

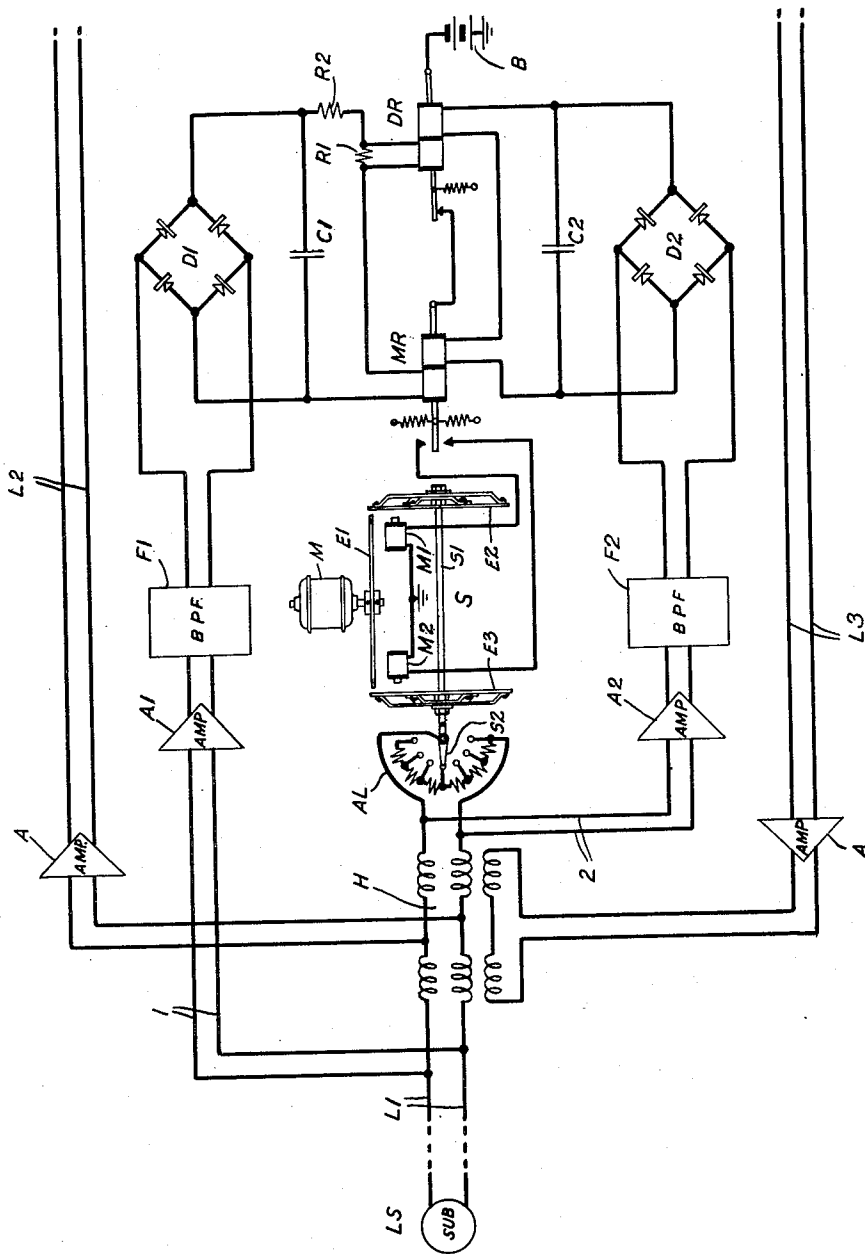
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TWO-WAY SIGNAL TRANSMISSION SYSTEM

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TWO-WAY SIGNAL TRANSMISSION SYSTEM

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5 Claims. (Cl. 179-170)

The invention relates to a two-way transmission system and particularly to a two-way signaling system including a two-wire line and an adjoining link, such as a four-wire circuit, providing separate paths, one for transmitting to the two-wire line and the other for transmitting from that line. It is well known in the art that systems of this sort are used in connecting a toll line from a distant point to a local subscriber. The two-wire circuit to the local subscriber may and customarily does include one or more inter-office trunks and the subscriber's line so that the impedance of the two-wire line for a given connection depends upon the particular route and instrumentalities used in extending the connection to the local subscriber.

In systems of this sort where a four-wire circuit is connected to a two-wire line, as is well known in the art, a hybrid coil is used and an artificial balancing line is provided for the purpose of balancing the two-wire line. As the impedance of the two-wire line may vary, as above stated, it is difficult to obtain an accurate balance with a given artificial line. It has been proposed, however, to provide switching arrangements which interchange artificial lines and insure in a particular connection the use of an artificial line which is a fair approximation to that of the two-wire line. Where unbalance is present due to inaccurate matching of the artificial line and the actual line undesirable effects arise, the most important of which manifests itself in echoes and, as is well known in the art, devices known as echo suppressors are generally provided to minimize this effect.

In accordance with the present invention it is proposed to provide an artificial balancing line which can be adjusted continuously during the passage of the signals and in this way provide a balance sufficiently close so that the echo suppressors may either be left out or used in a manner such that their effects on the transmission are less harmful than if a fixed artificial balancing line were used. Broadly, in accordance with the invention, devices are provided which function automatically to determine at any instant whether the line impedance or the network impedance is higher and to raise or lower the network impedance accordingly. Also, in accordance with the invention, his control is exercised by the distant talker rather than by the local subscriber and instrumentalities are provided whereby the talking currents originated by the local talker are ineffective in exercising any control over the balancing arrangement. The ad-

vantage of such arrangement is that once the balance has been arrived at in response to the voice currents from the distant talker it will not be disturbed when the local talker takes command of the circuit.

In a copending application of K. G. Van Wylen, Serial No. 380,428, filed Feb. 25, 1941, other arrangements for a similar purpose are disclosed, in which an optimum artificial line is automatically selected and associated with the two-wire line prior to the start of conversation.

In the drawing the single figure shows schematically a circuit diagram of an incoming toll telephone connection involving the connection of a four-wire circuit to a two-wire line.

Referring to the drawing, the four-wire toll circuit includes the oppositely-directed two-wire circuits L2 and L3 and the two-wire line is indicated by the line L1. The usual amplifiers or repeaters, one for each of the circuits L2 and L3, are indicated by the triangles A, the apex of each triangle indicating the direction of transmission. The two-wire circuit L1 is extended to the local subscriber's station and may include a number of links, not shown, such as interoffice trunks and cord circuits, as is common in well-known telephone toll switching practice. The usual hybrid coil for connecting the four-wire circuit to the two-wire line is indicated by H and the artificial line or balancing network is shown at AL.

The impedance of the artificial line AL as shown is arranged to be varied by the operation of a well-known type of two-motion switch indicated generally at S. In switch S, a source of power M continuously rotates the disc E1 which may be frictionally engaged with either of the discs E2 and E3 by the operation of the magnets M1 and M2. As shown, the discs E2 and E3 are flexibly mounted on the shaft S1 coupled to the switch-arm S2 which varies the impedance of the artificial line. The arrangement is such that if the magnet M1 is energized the switch-arm S2 is moved in a clockwise direction to increase the impedance of the artificial line and if the magnet M2 is energized the switch-arm S2 is moved in the opposite direction to decrease the impedance of the artificial line. As illustrated, the switch S varies the resistance of the artificial line, but it is obvious that any other characteristic of the line may be similarly varied, as, for example, the capacity or inductance or a combination of resistance, inductance and capacity.

The energization of magnets M1 and M2 is controlled by two differentially wound relays, one a measuring relay MR, and the other a direction

indicating relay DR, these relays through their armatures and contacts serving to connect the energizing battery B to magnet M1 or magnet M2, or to disconnect the battery from either magnet, depending on the manner of relay operation to be described. The relay MR is adjusted so that with equal currents in its two windings its armature remains in a neutral position. If the current in the left-hand winding is greater than in the right-hand winding, an upper contact is made and under reverse conditions a lower contact is made. The DR relay is biased so that the left-hand winding is rendered less sensitive than the right-hand winding and its contact is maintained closed except when the current in the left-hand winding is sufficient to overcome the more sensitive right-hand winding. The difference in sensitiveness of the two windings is provided by shunting a suitable resistance R1 across the left-hand winding.

Connected across the two-wire line L1 is a control circuit 1 including in order the high impedance input amplifier A1, band-pass filter F1 and rectifier D1, the output of which is passed through the left-hand windings of the relays MR and DR in series. Connected across the artificial line AL is a second control circuit 2 including the high impedance input amplifier A2, band-pass filter F2, and the rectifier D2, the output of which is passed through the right-hand windings of the relays MR and DR in series. Smoothing condensers C1 and C2 are connected across the output of the rectifiers D1 and D2, respectively. The resistance R1, the function of which has been described, being connected in shunt with the left-hand winding of the DR relay, would lower the resistance of the output circuit of the D1 rectifier and disturb the balance except that it is compensated for by the insertion of the series resistance R2.

Assuming that a connection has been established between the four-wire circuit shown and the two-wire local line, the operation of the circuit will now be described. First, assuming that the distant party is talking, the telephonic signal currents will be received over circuit L3 through amplifier A and through the lower windings of the hybrid coil H. If there is an approximate balance between the two-wire line and the artificial line, as will normally be the case, this energy will divide between the two-wire line L1 and the artificial line AL depending upon the degree of balance. As the input impedances of amplifiers A1 and A2 in control circuits 1 and 2 are high and equal, a small portion of this energy will pass through each of these circuits 1 and 2 in which it will be amplified by the amplifier A1 or A2, filtered by filter F1 or F2, rectified by rectifier D1 or D2 and passed through the left-hand or right-hand windings of the MR and DR relays, respectively. If the impedance of the two-wire line L1 is lighter than that of the artificial line AL, the voltage applied to A1 will be greater than that applied to A2. Thus, since these amplifiers have high impedance inputs, the current in the output of the rectifier D1, including the left-hand windings of the MR and DR relays, will be greater than the current in the output of the rectifier D2, which passes through the right-hand windings of the MR and DR relays. Under these conditions, the MR relay will close its upper contact but the DR relay will not open its contact because, as previously explained, it is biased so that the current passing through its left-hand winding must exceed by a

certain predetermined margin that flowing in its right-hand winding. As long as this unbalance exists between the artificial line and the two-wire line, the relay MR will close its upper contact and the switch S will drive the switch-arm S2 in its clockwise direction to increase the amount of impedance in AL. When a balance is obtained, the relay MR will restore to its neutral position and the artificial line AL will remain in adjustment. If, on the other hand, the energy in the control circuit 2 is measurably greater than in the control circuit 1, the right-hand windings of the relays MR and DR will become effective and the relay MR will close its lower contact and the switch S will move the switch-arm S2 in the opposite direction to decrease the amount of impedance in AL until it reaches a balanced point.

Inasmuch as the artificial line AL should be balanced with the two-wire L1, with respect principally to the incoming energy, means are provided to prevent this balance from being upset by transmission in the other direction. In the first place, it is obvious that the local subscriber's transmission may contain considerably more energy than the distant subscriber's and that such means must be provided to prevent the local subscriber from taking command of the circuit and upsetting the balance. This is accomplished by the DR relay. Energy from the local subscriber's line L1 will pass through hybrid coil H into the outgoing circuit L2, and under balanced conditions a much greater portion of that energy will pass through the control circuit 1 from L1 than will pass through the hybrid coil H to the artificial line AL and to control circuit 2, so that under any ordinary conditions a much greater amount of energy will pass through the left-hand windings of relays DR and MR than will pass through the right-hand winding of these relays. As a result, the DR relay will immediately release to disconnect battery B so that operation of the MR relay by control circuit 1 or 2 will not result in the energization of the magnets M1 or M2 from battery B. Thus, the previously established adjustment of the artificial line AL will not be disturbed by the outgoing speech energy of the local subscriber.

Various modifications of the circuits illustrated and described which are within the spirit and scope of the invention will be apparent to persons skilled in the art.

What is claimed is:

1. In combination in a two-way signal transmission system, a two-way signal transmission medium of variable impedance characteristics, a four-wire signal transmission circuit comprising two oppositely directed one-way signal transmission paths, a bridge circuit comprising a hybrid coil and an associated balancing network coupling said medium to one terminal of said four-wire circuit, and means to reduce echoes in said four-wire circuit during signal transmission between it and said medium comprising measuring means for effectively balancing the portion of incoming signals transmitted from the incoming path of said four-wire circuit through said hybrid coil to said medium against the portion of incoming signals transmitted from said incoming path through said hybrid coil to said balancing network, and means responsive to the direction and amount of the measured unbalance to adjust the impedance of said network accordingly so that it substantially balances the impedance of said line.

2. In combination in a telephone system, a two-way telephone line of variable impedance characteristic, a four-wire telephone circuit, a hybrid coil and associated balancing network for connecting one terminal of said four-wire circuit to said telephone line, and means to reduce echoes in said four-wire circuit during signal transmission between said four-wire circuit and said line comprising measuring means for effectively balancing the portion of incoming telephone signals transmitted from said four-wire circuit through said hybrid coil to said line against the portion thereof transmitted from said four-wire circuit through said hybrid coil to said network, and means responsive to the measured unbalance to adjust the impedance of said network accordingly until it provides a tolerable balance of the impedance of said line.

3. In combination in a telephone system, a two-way subscriber's telephone line, a four-wire telephone circuit, a hybrid coil and associated balancing network coupling said line and circuit, and means to reduce echoes in said circuit during telephone transmission between said line and circuit, comprising measuring means for effectively balancing the voice signals in said line received over said four-wire circuit from a distant subscriber against the voice signals supplied to said network, means responsive to the direction and amount of the measured unbalance to adjust the impedance of said balancing network accordingly so that it substantially balances the impedance of said line, and means to prevent false adjustment of the impedance of said network when voice signals from the local subscriber are being received over said two-way subscriber's line.

4. In combination in a telephone system, a two-way subscriber's telephone line, a four-wire telephone circuit, a hybrid coil and associated balancing network coupling said line and circuit, and means to reduce echoes in said circuit during telephone transmission between said line and circuit, comprising two voice-operated switching circuits respectively connected across said two-way line and said network on opposite sides of said hybrid coil, differential relay means

controlled by said switching circuits, operating in one direction for a greater predetermined voltage input to the switching circuit connected across said line than to the switching circuit connected across said network, and in the opposite direction for a predetermined greater voltage input to the switching circuit connected across said network than to the switching circuit connected across said line, means responsive to the operation of said differential relay means in said one direction to increase the impedance of said network and responsive to the operation of said differential relay means in said opposite direction to decrease the impedance of said network, and means to prevent false adjustment of the impedance of said network in response to voice signals from a local subscriber received over said line.

5. In combination, in a telephone system, a two-way subscriber's telephone line, a four-wire telephone circuit, a hybrid coil and associated balancing network coupling said line and circuit, and means to reduce echoes in said circuit during telephone transmission between said line and circuit comprising one voice-operated switching circuit connected across the line side, said hybrid coil and another voice-operated switching circuit connected across the network side of said hybrid coil, differential relay means controlled by the two switching circuits operating in one direction for a predetermined greater voltage input to said one switching circuit than to said other switching circuit and operating in the other direction for a predetermined greater voltage input to said other switching circuit than to said one switching circuit, means for increasing the impedance of said network when said differential relay means is operated in said one direction and decreasing its impedance when said differential relay means is operated in said other direction, in order to improve the balance of said line, and other differential relay means controlled by said switching circuits operating to prevent the adjustment of the impedance of said network when voice signals are being received over said line from the associated telephone subscriber.

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