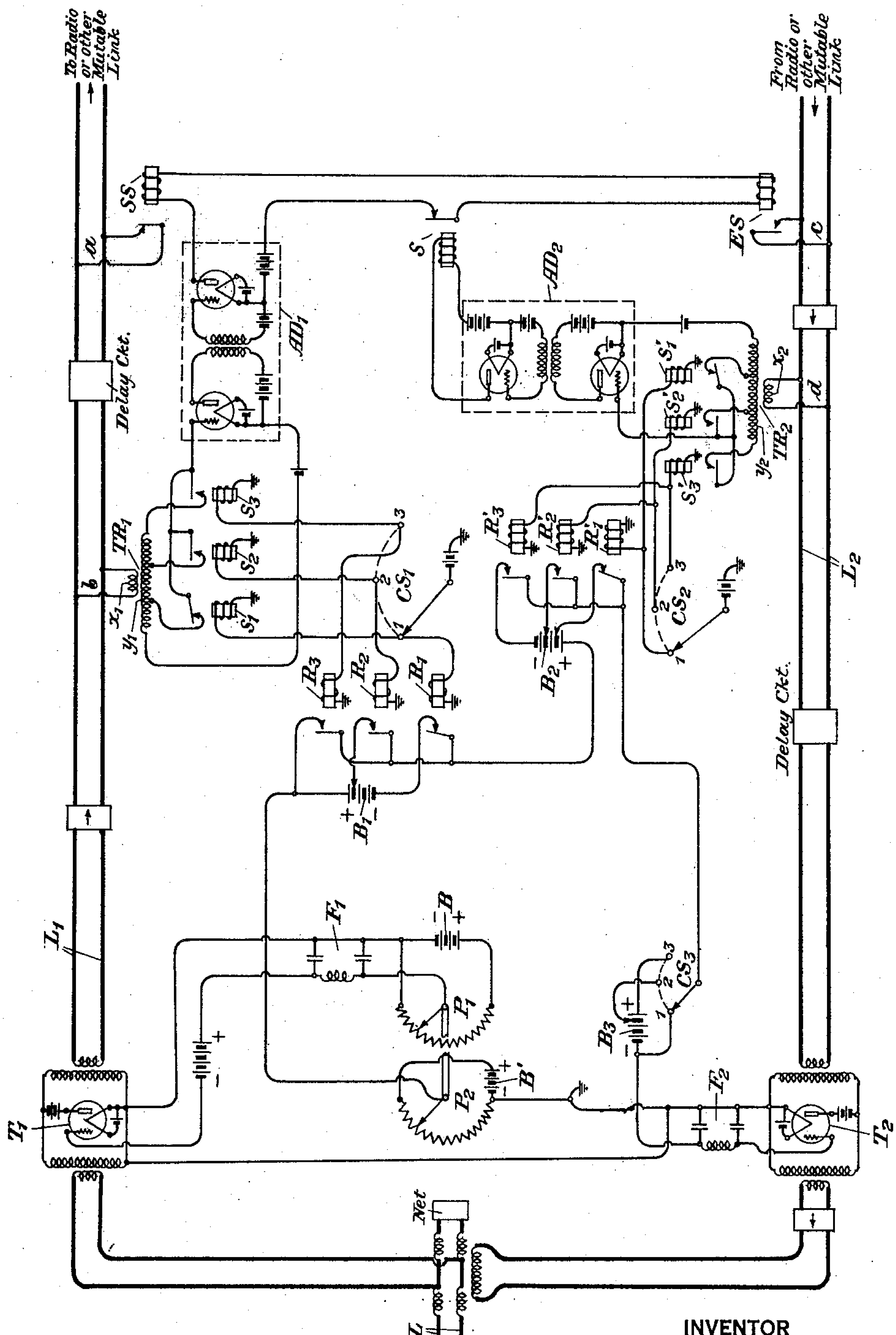
April 18, 1933 D. MITCHELL 1,903,875

TRANSMISSION CONTROL

Filed Sept. 18, 1931



INVENTOR
D. Mitchell

BY

ATTORNEY

Patented Apr. 18, 1933

1,903,875

UNITED STATES PATENT OFFICE

DOREN MITCHELL, OF MARTINSVILLE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

TRANSMISSION CONTROL

Application filed September 18, 1931. Serial No. 563,646.

This invention relates to systems for the transmission of energy and more particularly to telephone systems, over which are transmitted the electrical waves representing speech. With greater particularity the invention relates to telephone circuits—especially four-wire circuits—in which transmission is controlled by switching devices responsive to energy in the transmission paths.

In a telephone circuit it is often desirable to maintain a normal or non-operating condition of disability in order to prevent "singing". It then becomes necessary, of course, to cause the removal of this disability when speech energy is transmitted. In the case of a four-wire circuit, in which the path normally disabled is associated with a path for transmission in the opposite direction (usually through a hybrid coil connection to an extending two-wire circuit), unbalance conditions may and usually do result in the reflection of energy transmitted over the latter path into the former. Again, the normally operative one-way path usually has associated with it wave responsive devices for controlling the transmission over the four-wire circuit. If this normally operative path is adapted for transmission from a link of the system which is noisy or unstable—a link which may be termed generically "mutable"—such as a radio link, which may be noisy due to static, the interfering energy may cause undesired operation of the transmission control apparatus.

Accordingly, it becomes desirable to effect adjustments of the volumes in the transmission paths and adjustments of the sensitivities of the wave responsive apparatus for controlling transmission, with a view to assuring satisfactory operation of the wave responsive apparatus and at the same time preventing false or undesired operation of such apparatus. In this connection various factors must be taken into consideration. For instance, when energy comes in over the receiving one-way path of a four-wire circuit, the "return loss" which is determined by the degree of unbalance between the connected two-wire line and the artificial network affects the amount of echo transmission occurring in the transmitting path of the four-wire circuit. Again, the ability of a local talker to operate the transmission control apparatus responsive to energy in the transmitting path determines the volume control which is desirable in the transmitting path. If it becomes necessary to make a considerable increase in gain in the transmitting path and the return loss is low, it will be understood that it becomes desirable to lower the volume in the receiving path to prevent false operation of the transmitting control apparatus by echoes of incoming energy which was too weak to operate the receiving control apparatus. Further, it is always desirable to maintain the volume in the receiving path at the highest point consistent with the prevention of the above-mentioned false operation.

The principal object of the present invention is to provide for the lowering of the volume in the receiving path of a four-wire circuit when the loss in the "echo path" becomes low enough to threaten false operation of the switches controlled by the transmitting path—but to retain the normal volume in the receiving path until this lowered loss renders the change necessary.

In general, the applicant, in accomplishing the above stated object, utilizes a variable impedance bridged across each of the paths of the four-wire circuits; increases the transmitting path impedance when this is necessary to take care of a weak talker; simultaneously therewith decreases the receiving path impedance if such change is necessary to prevent false operation of the transmitting control apparatus, and provides for the maintenance of the normal bridged impedance value in the receiving path as long as the increase of volume in the transmitting path is not so great as to threaten false operation.

The nature of the invention and various advantages thereof will be understood when the following description of one desirable embodiment of the invention is read with reference to the accompanying drawing, which shows diagrammatically the application of the applicant's arrangements to the terminal of a four-wire circuit.

The four-wire circuit includes a transmitting path L_1 adapted for transmission from a two-wire line L to a radio link or other mutable link indicated at the right, and a receiving path L_2 adapted for transmission from the mutable link to the two-wire line L. The connection between the four-wire circuit and the line L is made through the usual arrangement of hybrid coil and artificial network which simulates somewhat roughly the impedance of the line L.

In order to prevent singing in the four-wire circuit the transmission path L_1 is normally disabled at some point a. At the point b in path L_1 a portion of the outgoing energy is taken off through a transformer TR_1, which has its primary winding x_1 bridged across the line. The secondary winding y_1 of this transformer is connected in the input circuit of an amplifier-deflector AD_1, the output of which controls the singing suppressor relay SS designed to remove the disability at point a and a second relay ES designed to disable the path L_2 at point c to prevent echoes. If energy in the receiving path L_2 is not blocked at point c, a portion of the energy is taken off at point d through the transformer TR_2, which has its primary winding x_2 bridged across the line L_2. The secondary winding y_2 of the transformer TR_2 is connected in the input circuit of the amplifier-detector AD_2, the output of which controls the relay S. When this relay operates in response to the energy in path L_2, the output circuit of amplifier-detector AD_1 is broken and the operation of relays SS and ES in response to later arriving energy in the path L_1 is prevented.

Bridges across the transmitting path L_1 is a three-electrode vacuum tube T_1, and a second three-electrode vacuum tube T_2 is bridged across the receiving path L_2. Each of these vacuum tube circuits, of course, provides a variable bridged impedance which, upon regulation of the voltage applied to the grid, serves as a means for introducing a variable amount of loss in the associated transmission path.

The control of the volume in the transmitting path L_1 is effected by the operation of a potentiometer P_1, which varies the amount of negative voltage from battery B which is applied to the grid of tube T_1. A second potentiometer P_2 is operated simultaneously with the potentiometer P_1, as indicated in the drawing, and serves to vary the amount of positive voltage impressed on the grid of tube T_2 from battery B′. It will be noted that as the potentiometer arms are turned simultaneously in a clockwise direction, the negative voltage on the grid of tube T_1 is increased while the positive voltage on the grid of tube T_2 is increased. This operation of the potentiometers raises the bridged impedance of tube T_1 and thus lowers the loss introduced in the transmitting path L_1 (which change would be required to take care of a weak local talker); simultaneously this potentiometer operation, unless it is partially or fully offset, reduces the bridge impedance of the tube T_2 and increases the loss introduced in the receiving path L_2.

In order to prevent the lowering of the received volume by the decrease of the value of the bridged impedance through the tube T_2 when such change is not necessary to prevent false operation of amplifier-detector AD_1, the applicant provides for the application of a variable negative voltage to the grid of tube T_2, as will now be more fully described. The switch CS_1 may be termed the "clipping control". When this switch is operated to position 1, 2 or 3, it causes the operation of a relay S_1 or a relay S_2 or a relay S_3. The voltage applied to the first grid of the amplifier-detector AD_1 is determined by the portion of the secondary winding y_1 of transformer TR_1 which is connected into the input circuit of the first amplifier-detector tube, and it is the function of the chain of relays S_1, S_2 and S_3 to control this secondary winding connection. With the switch arm of CS_1 on contact 1, as indicated in the drawing, relay S_1 is operated and only a small portion of the winding y_1 is connected into the amplifier-detector circuit. This condition is one which gives a relatively low sensitivity to amplifier-detector AD_1 and is suitable for a talker connected to line L who has high ability to operate the amplifier-detector and the relays controlled thereby. It will be understood that if such a talker has lower ability to operate this apparatus, the switch CS_1 will be operated to position 2 or position 3 to cause the operation of relay S_2 or relay S_3 to render effective a greater portion of the winding y_1 and thus increase the sensitivity of the amplifier-detector AD_1. Ability to operate relays varies with different talkers, even though the volumes representing their voices (usually measured with the use of strong sounds as a criterion) are regulated to give a constant value at point b.

It will be noted that when the switch CS_1 is operated, circuit changes are made in the chain of relays R_1, R_2 and R_3, associated with a battery B_1. This battery B_1 is designed to impress a variable amount of negative voltage on the grid of tube T_2 or, more accurately, to contribute a variable amount of negative voltage to the circuit which controls the grid voltage of the tube. With the arm of switch CS_1 on contact 1, as indicated in the drawing, a relay R_1 (in addition to relay S_1) is operated, and the maximum value of negative voltage from battery B_1 is applied. This comparatively large negative voltage impressed on the grid of tube T_2 tends to raise the bridged impedance and to increase or maintain the volume in the receiving path L_2. It will be noted that as switch CS_1 is operated to position 2 or position 3 to increase the sensitivity of amplifier-detector AD_1, relay R_2 or relay R_3 is operated to cause the contribution of a smaller amount of negative voltage to the grid of tube T_2.

The switch CS_2, which may be termed the "static control", corresponds to the switch CS_1 described above. It operates one relay of the chain S_1', S_2' and S_3' to control the sensitivity of amplifier-detector AD_2 by rendering effective the different portions of the secondary winding y_2 of transformer TR_2 which is bridged across the receiving path L_2 at point d. The operation of switch CS_2 also controls the operation of the chain of relays R_1', R_2' and R_3' to connect into the circuit controlling the voltage impressed on the grid of tube T_2 a variable amount of negative voltage from battery B_2. With switch CS_2 in position 1, as indicated, relays S_1' and R_1' are operated. The operation of relay S_1' renders effective only a small portion of the winding y_2 and adjusts the sensitivity of amplifier-detector AD_2 for a relatively high static condition. Likewise the operation of relay R_1' connects into the circuit controlling the grid of tube T_2 only a small amount of negative voltage.

The third switch shown CS_3 may be termed the "return loss control" and serves merely to connect into the circuit controlling the grid of tube T_2 various amounts of battery from B_3. This variation is designed to take care of different return losses at the circuit terminal.

It is seen from the discussions given above of the operation of switches CS_1, CS_2 and CS_3 that these controls mutually contribute a negative voltage (from batteries B_1, B_2 and B_3) to the grid of tube T_2 and that the amount of negative voltage contributed by each of the switches depends upon certain conditions of the circuit—specifically, the condition requiring adjustment of the sensitivity of amplifier-detector AD_1, the noise condition affecting the desirable sensitivity of amplifier-detector AD_2, and the return loss at the left end of the four-wire circuit. It will be understood further that the algebraic sum of the negative voltages from batteries B_1, B_2 and B_3 and the positive voltage from battery B', which is controlled by potentiometer P_2, determines the effective voltage on the grid of tube T_2. As long as the sum of the negative voltages from B_1, B_2 and B_3 is great enough to offset effectively the positive voltage from battery B', there will be no increase of loss in the receiving path L_2 or, in other words, the receiving volume will be maintained at its normal level. If, however, the potentiometers P_1 and P_2 are turned so far in the clockwise direction (to take care of a weak talker connected to line L) that the positive voltage impressed on the grid of tube T_2 from battery B' is in effect only partially cancelled out by the negative voltage on the grid, the bridged impedance through T_2 is decreased, and increased loss is introduced in the path L_2. It will be understood, of course, that the various elements controlling the voltage on the grid of tube T_2 should be proportioned to produce this increase of loss in the path L_2 only when a failure to increase the loss would result in a level in the transmitting path L_1 high enough to cause the undesired operation of amplifier-detector AD_1 and the relays SS and ES controlled thereby.

It will be noted that filters F_1 and F_2 are included in the grid circuits of tubes T_1 and T_2, respectively. These filters serve to prevent clicks in the respective transmission circuits due to the operation of the potentiometer P_1, the potentiometer P_2 or one of the switches CS_1, CS_2 and CS_3.

Three steps are shown for each of the switches CS_1, CS_2 and CS_3, and the number of relays corresponds. It will be understood that the number of steps and the corresponding number of relays may be increased as required. The specific disclosure made is merely for the purpose of illustration and adequately brings out the operations resulting from actuation of any one of the switches.

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

What is claimed is:

1. In a system for the transmission of energy, a first path adapted for transmission in one direction, a second path adapted for transmission in the opposite direction, means responsive to energy in each of said paths for controlling the transmission over the paths, a three-electrode vacuum tube bridged across one of said paths for introducing a variable loss therein, means for impressing a voltage on the grid of said tube, means for regulating the voltage impressed on said grid, and a plurality of mutually contributing means for effecting auxiliary regulation of the voltage impressed on said grid, one of said plurality of means also acting to regulate the sensitivity of each of said transmission controlling means.

2. In a system for the transmission of energy, a first path adapted for transmission in one direction, a second path adapted for transmission in the opposite direction, means for normally disabling said first path, control means responsive to energy in said first path for removing the disability therefrom and for disabling said second path,

control means responsive to energy in said second path for preventing the operation of said first-stated control means, means associated with each of said control means for adjusting the sensitivity thereof, means associated with each of said transmission paths for introducing a variable loss therein, primary means associated with each of said loss introducing means for adjusting the operating point thereof, an auxiliary means for introducing adjustment of the setting of the loss introducing means in said second transmission path, and means associated with each of said sensitivity adjusting means for introducing auxiliary adjustment of said loss introducing means in said second path.

3. In a system for the transmission of energy, a transmitting path, a receiving path, means for normally disabling said transmitting path, control means responsive to energy in said transmitting path for removing the disability therefrom and for disabling said receiving path, control means responsive to energy in said receiving path for preventing the operation of said first-stated control means, means associated with each of said control means for adjusting the sensitivity thereof, a three-electrode vacuum tube bridged across each of said paths for introducing a variable loss therein, means for simultaneously effecting corresponding but opposite adjustments of the voltages on the grids of said tubes, and a plurality of mutually contributing means for making adjustment of the grid voltage of the tube bridged across the receiving path opposite to that made simultaneously with the adjustment of the grid voltage of the tube bridged across the transmitting path, one of said mutually contributing means being operable simultaneously with each of the means for adjusting the sensitivity of said control means.

4. In a system for the transmission of energy including a transmitting path, a receiving path and means in each path for regulating the volume therein, the method of transmission control which consists in making simultaneously an adjustment of the regulating means in the transmitting path in one direction and a corresponding adjustment of the regulating means in the receiving path in the opposite direction, and making a plurality of mutually contributing auxiliary adjustments of the regulating means in the receiving path which tend to oppose the adjustment made simultaneously with the regulation of the transmitted volume, whereby the regulation of the received volume will occur only when the regulation of the transmitted volume exceeds a predetermined degree.

5. In a system for the transmission of energy including a transmitting path, a receiving path, means responsive to energy in each path for controlling the transmission over the system and means in each path for regulating the volume therein, the method of securing satisfactory operation of the transmission controlling means without unnecessary reduction of the volume in the receiving path which consists in making an adjustment of the volume regulating means in the receiving path which tends to decrease the received volume simultaneously with an increase of the transmitted volume and in corresponding degree, adjusting the sensitivities of the respective transmission controlling means in accordance with the transmission conditions in the respective paths, and making simultaneously with any sensitivity adjustment an auxiliary adjustment of the volume regulating means in the receiving path which tends to oppose the adjustment thereof made simultaneously with the transmitted volume regulation, whereby the received volume will be determined by the algebraic sum of the principal adjustment and the several auxiliary adjustments of the regulating means in the receiving path.

In testimony whereof, I have signed my name to this specification this 17th day of September 1931.

DOREN MITCHELL.