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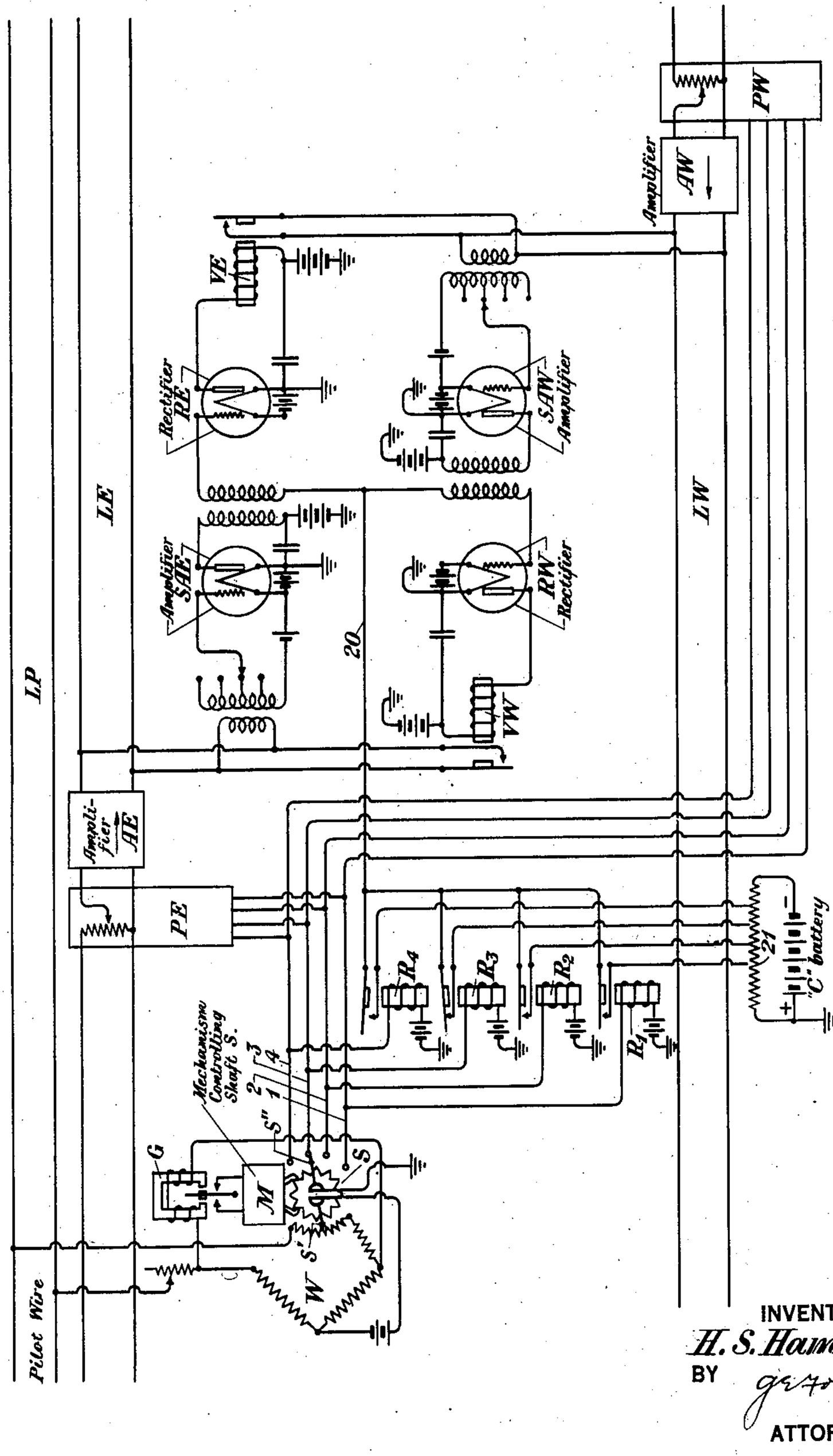


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# UNITED STATES PATENT OFFICE.

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## AUTOMATIC REGULATION OF ECHO-SUPPRESSOR SENSITIVITY.

Application filed September 10, 1925. Serial No. 55,541.

*To all whom it may concern:*

Be it known that I, HAROLD S. HAMILTON, a citizen of the United States, residing at New York, in the county of Bronx and State of New York, have invented certain Improvements in Automatic Regulation of Echo-Suppressor Sensitivity, of which the following is a specification.

This invention relates to transmission controlling arrangements and more particularly to arrangements for controlling the sensitivity of echo suppressors used in connection with transmission circuits.

In the operation of long toll circuits, the transmission varies from time to time due to changes in temperature and other causes. It is therefore customary to provide at some repeater point an automatic arrangement which adjusts the gain of the repeater at that point to bring the over-all transmission equivalent back to normal in case the transmission equivalent of the circuit has been varied. It is also necessary in some instances, particularly where a cable is employed for the toll circuit, to provide the circuits with echo suppressors which function when talking in one direction to disable the circuit for transmission in the opposite direction.

It is sometimes necessary to locate the echo suppressor equipment at the repeater point in the circuit where the transmission adjustment is made. At such a repeater point the transmission level at the output of the repeater will vary over a considerable range since the gain of this repeater is changed by a sufficient amount to compensate for the transmission changes in an entire regulator section which may have several repeaters in it. As the echo suppressor apparatus must ordinarily be applied to the output side of the repeater, difficulties may be encountered in the satisfactory operation of the echo suppressor due to the change in transmission level at the point where it is applied.

For example, if the gain of the repeater is increased several transmission units to compensate for increased transmission loss of the regulator section, satisfactory echo suppressor operation may be interfered with due to the higher level impressed upon the echo suppressor. As the transmission level is raised the noise level is correspondingly elevated, and if the echo suppressor, as is often the case, is adjusted for a close marginal operation above the noise level it may be caused to function in response to noise when no voice currents are being transmitted over the circuit. On the other hand, if the transmission level is decreased several transmission units below the average level, the echo suppressor may fail to operate in response to low volume transmission applied to the sending end of the circuit.

In accordance with the present invention it is proposed to obviate these difficulties by regulating the sensitivity of the echo suppressor as the gain of the repeater is changed; that is, as the gain of the repeater is increased the sensitivity of the echo suppressor will be reduced by a corresponding amount, and vice versa. An arrangement operating in the manner stated will have the result of maintaining substantially constant the net transmission level applied to the echo suppressor.

The invention may now be more fully understood from the following detailed description thereof when read in connection with the accompanying drawing, the figure of which illustrates a preferred embodiment of the invention.

Referring to the drawing, LE and LW designate the transmission lines of a four-wire circuit provided with one-way repeaters AE and AW at one repeater point. In order to automatically adjust the transmission level at the repeater point illustrated when the over-all transmission of the circuit departs from normal, due to temperature changes or other causes, a pilot circuit LP is provided, said pilot circuit being a transmission line subjected to the same conditions producing transmission changes as those to which the lines of the four-wire circuit are subjected.

The transmission regulating arrangement comprises a Wheatstone bridge W, so organized that the pilot circuit LP forms one effective arm of the bridge. A galvanometer relay G is connected across neutral points of the bridge and this relay controls a suitable mechanism M for adjusting a shaft S carrying switch arms $s'$ and $s''$. The mechanism whereby the shaft is rotated in one direction or the other, depending upon the direction of current flow through the galvanometer, is fully described in U. S. Patent No. 1,438,219, issued to A. B. Clark, December 12, 1922, and the details

of said mechanism are therefore not described herein. If the resistance of the pilot circuit changes due to a change in temperature, the bridge W is unbalanced, thereby causing current to flow through the galvanometer G in accordance with the direction of unbalance. The deflection of the needle of the galvanometer causes the shaft S to be rotated step by step in a manner fully described in the Clark patent, thereby causing the switch arm *s'* to be rotated until the bridge is again balanced. This rotation of the shaft S produces a corresponding movement of the switch arms *s''* so that said switch arm is moved to a different one of the controlling contacts over which it is adapted to ride. This results in applying ground to one of the control wires 1, 2, 3, 4, etc.

The amplifier AE is provided with a potentiometer arrangement PE for determining the gain of the amplifier. This potentiometer arrangement is illustrated schematically but, as is well understood in the art, the setting of the potentiometer is determined by the energization of some one of a group of relays connected to the conductors 1, 2, 3, 4, etc. Similarly, the amplifier AW is provided with a potentiometer arrangement PW whose setting is likewise determined by the energization of one of a group of relays connected to the conductors 1, 2, 3, 4, etc. Consequently, when the switch arms *s''* is shifted to a new position, a different setting of the potentiometer arrangements PE and PW results so that the gain of the two amplifiers is changed in proportion to the transmission change indicated by the pilot wire mechanism.

The echo suppressor arrangement associated with the four-wire circuit comprises two sets of echo suppressor units, one associated with the line LE and the other associated with the line LW upon the output sides of the repeaters AE and AW respectively. The echo suppressor unit associated with the line LE comprises an amplifier SAE and a rectifying tube RE on the output side of which is connected a voice control relay VE. The amplifier functions to amplify the voice currents received and impress them upon the rectifier tube. The rectifier tube has its grid potential so adjusted in its normal operation that no current flows in the plate circuit, but when voice currents are superposed on the normal grid potential, rectified currents corresponding to the voice currents will flow through the relay VE. When the relay VE is actuated in response to voice currents it closes a short circuit connection in response to voice currents a short circuit connection across the output side of the amplifier AW to prevent echo currents being transmitted back over the line LW as the result of direct transmission over the line LE. The short-circuit connection established also short-circuits the input side of the echo suppressor unit associated with the line LW.

The last mentioned echo suppressor unit likewise comprises amplifier SAW, rectifier tube RW, and voice-operated relay VW operating in the same manner as the corresponding elements of the echo suppressor unit first described. When the relay VW operates in response to voice currents transmitted over the line LW it short-circuits the output side of the amplifier AE and also short-circuits the input side of the echo suppressor unit associated with the line LE.

Normal adjustments of the sensitivity of the echo suppressor units may be accomplished by connecting the grids of the amplifiers SAE and SAW to suitable taps on the secondary windings of the input transformers. The usual adjustment should be such that the echo suppressors will be responsive to weak voice currents transmitted over the lines, but will be unresponsive to noise currents. As already pointed out, if the gain of the amplifiers AE and AW be adjusted in order to bring the over-all transmission of the four-wire circuit back to normal the normal sensitivity adjustment of the echo suppressor units may no longer be satisfactory. If the gain of the amplifiers AE and AW be increased the level of the noise currents will be raised so that the echo suppressors may respond to noise currents. On the other hand, if the gain of the amplifiers be materially decreased the echo suppressor units may fail to respond to weak voice currents at the originating ends of the four-wire lines.

It is therefore proposed in accordance with the present invention to automatically change the sensitivity of the echo suppressor units as the Wheatstone bridge arrangement adjusts the setting of the potentiometers PE and PW. As shown in the drawing, this result is accomplished by connecting relays $R_1$, $R_2$, $R_2$ and $R_3$ to the wires 1, 2, 3 and 4, over which circuits may be completed by means of the switch arm *s''* of the adjusting mechanism. The contacts of these relays connect wire 20 to different points upon a potentiometer 21 bridged across the C battery which supplies the normal operating potential to the grids of the rectifiers RE and RW.

When the regulating apparatus operates to increase the gain of the amplifiers AE and AW the particular relay of the group $R_1$, $R_2$, etc., which is operated will connect the grids of the rectifier tubes to a point on the potentiometer which is more negative than the point to which the grids were connected before. Obviously, it will then require a greater volume of voice currents to produce rectified currents in the output circuit of the tubes RE and RW. If, on the

other hand, the gain of the amplifiers AE and AW is decreased the relay operated will connect conductor 20 in an obvious manner to a point upon the potentiometer 21 which is less negative than the point to which the grids of the rectifiers were previously connected. Under these conditions it will require voice currents of less volume to produce rectified currents in the output circuits of the tubes RE and RW.

It will be clear therefore that as the gain of the amplifiers in the four-wire circuit is changed in one direction or the other a compensating change is made in the sensitivity of the echo suppressor units so that in effect the rectified voice currents operating the relays VE and VW will be the same regardless of the adjustment of the amplifiers AE and AW for a given volume of current applied at the transmitting end of the circuit.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a signaling system, a transmission circuit, a variable transmission element associated with said circuit, means to automatically vary the transmission of said transmission element in response to changes in the over-all transmission equivalent of said circuit, an echo suppressor associated with said circuit, and means automatically responsive to changes in the adjustment of said transmission element to produce compensating changes in the sensitivity of the echo suppressor.

2. In a signaling system, a transmission circuit, a variable transmission element associated with said circuit, mechanism automatically responsive to changes in the over-all transmission of said circuit to vary the adjustment of said transmission element, an echo suppressor associated with said circuit, and means automatically controlled by said automatic mechanism for automatically adjusting the sensitivity of said echo suppressor.

3. In a signaling system, a transmission circuit, a variable transmission element associated therewith, automatic mechanism responsive to changes in the transmission equivalent of said circuit to variably adjust said transmission element, an echo suppressor including a vacuum tube associated with said circuit, and means controlled by said automatic mechanism for varying the normal potential applied to the grid of said tube.

4. In a signaling system, a transmission circuit, a variable transmission element associated with said circuit, a pilot conductor subjected to transmission conditions similar to those affecting said transmission circuit, an automatic adjusting device responsive to changes in the current flow in said pilot circuit, means controlled by said automatic adjusting device for automatically adjusting the transmission of said transmission element, an echo suppressor associated with said transmission circuit, and means controlled by said automatic adjusting device for adjusting the sensitivity of said echo suppressor.

5. In a signaling system, a transmission circuit, a variable transmission element associated with said circuit, a pilot conductor subjected to transmission conditions similar to those affecting said transmission circuit, an automatic adjusting device responsive to changes in the current flow in said pilot circuit, means controlled by said automatic adjusting device for automatically adjusting the transmission of said transmission element, an echo suppressor associated with said transmission circuit, said echo suppressor including a vacuum tube, and means controlled by said automatic adjusting device for automatically varying the normal grid potential applied to said tube.

6. In a signaling system, a four-wire transmission circuit, an amplifier in each line of the four-wire circuit, a pilot circuit subjected to the same transmission conditions as the lines of the four-wire circuit, an automatic adjusting device associated with said pilot circuit, means controlled by said automatic adjusting device for adjusting the gain of said amplifiers, an echo suppressor unit associated with each line of the four-wire circuit, and means controlled by said automatic adjusting device for adjusting the sensitivity of said echo suppressor units to compensate for the change in the gain of said amplifiers.

7. In a signaling system, a four-wire transmission circuit, an amplifier in each line of the four-wire circuit, a pilot circuit subjected to the same transmission conditions as the lines of the four-wire circuit, an automatic adjusting device associated with said pilot circuit, means controlled by said automatic adjusting device for adjusting the gain of said amplifiers, an echo suppressor associated with each line of the four-wire circuit, each echo suppressor including a vacuum tube, and means controlled by said automatic adjusting device for varying the normal grid potential applied to said vacuum tubes to compensate for the change in the gain of said amplifiers.

In testimony whereof, I have signed my name to this specification this 9th day of September, 1925.

HAROLD S. HAMILTON.