July 1, 1924. 1,499,464

O. H. LOYNES

TRANSMISSION REGULATING CIRCUITS

Filed Jan. 26, 1921 2 Sheets-Sheet 1

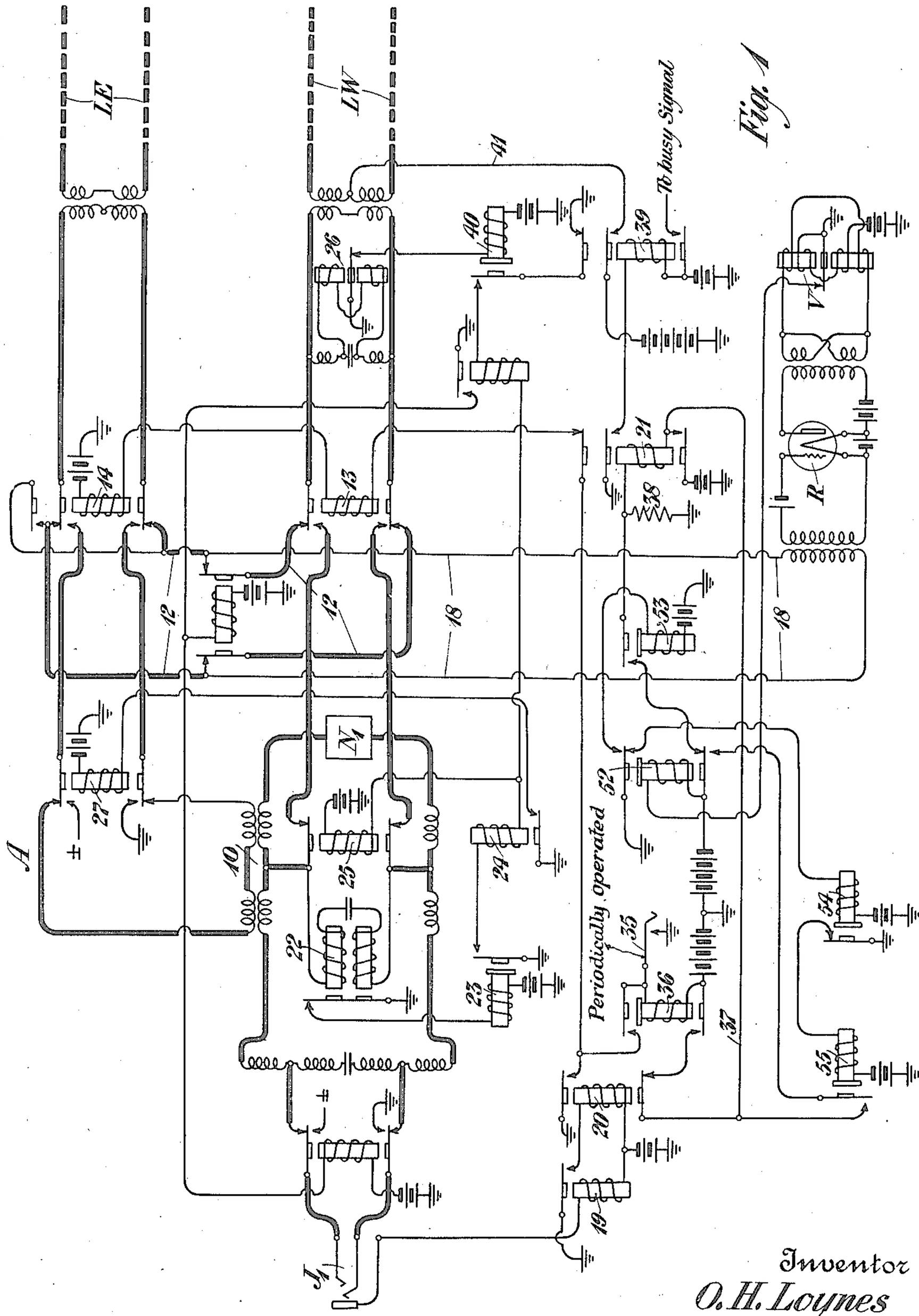

Fig. 1

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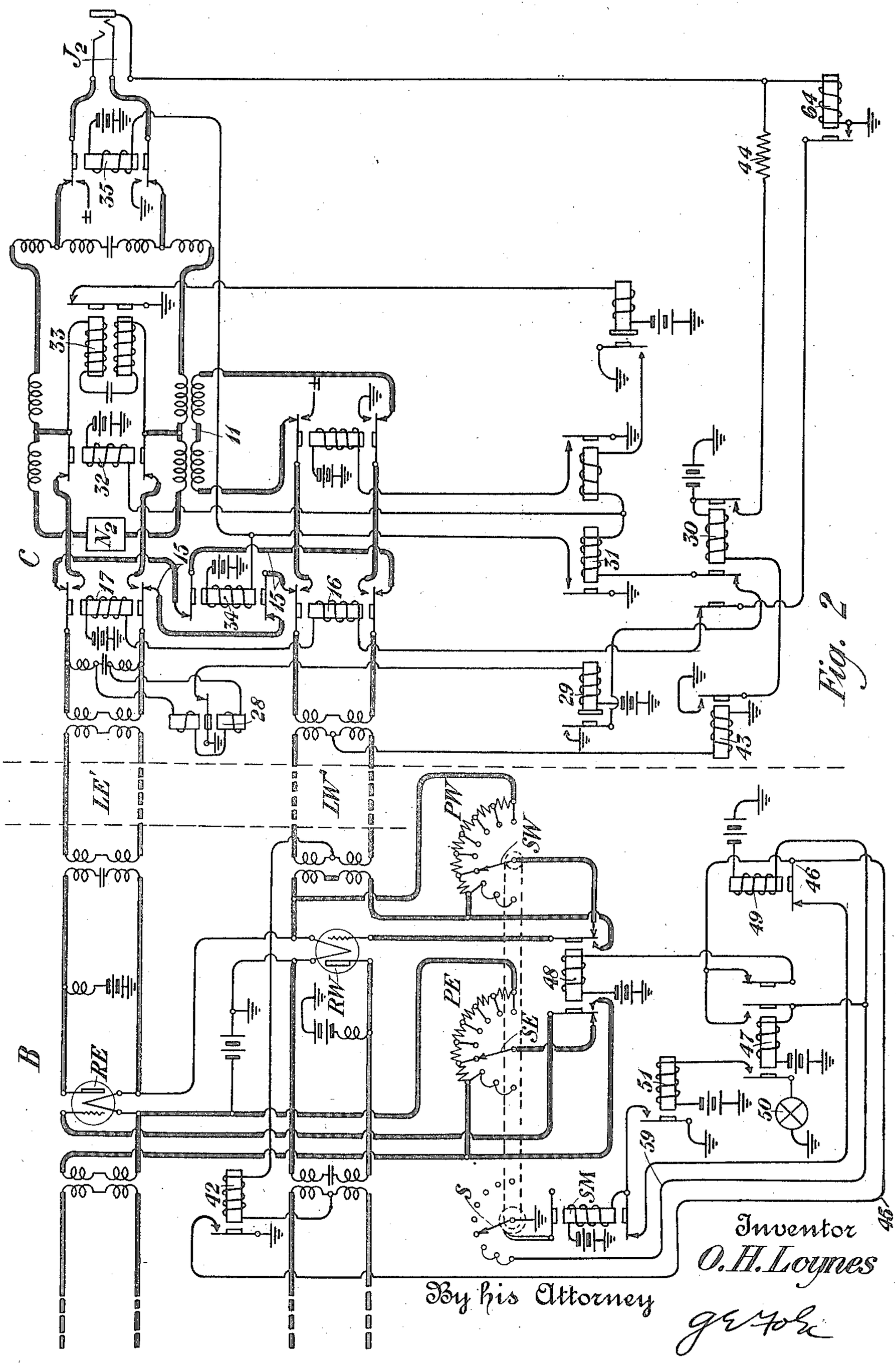

Fig. 2

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Patented July 1, 1924. 1,499,464

UNITED STATES PATENT OFFICE.

OWEN H. LOYNES, OF WOODRIDGE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TRANSMISSION-REGULATING CIRCUITS.

Application filed January 26, 1921. Serial No. 440,103.

To all whom it may concern:

Be it known that I, OWEN H. LOYNES, residing at Woodridge, in the county of Bergen and State of New Jersey, have invented certain Improvements in Transmission-Regulating Circuits, of which the following is a specification.

This invention relates to signaling circuits and more particularly to means for controlling the transmission equivalent of such circuits.

In general, the transmission equivalent of a circuit varies, due to a number of causes. For example, in the case of a transmission circuit of the four-wire type in which a pair of separate transmission lines are employed for transmission in opposite directions, the transmission may vary due to causes which affect both sides of the circuit in the same manner. For example, variations may occur in the resistance of the conductors or loading coils, or variations in the capacity, inductance, or electrical characteristics of the cable may affect the transmission equivalent. The same holds true of variations in the potential of repeater batteries common to repeaters in both sides of the circuit. There are also a number of factors which affect the two sides of the circuit differently, such as variations in the structure of the repeater bulbs, variations in the potential of the grid batteries, or accidental variations due to the existence of bad joints, etc.

All of these causes may contribute to produce considerable variation in the transmission over a circuit from time to time, thus rendering it desirable that some means be provided whereby the transmission equivalent may be maintained constant. It has heretofore been proposed to control the adjustment of the transmission equivalent by disconnecting the ends of the two transmission lines, comprising a four-wire circuit from their terminating arrangements, and then interconnecting the ends through loop connections which may include adjustable transmission devices. The gain in the four-wire circuit thus looped together at the ends is then increased to a maximum value so that singing takes place in the circuit. By gradually decreasing the transmission equivalent, as for example, by varying the amplification of a repeater in the circuit, a point will be reached at which singing just ceases. The circuit will then have a desired transmission equivalent determined by the equivalent of the transmission device included in the loop.

It is one of the objects of this invention to provide a circuit in which the transmission equivalent may be controlled in accordance with the method above outlined, the circuit being so arranged that the two lines of the four-wire circuit are normally looped together with the singing responsive relay bridged across the circuit when it is not in use.

Another object of the invention is to provide a circuit of the character above set forth in which the voice operated or singing responsive relay is bridged across the circuit at one end and the regulating element is located at an intermediate point in the four-wire circuit.

Another object of the invention is to provide a regulating circuit which is arranged to function at regular intervals, but which is so organized that if the circuit is busy at the time the regulating means normally functions, the regulating mechanism will be maintained unoperative until the circuit is released, when it will proceed to correct the transmission equivalent in the usual manner.

Another object of the invention is to provide a circuit which is arranged to give a busy indication during the period when it is being regulated to warn the operator that she should not plug into the line. The circuit is also preferably so arranged that should the operator plug in while it is being regulated, no harm can be done.

Another object of the invention is to provide a circuit which is so arranged as to prevent ringing current from coming back on one side of the circuit when ringing on the other side, due to the ends being normally looped together.

The arrangements for accomplishing these objects as well as other objects, more fully appearing hereinafter, will be clear from the following description when read in connection with the accompanying drawing; Figs. 1 and 2 of which, when taken together, constitute a circuit diagram embodying a preferred form of the invention.

Referring to the drawing, apparatus is shown associated with a four-wire circuit in-

terconnecting stations A, B and C, said circuit comprising lines LE and LW between stations A and B and lines LE′ and LW′ between stations B and C. The lines LE and LE′ serve for transmission from west to east from station A through station B to station C. Similarly, the lines LW and LW′ are used for transmission from east to west from station C through station B to station A. At station A the lines LE and LW are connected through a balanced transformer arrangement 10 with a two-wire terminal leading to a jack J_1 and an artificial line or network N_1, is provided for balancing the two-wire line which may be associated with the jack. In a similar manner, the lines LE′ and LW′ are connected through a balanced transformer 11 with a two-wire terminal leading to a jack J_2, which serves to connect the system with a two-wire line. A network N_2 is provided for balancing the two-wire line which may be connected to the jack. In the normal condition of the circuit, the lines LE and LW are disconnected from the balanced transformer 10 and the two-wire terminal and are looped directly together over conductors 12. Relays 13 and 14 are provided, however, which under proper conditions will disconnect the lines from conductors 12 and connect them to the balanced transformer and two-wire terminal arrangement. Similarly at station C the lines LE′ and LW′ are normally looped together over conductors 15 and relays 16 and 17 are provided for disconnecting the ends of the lines from each other and associating them with the transformer 11 and the other terminal apparatus.

At station B amplifying arrangements are provided, comprising one-way repeaters RE and RW, included between the line sections. These repeaters are provided with potentiometers PE and PW for controlling their amplifications, the setting of the potentiometers being determined by an automatic switch having wipers S, SE and SW. In order to control the setting of the switch, a bridge connection 18 is provided at station A, this bridge connection being associated with the conductors 12 and having connected therewith an amplifier R and a voice controlled relay V of well known type. The voice controlled relay V determines the action of the switch S by means of a simplex circuit extending through the several stations over the two sides of one of the lines in parallel.

Further details of the apparatus will now be clear from a detailed description of the operation which is as follows:

An operator at the station A, desiring to establish a connection with a two-wire line at the station C, will plug into the jack J_1, thereby energizing the relay 19, which in turn closes a circuit of relay 20. Relay 20 completes a circuit from ground over its upper contact, upper normal contact of relay 21 and through the windings of relays 13 and 14 to battery. Relays 13 and 14, upon being energized, disconnect the lines LE and LW from the loop through the circuit 12 and connect said lines through the balanced transformer 10 with the two-wire terminal leading to the jack J_1, so that the circuit, so far as station A is concerned, is in condition for carrying on a conversation. The operator at station A then applies ringing current to the talking conductors of the two wire-terminal, thereby operating the ringing responsive relay 22. Relay 22, operating in response to the ringing current applied to the two-wire terminal, opens the circuit of a slow release relay 23, which in turn closes a circuit through relays 24 and 25. Relay 25 disconnects the line LW from the bridge across the midpoints of the balanced transformer 10 to prevent the ringing current from actuating the ringing relay 26, associated with the line LW. Relay 24 completes a circuit for the ringing relay 27, which connects ringing current over its front contacts to the terminals of the line LE, so that the ringing current is transmitted over the lines LE and LE′, to station C. The ringing current thus transmitted actuates the relay 28 at station C to open the circuit of the slow release relay 29. Relay 29, upon releasing its armature, completes a circuit from ground over the inner left hand back contact of relay 30 through the winding of relay 31 and through the winding of relay 32 to battery. Relay 32 disconnects the line LE′ from the bridge connected across the midpoints of the windings of the transformer 11, thereby preventing the ringing current from actuating the ringing responsive relay 33. Relay 31 completes a circuit through the windings of relays 34 and 35, the former of which opens the connection 15 between the lines LE′ and LW′ to prevent the ringing current from being transmitted back over the lines LW′ and LW to station A. Relay 35 over its front contacts applies ringing current to the terminal dro· (not shown). The operator at station C, in response to the ringing signal thus transmitted, will plug into the jack J_2, thereby operating the relay 64. Relay 34 completes a circuit from ground over its front contact over the left-hand back contact of relay 30 and through the windings of relays 16 and 17 to battery. Relays 16 and 17 disconnect the lines LE′ and LW′ from the loop through the circuit 15, and connect the lines directly to the transformer 11 and terminal equipment so that the entire circuit from station A to station C is now in condition to carry on a conversation in the usual manner.

In order to adjust the transmission equivalent of the circuit thus described at pe-

riodic intervals, a contact 35 is provided at station A. This contact may be operated by a clock or other suitable mechanism which may be arranged to close the contact, for example, every half hour. Contact 35, when operated, completes a circuit through the slow release relay 36. Relay 36 at its lower front contact completes a circuit from battery over the lower back contact of relay 20 over conductor 37, and through the winding of relay 21 and resistance 38 to ground. This circuit will not be completed if the four-wire circuit is busy at the moment when the key 35 is operated, since the relay 20 is actuated when the circuit is busy, thereby holding open the circuit just traced. Under these circumstances relay 36 will be locked up over its upper front contact and the upper front contact of the relay 20 until the circuit is released, when the circuit just described will be completed over the lower back contact of the relay 20. As the switch 35 has opened in the meantime, relay 36 will release, but as it is slow acting, a sufficient interval is provided to transmit an impulse through the relay 21. Relay 21 locks up over its lower front contact, and at its upper contact opens the circuit of relays 13 and 14 to prevent any possibility of these relays being actuated to disconnect the lines LE and LW from the loop connection 12, should an operator plug into the jack J_1. At its remaining front contact, relay 21 completes a circuit for the relay 39. Relay 39, at its lower front contact, connects battery to a busy signal (not shown) and at its upper contact opens the circuit controlled by the ringing responsive relay 26 through the slow release relay 40. At its middle front contact relay 39 connects a Morse battery to a simplex circuit over conductor 41, the two sides of the line LW in parallel through the winding of relay 42 at station B over the two sides of the line LW′ in parallel and through the winding of relay 43 at station C to ground. Relays 42 and 43 are operated over the circuit just traced, the latter functioning to complete the circuit of the relay 30 which at its right hand contact connects battery through a resistance 44 to the sleeve wire to put a busy test on the sleeve. At its extreme left hand contact relay 30 opens the circuit of the relays 16 and 17 to prevent the disconnection of the lines LE′ and LW′ from the loop through the circuit 15 in case an operator should plug in the jack J_2. At its milddle contact relay 30 opens the circuit of relays 31 and 32 to prevent the transmission of a false ringing signal due to any possible actuation of the relay 28.

At station B the actuation of the relay 42 completes a circuit from ground over its left hand front contact over conductor 45 to point 46, and thence over the right hand back contact of relay 47 through the winding of relay 48 to battery. A parallel connection extends from point 46 over the normal contact of relay 49 over the lower back contact of stepping magnet SM to battery. Relay 48 upon being actuated, shifts the potentiometer connections so that they are no longer controlled by the switch arms SE and SW but are set for maximum gain. Under these conditions, the four-wire circuit which is looped together at its ends, begins to sing or howl. Returning for the moment to the stepping magnet SM the said magnet is operated over the circuit previously traced through its winding and intermittently interrupts its own circuit, thereby stepping the switch wipers S, SE and SW from the position of adjustment in which they were previously set, to the position for maximum gain, at which point connection will be established from ground over the wiper S, over the conductor 59 and thence in parallel through the windings of relays 47 and 49 to battery. Relay 49 opens a circuit previously traced for the stepping magnet SM, and relay 49 at its outer right hand contact opens a circuit of the relay 48, which releases to restore the control of the potentiometers PE and PW to the switch wipers SE and SW. At its inner right hand front contact, relay 47 locks up over conductor 45 so that the circuit is now controlled by the relay 42. At its left hand front contact, relay 47 completes a circuit through the interrupter 50 and the winding of relay 51. Relay 51 is therefore intermittently energized and at its front contact controls the energization of the stepping magnet SM, which now continues to step the switch wipers step by step to gradually reduce the gain of the amplifiers RE and RW.

As soon as the circuit began to sing upon the energization of the relay 48 at station B and during the continuance of the singing while the potentiometers are being adjusted, the singing tone was impressed through the circuit 18 and amplifier R upon the voice operated relay V. The armature of this relay is normally adjusted to maintain the circuit of a slow release relay 52 closed. The chattering of the armature of relay V reduces the current through the relay 52, which is deenergized. At its upper back contact relay 52 completes a circuit for relay 53 and the circuit remains in this condition so long as the singing continues. When, however, the stepping of the switch at the station B has reduced the gain of the repeaters until the four-wire circuit has a zero transmission equivalent, the singing ceases and the voice operated relay V assumes its normal condition, so that the circuit through the slow release relay 52 is again closed. At its upper contact relay 52 opens a circuit of the slow release relay 53, but before the armature of

the relay 53 falls off a momentary impulse is transmitted from battery over the lower front contact of relay 52 and front contact of relay 53 through the resistance 38 to ground. This path acts as a short circuit to the winding of the relay 21 which is accordingly released. Relay 21 opens a circuit of relay 39, thereby restoring the busy signal disconnecting the Morse battery from the simplex circuit over the conductor 41 and causing the deenergization of relay 42 at station B and relay 43 at station C. Relay 43 at station C opens a circuit of relay 30, thereby removing the busy test from the sleeve of jack J_2 and restoring the apparatus at station C to normal. Relay 42 at station B, by removing the ground from the point 46, causes the release of relay 47, which opens the impulse circuit for the stepping magnet SM, thus bringing the switch wipers to rest in the position to which they have been adjusted. During the stepping of the switches, the relay 49 was locked up over the middle locking contact of relay 47 to hold open the original stepping circuit of the magnet SM. The disconnection of the ground from point 46 therefore, releases relay 49 at the same time that relay 47 is deenergized.

It will be observed that during the process of adjustment of the transmission equivalent just described, relay 21 at station A and relay 30 at station C are maintained energized. The relay 21 through the relay 39, as previously described, controls the busy signal and the relay 31 applies a busy test to the jack J_2. Operators are therefore warned against interfering with the process of adjustment of the circuit by being apprised that the circuit is busy. Should an operator plug into either end of the circuit, however, the process of adjustment will not be interfered with since relays 21 and 30 hold open the circuits of relays 13 and 14 at station A and relays 16 and 17 at station C, thereby preventing the opening of the loop.

Should the condition of the circuit at any time become such that a continuous singing or howling takes place, this fact alone will be sufficient to institute the operations necessary to adjust a circuit without the actuation of the time controlled key 35. For example, when the apparatus associated with the four-wire circuit is in normal condition, a singing oscillation transmitted over the circuit will operate the voice relay V in the manner already described, to cause the release of the slow release relay 52. The relay 52 at its upper back contact completes a circuit for relay 53, as already described; at its upper front contact relay 52 when energized, maintains the circuit of slow release relay 54 closed and relay 54 in turn maintains the circuit of a slow release relay 55 closed. The release of relay 52 is therefore followed after an interval, by the release of relay 54, which in turn is followed after another interval by the release of relay 55. Relay 55 closes a circuit from battery over the lower back contact of relay 52, back contact of relay 55 and over conductor 37 through the winding of relay 21 and through resistance 38 to ground. As soon as the relay 21 is energized over this path the succeeding operations incident to adjustment of the circuit, take place in exactly the same manner as has been previously described. The purpose of the chain of slow release relays 52, 54 and 55 is to prevent the actuation of the relay 21 under the conditions just described, where the circuit picks up a temporary noise or howl by induction from some external circuit, thus preventing an unnecessary adjustment of the switches.

If, after the process of adjustment has started and the switch wipers at station B are being rotated, the conductors of the four-wire circuit should be opened at any point, as for example, by an operator at a testboard, the singing would at once cease and the rotation of the switch would be stopped in the same manner as occurs when singing ceases because of proper adjustment of the circuit. As soon as the circuit is closed again, however, singing will commence owing to the fact that the four-wire circuit is out of adjustment and the chain of slow release relays 52, 54 and 55 will again be set in operation to negotiate the process of adjustment anew, so that it can continue from the point at which it was interrupted.

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 of the invention as defined in the following claims.

What is claimed is:

1. A four-wire circuit comprising two lines for transmitting in opposite directions, means normally looping the lines together at their ends, terminal arrangements for connecting said lines with terminal two wire lines, and means responsive to the connection of said two wire lines with said terminating arrangements for opening said loop connections and connecting the lines of the four wire circuit with said terminating arrangements.

2. A four-wire circuit comprising a pair of lines for transmitting in opposite directions, means normally looping said lines together at their ends, terminal apparatus at each end comprising a two-wire terminal and a hybrid coil for associating said two-wire terminal with the ends of said pair of lines, and means responsive to the association of a two-wire line with said two-wire terminal for disconnecting said pair of lines

from the means for looping the ends of said lines together, and for connecting said pair of lines with said hybrid coil.

3. A four-wire circuit comprising a pair of transmission lines for transmitting in opposite directions, means normally looping the ends of said lines together, terminal arrangements whereby the ends of said pair of lines may be associated with terminal two wire lines, means whereby in response to the establishment of a transmission connection with one of said terminal arrangements, the corresponding ends of said pair of lines are disconnected from said means for looping the ends thereof together, and are associated with said terminal arrangements, means for transmitting ringing current over one of the lines to the opposite end thereof, and means responsive to ringing current, thus transmitted, for opening the means for looping the opposite ends of said pair of lines together, in order to prevent the ringing current from being transmitted back over the other line.

4. A four-wire circuit comprising a pair of transmission lines for transmitting in opposite directions, means for looping the ends of said lines together, terminal arrangements for associating the ends of said lines with terminal two-wire lines, said terminal arrangements including signaling means for calling the attention of an operator, means responsive to the establishment of a connection with the terminating arrangement associated with one end of the lines for disconnecting the ends of said lines from said means for looping the ends together, and connecting the lines to the terminating arrangement associated therewith, means for transmitting ringing current over one of the lines to the distant end thereof, means at the distant end of said line responsive to said ringing current for opening the means for looping the opposite ends of the lines together, to prevent the ringing current from being transmitted back in the opposite direction over the other line, and means whereby the ringing current will actuate the signaling means for calling the attention of an operator.

5. A four-wire circuit comprising a pair of transmission lines for transmitting in opposite directions, means for normally looping the ends of said lines together, to form a circuit which will sing when the gain exceeds the loss, terminating arrangements for said lines, means whereby when a transmission circuit is extended over said lines, the ends of said lines will be disconnected from said means for looping the ends together, and connected with said terminating arrangements, and devices associated with one of the means for looping the ends of said lines together for responding to the singing of the circuit.

6. A four-wire circuit comprising a pair of transmission lines for transmitting in opposite directions, means for normally looping the ends of said lines together to form a circuit which will sing when the gain exceeds the loss, terminating arrangements for said lines, means whereby when a transmission circuit is extended over said lines, the ends of said lines will be disconnected from said means for looping the ends together and connected with said terminating arrangements, devices associated with one of the means for looping the ends of said lines together for responding to the singing of the circuit, and means controlled by said singing responsive devices for adjusting the transmission equivalent of the circuit.

7. A four-wire circuit comprising a pair of transmission lines for transmitting in opposite directions, means for normally looping the ends of said lines together to form a circuit which will sing when the gain exceeds the loss, terminating arrangements for said lines, means whereby when a transmission circuit is extended over said lines, the ends of said lines will be disconnected from said means for looping the ends together and connected with said terminating arrangements, devices associated with one of the means for looping the ends of said lines together for responding to the singing of the circuit, and means controlled by said singing responsive devices for adjusting the transmission equivalent of the circuit, said adjusting means being located at a point along said lines intermediate between the ends thereof.

8. In a signaling system a transmission circuit whose equivalent may vary from time to time, means associated with said circuit for periodically adjusting the equivalent thereof, and means whereby, if said circuit is in use for the transmission of signals during an adjusting period, said adjusting means will not function.

9. In a signaling system a transmission circuit whose equivalent may vary from time to time, means associated with said circuit for periodically adjusting the equivalent thereof, and means whereby, if said circuit is in use for the transmission of signals during an adjusting period, the operation of said adjusting means will be delayed and the adjusting means will function to adjust the transmission equivalent of the circuit as soon as it is idle.

10. In a signaling system, a transmission circuit whose equivalent may vary from time to time, means for adjusting the equivalent of said circuit and means to give a busy indication when said circuit is being adjusted.

11. In a signaling system a transmission circuit whose equivalent may vary from time to time, means for periodically adjusting the

transmission equivalent of said circuit and means to give a busy indication during the periods when the circuit is being adjusted to warn an operator from establishing a connection over the said circuit.

12. In a signaling system a transmission circuit comprising two transmission lines for transmitting in opposite directions, means for looping the ends of said lines together in order to adjust the transmission equivalent thereof, terminating arrangements adapted to be associated with the ends of said lines, means responsive to the establishment of a transmission connection with said terminating arrangements for disconnecting the ends of the lines from the means for looping said ends together and associating the ends of the lines with the terminating arrangements, and means whereby when the transmission equivalent of the lines is being adjusted, the operation of the means for disconnecting the ends of the lines from the means for looping the ends together will be defeated.

13. In a signaling system a tranmission circuit comprising two transmission lines for transmitting in opposite directions, means for looping the ends of said lines together in order to adjust the transmission equivalent thereof terminating arrangements adapted to be associated with the ends of said lines, means responsive to the establishment of a transmission connection with said terminating arrangements for disconnecting the ends of the lines from the means for looping said ends together and associating the ends of the lines with the terminating arrangements, and means whereby when the transmission equivalent of the lines is being adjusted, the operation of the means for disconnecting the ends of the lines from the means for looping the ends together will be defeated, and a busy signal will be given.

14. In a signaling system, a four-wire circuit comprising a pair of transmission lines for transmitting in opposite directions, means for looping the ends of said lines together to form a circuit which will sing when the gain exceeds the loss, means for adjusting the transmission equivalent of said lines, said means functioning whenever the transmission conditions become such that the circuit sings.

15. In a signaling system, a four-wire circuit comprising a pair of lines for transmitting in opposite directions, means for looping the ends of said lines together to form a circuit which will sing when the gain exceeds the loss, means responsive to the singing of said circuit for adjusting the transmission equivalent thereof, and means so controlled by the singing of the circuit that if the circuit be inadvertently interrupted during the process of adjustment, the adjusting means will cease functioning until the circuit is again closed, whereupon the adjustment of the transmission equivalent will be completed.

16. In a signaling system a four-wire circuit comprising a pair of lines for transmitting in opposite directions, means for normally looping the ends of said lines together to form a circuit which will sing when the gain exceeds the loss, terminal arrangements to which the ends of said lines may be connected independently of said looping means when the lines are used for the transmission of signals, means at an intermediate point along said lines for adjusting the transmission equivalent thereof, said means comprising variable transmission devices and automatic switches for controlling the adjustment of said variable transmission devices, devices associated with said means for looping the ends of the lines together for responding to the singing of the circuit, and means whereby said devices control the operation of said automatic switches.

In testimony whereof, I have signed my name to this specification this 24th day of January 1921.

OWEN H. LOYNES.