IN FOUR-WIRE CIRCUITS.

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This invention relates to two-way communication systems, and more particularly to two-way telephone systems which include, between two-wire lines, a four-wire circuit containing a radio link.

While the term "four-wire circuit" is ordinarily used, in connection with such systems, to denote the part of the system which connects the two distant two-wire lines and includes the radio link, this term "four-wire circuit" will be used hereinafter, with a view to a clear description of the invention, to denote that four-wire section of a half of the complete system which lies between one two-wire line and one end of the radio link.

In a telephone system of this class, in which the two paths of the four-wire circuit are adapted for transmission in opposite directions, it is, under certain conditions, a requirement, if the best possible results are to be secured, that one path of the four-wire circuit be normally blocked and consequently normally disabled. This arrangement serves to prevent singing in the circuit in its normal condition. In addition, in association with each transmission path of the four-wire circuit there must be provided means responsive to waves in this path for blocking the transmission over the other path, in order to secure the suppression of echoes returning from the two-wire line over that other path. The arrangement of the four-wire circuit which is ordinarily preferable is that in which the outgoing path—that is, the one adapted for transmission to the radio link—is normally blocked, while the path adapted for reception from the radio link is normally cleared. With this arrangement it is, of course, necessary to provide means responsive to voice waves in the outgoing path for clearing this transmission path.

In the arrangement of four-wire circuits which has been found comparatively successful in all-wire systems, an amplifier-detector device is associated with each path of the circuit. Voice waves in the transmission (or outgoing) path enter the associated amplifier-detector, and the output causes the operation of a relay or relays to place a short circuit on, or otherwise block, the reception path, and also to clear the transmission path. Voice waves in the reception path, provided this path is not blocked at the time, enter the associated amplifier-detector, and the output causes the operation of a relay or relays to block the transmission path.

The applicant has invented improved methods of and means for controlling the paths of a four-wire circuit, in the class of two-way systems defined above, so that echoes and singing will be suppressed.

The principal object of the invention is to overcome the tendency of voice waves or noise entering the four-wire circuit from the radio link, which are reflected as echoes from the two-wire line, to cause false operation of the relays associated with the transmission or outgoing path, and to accomplish this without affecting the sensitiveness of these relays to waves originating in the two-wire line.

The invention will be more clearly understood when the following description is read with reference to the accompanying drawing, which shows diagrammatically the essential transmission features of the applicant's improved arrangement.

The four-wire circuit is connected at its left end to a two-wire line through the usual hybrid coil H, the two-wire line being balanced by the usual network. The lower path of the four-wire circuit is adapted for transmission to a radio link (at the right) and includes the usual one-way repeater or amplifier and the usual delay circuit. The upper path of the four-wire circuit is adapted for reception from the radio link and includes a one-way repeater or amplifier.

Associated with the transmission path of the four-wire circuit are the amplifier A_1 and the detector D_1. The amplifier A_2 and the detector D_2 are associated with the reception path of the circuit.

A polar relay S_1 has one winding in the plate circuit of the detector D_1 and a second winding in the plate circuit of the detector D_2. These two windings are differentially connected, so that a current flow in the lower winding tends to operate the relay and current in the upper winding opposes this operation. The battery B is connected as shown. The operation of the relay S_1 causes the

operation of the relays S_2 and S_3. The transmission path of the four-wire circuit is normally blocked by a short circuit which can be removed by the operation of relay S_2. The reception path is normally clear but will be blocked by a short circuit upon the operation of relay S_3.

When the four-wire circuit is quiet and voice waves pass over the two-wire line to the transmitting path of the four-wire circuit, the waves enter the amplifier-detector A_1—D_1. This amplifier-detector is operated, and the output current causes the operation of relays S_1, S_2 and S_3, there being no current flow in the upper winding of relay S_1. The operation of the relays blocks the reception path and clears the transmission path.

When, however, noise or voice waves enter the reception path of the four-wire circuit from the radio link and are transmitted on to the two-wire line, they act upon the amplifier-detector A_2—D_2 and cause a current flow in the upper winding of relay S_1 which opposes the operation of the relay. If these waves are reflected in the two-wire line back over the transmission path of the four-wire circuit, the echoes act upon the amplifier-detector A_1—D_1, setting up a current in the plate circuit of the detector which tends to operate the relay S_1. The magnitude of these echoes depends upon the closeness with which the two-wire line is balanced by its network. The two amplifier-detectors are given the proper sensitivities, with due regard to this closeness of balance, and the two currents in the windings of relay S_1 tend to balance each other. Thus the operation of the relay and of the relays S_2 and S_3 is prevented or at least there is a substantial reduction of the tendency toward this relay operation in response to voice waves or noise entering the receiving side of the four-wire circuit from the radio link. In other words, there is an elimination of or at least a reduction of the tendency toward false operation of the transmitting relays by noise in the receiving side of the four-wire circuit, and, consequently, there is at least a reduced interference with the passage of voice waves from the two-wire line over the transmission path of the four-wire circuit

Small delays in the echoes are taken care of by the insertion of a resistance R_1 and a condenser C_1 in the circuit of the amplifier-detector A_2—D_2. This arrangement has the effect of delaying the establishment and the removal of the current in the upper winding of the relay S_1. In order that the characteristics of the two amplifier-detectors may be similar, a resistance R_2 and a condenser C_2 are introduced into the plate circuit of the detector D_1. This arrangement does not produce a hang-over effect in the circuit.

It will be noted that the improved arrangement of the applicant produces an effect somewhat similar to the improvement of the balance between the two-wire line and the corresponding network. It permits an increase of the volume of sound delivered over the four-wire circuit to the two-wire line without causing interference with the operation of the system. The adjustment of applicant's apparatus, however, is far simpler than the matching of impedances, involving only the equalization of two direct currents. Furthermore, it is to be noted that the applicant's improvement over the echo and singing suppressor arrangements heretofore devised involves the elimination of the entire relay train ordinarily included and designed to be operated by voice waves entering the receiving side of the four-wire circuit.

While the invention has been specifically disclosed as applied to a four-wire circuit containing a radio link, it is to be understood that it is applicable as well to an all-wire two-way telephone system which includes a four-wire circuit directly connecting two distant two-wire lines. It will readily be understood that in the case of the all-wire system, the "radio link" of the above description is replaced by a length of the four-wire circuit.

While a specific circuit arrangement has been shown for the purpose of clear illustration, it is to be understood that the scope of the applicant's invention is not limited thereby, but is defined by the appended claims.

What is claimed is:

1. In a two-way telephone system including a four-wire circuit having a radio link at one end thereof and a two-wire circuit connected thereto at the other end, the path of the four wire circuit which is adapted for transmission to the radio link being normally blocked and the path of said circuit which is adapted for reception from the radio link being normally cleared, an amplifier-detector associated with the transmission path, an amplifier-detector associated with the reception path, a relay having two windings differentially connected and included one in the output circuit of each of said amplifier-detectors, and means responsive to the operation of said relay for clearing said transmission path and simultaneously blocking said reception path.

2. In a two-way telephone system including a four-wire circuit having a radio link at one end thereof and a two-wire circuit connected thereto at the other end, the path of the four wire circuit which is adapted for transmission to the radio link being normally blocked and the path of said circuit which is adapted for reception from the radio link being normally cleared, an amplifier-detector associated with the transmission path, an amplifier-detector associ-

ated with the reception path, a relay having two windings differentially connected and included one in the output circuit of each of said amplifier-detectors, means for delaying the establishment of current in the relay winding included in the circuit of the amplifier-detector associated with the reception path, and means responsive to the operation of said relay for clearing said transmission path and simultaneously blocking said reception path.

3. In a two-way telephone system including a four-wire circuit having a radio link at one end thereof and a two wire circuit connected thereto at the other end, the path of the four wire circuit which is adapted for transmission to the radio link being normally blocked and the path of said circuit which is adapted for reception from the radio link being normally cleared, and means responsive to waves in the outgoing path for clearing said path and blocking the incoming path, the method of preventing the false operation of said wave responsive means by echoes in the outgoing path which consists in causing the returning echoes in the outgoing path to produce an effect tending to operate said means and causing the waves entering the incoming path from the radio link to produce an off-setting effect opposing the operation of said means.

4. In a two-way telephone system including a circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, the first path being normally blocked and the second path being normally cleared, and a two-wire line connected to said circuit at one end thereof; an amplifier-detector associated with the first path, an amplifier-detector associated with the second path, a relay having two windings differentially connected and included one in the output circuit of each of said amplifier-detectors, and means responsive to the operation of said relay for clearing the first path and simultaneously blocking the second path.

5. In a two-way telephone system including a circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, the first path being normally blocked and the second path being normally cleared, and a two-wire line connected to said circuit at one end thereof; an amplifier-detector associated with the first path, an amplifier-detector associated with the second path, a relay having two windings differentially connected and included one in the output circuit of each of said amplifier-detectors, means for delaying the establishment of current in the relay winding included in the circuit of the amplifier-detector associated with the second path, and means responsive to the operation of said relay for clearing said first path and simultaneously blocking said second path.

6. In a two-way telephone system including a circuit having a first path adapted for transmission in one direction and a second path adapted for transmission in the opposite direction, the first path being normally blocked and the second path being normally cleared, a two-wire line connected to said circuit at one end thereof, and means responsive to waves in the first path for clearing said path and blocking the second path; the method of preventing the false operation of said wave responsive means by echoes in the first path which consists in causing the returning echoes in the first path to produce an effect tending to operate said means and causing the waves entering the second path to produce an offsetting effect opposing the operation of said means.

7. In a two-way telephone system including a four-wire circuit having a two-wire line connected to one end thereof, the path of the four-wire circuit which is adapted for transmission from the two-wire line being normally blocked and the path of said circuit which is adapted for transmission to the two-wire line being normally cleared, an amplifier-detector associated with each path, a relay having two windings differentially connected and included one in the output circuit of each amplifier-detector, and means responsive to the operation of said relay for clearing the normally blocked path and simultaneously blocking the normally cleared path.

8. In a two-way telephone system including a four-wire circuit having a two-wire line connected to one end thereof, the path of the four-wire circuit which is adapted for transmission from the two-wire line being normally blocked and the path of said circuit which is adapted for transmission to the two-wire line being normally cleared, an amplifier-detector associated with each path, a relay having two windings differentially connected and included one in the output circuit of each amplifier-detector, means for delaying the establishment of current in the relay winding included in the circuit of the amplifier-detector associated with the normally cleared path, and means responsive to the operation of said relay for clearing the normally blocked path and simultaneously blocking the normally cleared path.

9. In a two-way telephone system including a four-wire circuit having a two-wire line connecteed to one end thereof, the path of the four-wire circuit which is adapted for transmission from the two-wire line being normally blocked and the path of said circuit which is adapted for transmission to the two-wire line being normally cleared,

and means responsive to waves in the normally blocked path for clearing said path and blocking the normally cleared path, the method of preventing the false operation of said wave responsive means by echoes in the normally blocked path which consists in causing the returning echoes in the normally blocked path to produce an effect tending to operate said means and causing the waves entering the normally cleared path to produce an offsetting effect opposing the operation of said means.

In testimony whereof, I have signed my name to this specification this 24th day of November 1926.

HAROLD C. SILENT.