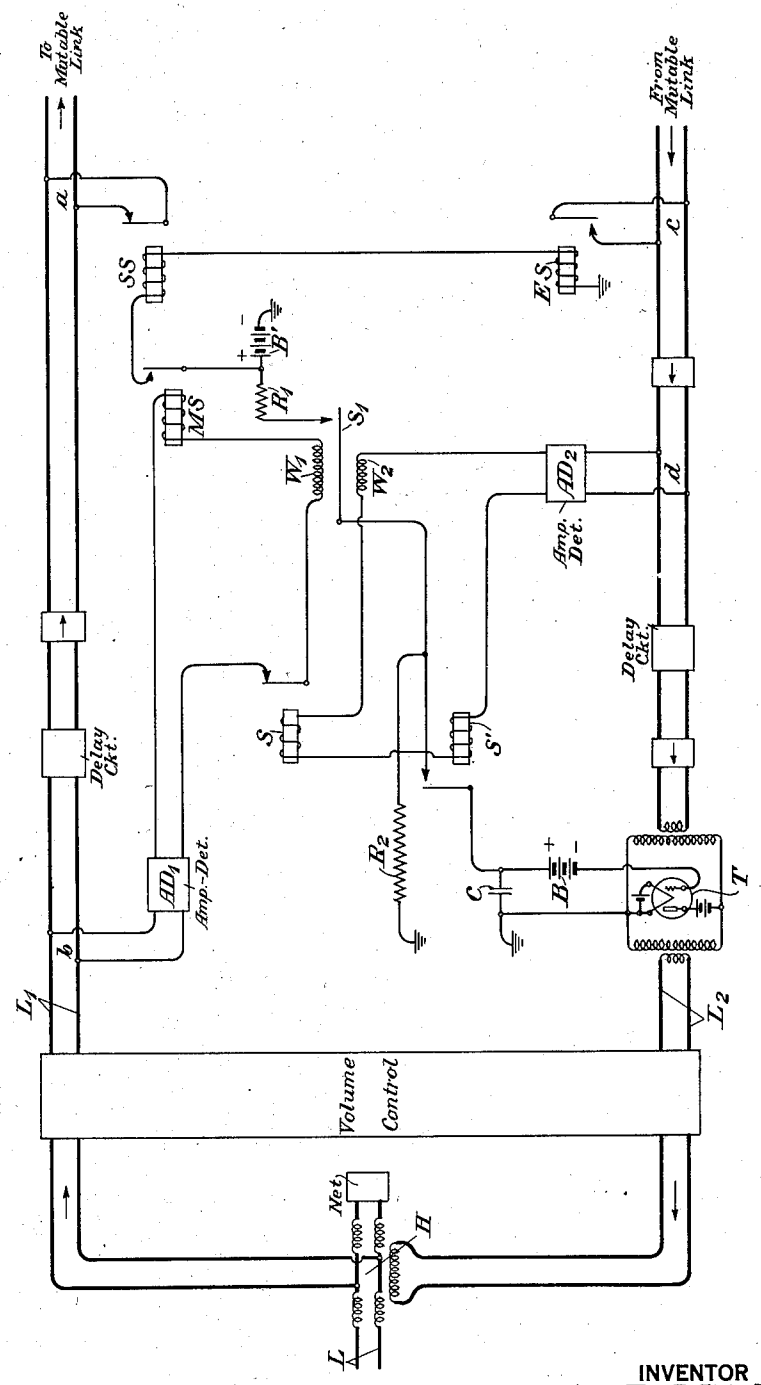
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TRANSMISSION CONTROL

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TRANSMISSION CONTROL

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This invention relates to systems for the transmission of energy, such as telephone systems, over which are transmitted the electrical waves representing speech. More particularly, the invention relates to four-wire telephone circuits connected to a two-wire line, in which transmission is controlled by switching devices responsive to the voice waves.

In the usual terminal arrangement of a four-wire circuit connected to an extending two-wire line, the "transmitting" path is adapted for transmission from the two-wire line, and the "receiving" path is adapted for transmission to that line. These two paths of the four-wire circuit are connected to the two-wire line through a hybrid coil, and the impedance of the two-wire line can be only imperfectly balanced by an artificial network.

The transmitting path of the four-wire circuit is usually maintained in a normal, or non-operating, condition of disability, in order that "singing" may be avoided; arrangements are then provided whereby voice energy in the transmitting path causes the removal of this normal disability and the simultaneous disabling of the receiving path.

Since the balance between the two-wire line and the artificial network is not perfect, when energy travels to the two-wire line over the receiving path of the four-wire circuit, a part of this energy is usually reflected over the transmitting path, and if this "echo" energy is of sufficiently high value to cause operation of the transmission control apparatus responsive to energy in the transmitting path, a serious condition of false operation and interference with speech transmission is encountered.

The principal object of the present invention is the prevention or substantial reduction of such false operation by echo energy due to poor or varying two-wire balance.

In accomplishing the above-stated object the applicant utilizes a volume regulator in the receiving path and provides for the reduction of the received volume when the margin between the energy in the receiving path and the reflected energy in the transmitting path reaches a predetermined amount.

The invention will be clearly understood when the following description is read with reference to the accompanying drawing, which shows diagrammatically one suitable form of the applicant's terminal arrangement.

With reference to the details of the drawing, there is shown one terminal of a four-wire circuit comprising a one-way path L_1 adapted for transmission from left to right, and a second one-way path L_2 adapted for transmission from right to left. At its left end, the four-wire circuit is connected to a two-wire line L through the usual arrangement of hybrid coil H and an artificial network which imperfectly balances the impedance of the line L. It will be understood that the four-wire circuit may be extended to the right by a mutable link, such as a radio link.

The one-way paths L_1 and L_2 are equipped with the usual one-way amplifiers and delay circuits, and there is schematically indicated apparatus for controlling the volume in these two paths.

The path L_1 of the four-wire circuit, which may be termed the transmitting path, is normally disabled at the point *a* for the purpose of suppressing singing. An amplifier-detector AD_1 is connected across the path L_1 at the point *b*. The output circuit of this amplifier-detector includes the winding of a master transmitting relay MS and the winding W_1 of a marginal relay S_1 to be discussed hereinafter. When the relay MS operates, a circuit is closed through battery B' and the windings of relays SS and ES. The relay SS controls the singing suppressing disability at point *a* in the path L_1, while the relay ES is designed to disable the receiving path L_2 at point *c*.

A second amplifier-detector AD_2 is connected across path L_2 at point *d* and includes in its output circuit the windings of relays S and S' and the winding W_2 of the above mentioned marginal relay S_1.

The apparatus described above is, with the exception of the marginal relay S_1 and the relay S', the apparatus usually provided in a four-wire circuit for the suppression of singing and echoes. When a subscriber connected to the two-wire line L talks, the energy representing his voice travels over the path L_1. At the point *b*, a portion of this energy is diverted to operate the amplifier-detector AD_1. Unless control of the circuit has been taken by the subscriber at the right end of the system, the operation of amplifier-detector AD_1 results in the operation of relay MS, which operation in turn results in the operation of relays SS and ES. The operation of relay SS removes the disability at point *a* and clears the path L_1 for the transmission of the outgoing voice energy, a suitable delay being introduced by the delay circuit to insure the timely removal of this disability. The operation of relay ES places a disability on the

receiving path L_2 at point c, thus preventing echoes and the interrupting of the transmission control by later arriving energy in path L_2. Furthermore, as will be discussed more fully hereinafter, the operation of amplifier-detector AD_1 causes the energization of winding W_1 of the marginal relay S_1. This relay S_1, with respect to the winding W_1, should be made slightly more sensitive than relay MS.

When the subscriber at the right end of the system talks, the energy representing his voice passes from right to left over the path L_2. If control has been taken by the subscriber at the left end of the system, the incoming waves are cut off at point c in the path L_2. If such control has not been taken, however, the voice energy passes on toward the line L, and a small portion of this energy is diverted at point d to operate the amplifier-detector AD_2. The operation of this amplifier-detector tends to energize the windings of relays S and S' and also the winding W_2 of the marginal relay S_1, which winding, as indicated on the drawing, is smaller than the winding W_1. The relay S' should be made considerably more sensitive than the relay S, and when so adjusted, will operate on substantially any incoming energy. If the incoming energy is of sufficiently high volume, it will result not only in the operation of relay S' but also in the operation of relay S and the appreciable energization of winding W_2 of relay S_1. When relay S operates, the output circuit of amplifier-detector AD_1 is broken; this results in the prevention of the operation of relays MS, SS and ES in response to later arriving energy in the path L_1.

A three-electrode vacuum tube T is connected across the receiving path L_2 to form a variable bridged impedance. A suitable negative voltage is impresesd on the grid of tube T from battery B. The function of the applicant's arrangement of relays and associated apparatus is to reduce the bridged impedance of the tube T and thus increase the loss introduced in the path L_2, but to do this only when the energy in path L_2 is reflected back over path L_1, because of inadequate balance between the line L and the artificial network, to an extent which threatens false operation of the relay MS and the relays SS and ES controlled thereby. To assist in the accomplishment of this function, the applicant utilizes a condenser C potentially in circuit with a resistance R_1 and the battery B'.

Let it be assumed that the energy coming in over path L_2 is too weak to operate relay S but is reflected back over path L_1 at a value sufficiently high to operate relay S_1 through the energization of winding W_1. The energy in path L_2, though too weak to operate relay S, will operate relay S' and partially prepare a charging circuit for the condenser C. When the echo energy in path L^1 operates relay S_1, this charging circuit is completed and the condenser C renders the voltage impressed on the grid of tube T less negative, and the bridged impedance is lowered. The result is an increase of the loss introduced in path L_2.

It will be noted that a resistance R_2, which is quite large, is connected across the condenser C on the far side of the contact of relay S'. This resistance provides for the slow leakage of the charge on condenser C when the contact of relay S_1 is opened. It will be noted that the charging of condenser C and the resultant reduction of the negative voltage on the grid of tube T is controlled by relay S' and the marginal relay S_1. Since relay S' is made very sensitive, it will operate in response to any appreciable energy passing the point c in the path L_2; in other words, the relay S' will operate unless the path L_2 has been blocked at point c in response to voice energy in path L_1. The operation of relay S_1 depends, of course, on the relation of the currents in the windings W_1 and W_2. This relation in turn is dependent upon the relation between the energy in path L_2 at point d and the reflected energy in path L_1 at point b. If the value of the energy in path L_1 is sufficiently high with respect to the value of the energy in path L_2, relay S_1 will operate and the loss introduced in the path L_2 by the tube T will be increased. Thus the applicant's arrangement serves to reduce the volume in path L_2 and thus, indirectly, to reduce or eliminate the chance of false operation of the transmitting relays, but avoids this reduction of volume in the receiving path when such reduction is not necessary because of the balance between line L and the network.

While the invention has been disclosed in one specific embodiment for the purpose of illustration, it will be understood that such disclosure is not necessarily limiting but that the scope of the invention is determined by the appended claims.

What is claimed is:

1. In a system for the transmission of energy, a two-wire line, a four-wire circuit connected thereto and including a receiving path for transmission to said line and a transmitting path for transmission therefrom, means in said receiving path for introducing a variable loss therein, control means for adjusting said loss introducing means to vary the loss introduced thereby, means for limiting the operation of said control means to a predetermined relation between the energy in said receiving path and the energy in said transmitting path which is an echo of said first-mentioned energy, and means for further limiting the operation of said control means to a predetermined or lower level of energy in said receiving path.

2. In a four-wire circuit for the two-way transmission of energy, a first path adapted for transmission in one direction, a second path adapted for transmission in the opposite direction, means for connecting said paths and for extending the transmission of energy such that energy transmitted over said second path will be partially reflected over said first path as echo, means in said second path for introducing a variable loss therein, and means for adjusting said loss introducing means to vary the loss introduced thereby in response to a predetermined margin of value between the energy in said second path and the echo thereof in said first path and only when the energy in said second path is of a predetermined or lower level.

3. In a four-wire circuit for the two-way transmission of energy, a first path adapted for transmission in one direction, a second path adapted for transmission in the opposite direction, means for connecting said paths and for extending the transmission of energy such that energy transmitted over said second path will be partially reflected over said first path, means in said second path for introducing a variable loss therein, means for normally disabling said first path, means responsive to non-reflected energy in said first path for removing the normal disability therefrom and for disabling said second

path, and means for adjusting said loss introducing means to vary the loss introduced thereby in response to a predetermined margin of value between the energy in said second path and the reflected energy in said first path and only when the energy in said second path is of a predetermined or lower level.

4. In a system for the transmission of energy, including a two-wire line, a four-wire circuit comprising a transmitting path adapted for transmission from the two-wire line and a receiving path adapted for transmission to said line, means for interconnecting said paths and said line such that energy transmitted over said receiving path is partially reflected over said transmitting path, and means responsive to energy in said transmitting path for controlling the transmission over the system; the method of preventing false operation of said transmission control means which consists in introducing a variable loss in said receiving path, varying the loss in said path in accordance with the margin between the energy transmitted over said path and the energy reflected over said transmitting path as echo of said first-mentioned energy, and limiting such variation to a condition in which the energy in said receiving path does not exceed a predetermined level.

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