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SIGNAL TRANSMISSION SYSTEM

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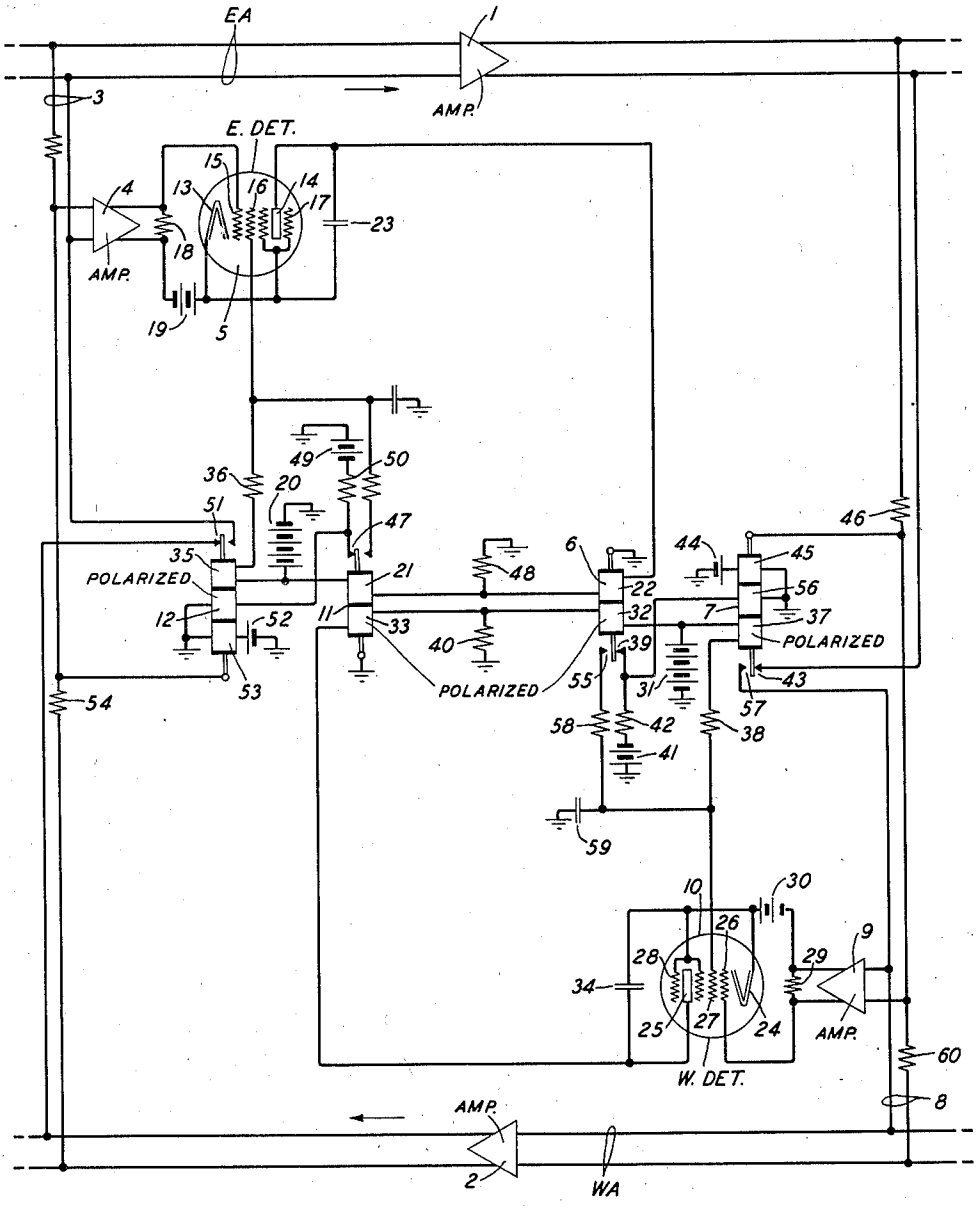

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SIGNAL TRANSMISSION SYSTEM

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This invention relates to two-way signal transmission systems and particularly to signal-controlled switching circuits for directionally controlling transmission in such systems while preventing singing and suppressing echoes.

To obtain proper operation of two-way signaling systems employing, at least over a part of the system, oppositely-directed one-way paths for repeating the signals in opposite directions, it has been found desirable in the past to employ a switching circuit connected to each path, responsive to signal transmission therein to switch losses between the two one-way paths, or to completely disable the other path, so as to suppress echoes and prevent singing, and to disable the switching circuit associated with the other path so as to prevent false switching. Such switching apparatus usually comprises means for diverting from the one-way path transmitting signals, a portion of the signaling energy, means for amplifying and detecting that energy, and then utilizing the detected energy to operate relays or other switching apparatus to apply short circuits to the circuits to be controlled, or to properly control the switching of loss pads or the operation characteristics of transmission apparatus in the controlled circuits.

It is an object of the present invention to improve such signal-operated switching apparatus to make it more positive and effective in operation, to reduce the chance of false operation, and to reduce distortion in the signaling paths due to its operation.

These objects are attained in accordance with one modification of the invention by employing for the detector in the switching circuit, one or more electron discharge devices having a plurality of grid electrodes including a screen grid, and by providing arrangements for making the operation of each switching circuit in response to applied signals, cause complete or partial disabling of the other switching circuit by applying the proper bias to the screen grid of a detector tube in the latter circuit.

Other objects and features of the invention will be brought out in the following detailed description thereof when read in connection with the accompanying drawing, the single figure of which shows schematically a portion of a two-way signaling system employing signaling apparatus embodying the invention.

In the single figure of the drawing is shown a one-way circuit EA including the one-way amplifying device 1, for repeating signals in the direction from west to east, and a one-way circuit WA including the one-way amplifying device 2 for repeating signals in the direction from east to west. These two circuits may be, for example, part of a two-way telephone repeater, or a four-wire telephone circuit, in which case they would be connected at their terminals to two-way line sections by the usual hybrid coils and associated balancing networks, or other suitable means, so that the one-way circuits are connected in transmitting relation with the line sections but in conjugate relation with each other.

Connected across the circuit EA in front of the amplifying device 1 is the input of a switching circuit 3 comprising the one-way amplifying device 4, the detector 5, and a chain of switching relays including the polarized relay 6 and the polarized relay 7, controlled by operation of the detector 5. Similarly, connected across the circuit WA in front of the amplifying device 2 is the input of the switching circuit 8 comprising the one-way amplifying device 9, the detector 10 and a chain of switching relays including the polarized relay 11 and the polarized relay 12 controlled by operation of the detector 10.

The detector 5 in switching circuit 3 comprises a single electron discharge tube of the pentode type having a cathode 13, which may be of the heater type supplied with heating current in any suitable manner, the anode 14, and spaced between the cathode and anode a control grid 15, a screen grid 16 and a suppressor grid 17 which is connected directly to the cathode. The control grid-cathode circuit of tube 5 is coupled to the output of the amplifying device 4 through resistance 18, and the tube 5 is normally biased to cut-off by a negative potential applied to the control grid 15 from the grid battery 19 through the resistance 18. Plate current is supplied to the anode 14 of detector tube 5 from plate battery 20 through the biasing winding 21 of relay 11 and the operating winding 22 of relay 6 in series, and a condenser 23 connected between the anode 14 and cathode 13 serves to shunt the alternating current component of the plate current from these relay windings when the detector tube 5 is operated.

Similarly, the detector 10 of the switching circuit 8 connected to the one-way circuit WA, comprises a single electron discharge device of the pentode type having a cathode 24, an anode 25, and spaced between the cathode and anode a control grid 26, a screen grid 27 and a suppressor grid 28. The control grid-cathode circuit of tube 10 is coupled to the output of the amplifying device 9 through resistance 29, and the tube 10 is

normally biased to cut-off by the negative potential on control grid 26 applied by the grid biasing battery 30 through resistance 29. Plate current is supplied to the anode 25 of detector tube 10 from plate battery 31 through the biasing winding 32 of relay 6 and the operating winding 33 of relay 11, and condenser 34 connected between the anode 25 and the cathode 24 of detector tube 10 shunts the alternating current component of the plate current from these relay windings.

The screen grid 16 of the east detector tube 5 is normally positively biased by plate battery 20 through winding 35 of polarized relay 12 and resistance 36 in series. Similarly, the screen grid 27 of the west detector tube 10 is normally positively biased by plate battery 31 through the winding 37 of polarized relay 7 and resistance 38 in series.

The armature of the polarized relay 6 is normally held on its contact 39 by current flowing from the plate battery 31 through winding 32 and resistance 40 to ground, so that current from the battery 41 is shorted to ground through the resistance 42, contact 39 and the armature of relay 6. Normally also, the armature of polarized relay 7 is held on its contact 43 by current flowing from the battery 44 through the biasing winding 45 to ground so that the resistance 46 is shunted across the circuit EA in the output of amplifying device 1, through the armature of relay 7. The value of resistance 46 may be chosen, for example, so that it provides a normal loss of about 5 decibels in the circuit EA.

Similarly, the armature of polarized relay 11 is normally held on its contact 47 by current from the plate battery 20 flowing through the biasing winding 21 and the resistance 48 to ground, so that current from battery 49 is shunted to ground through resistance 50, contact 47 and the armature of relay 11. Also, the armature of polarized relay 12 is normally held on its contact 51 by current from battery 52 flowing through biasing winding 53 to ground, so that a resistance 54 is shunted across the circuit WA in the output of amplifying device 2 through the armature of relay 12. The value of resistance 54 may also be chosen so that it provides a normal loss of about 5 decibels in the circuit WA.

The purpose of the other elements indicated in the drawing but not previously referred to will be brought out in the following complete description of the operation of the system.

In the absence of signal transmission over either circuit EA or WA, the condition of the elements of the switching circuits 3 and 8 are as indicated in the drawing, so that each circuit EA and WA includes a loss of about 5 decibels, and the switching circuits 3 and 8 are at maximum sensitivity.

Now, let it be assumed that west to east speech currents from a subscriber associated with the west end of the circuit EA are being received over that circuit and a portion thereof is diverted into the switching circuit 3, and at that time no east to west speech currents from the subscriber associated with the east end of the system are being received by the switching circuit 8 from the associated transmission circuit WA.

The speech currents diverted into the circuit 3 will be amplified by amplifier 4 therein, and the amplified waves impressed upon the control grid-cathode circuit of detector tube 5 across resistance 18. The impressed speech voltages will overcome the normal negative bias on the control grid of detector tube 5, so that current will begin to flow in its anode-cathode circuit. The alternating current component of this current will be shunted through condenser 23 and the direct current component will flow in series through the biasing winding 21 of relay 11 and the operating winding 22 of polarized relay 6 in such direction as to oppose the normal bias on the latter relay produced by the current from battery 31 flowing through the biasing winding 32. The amount of current flowing through the winding 22 will be sufficient to cause operation of that relay to shift its armature from contact 39 to contact 55.

As soon as the armature of relay 6 leaves contact 39 the connection of battery 41 to ground through the armature of relay 6 is broken, and current will flow from that battery to ground through resistance 42 and the winding 56 of polarized relay 7 in a direction and in sufficient amount to overcome the normal bias on the latter relay produced by the current from battery 44 flowing through the biasing winding 45. This will cause the armature of relay 7 to be shifted from the contact 43 to the contact 57. The breaking of contact 43 opens the circuit through resistance 46 normally connected across the circuit EA in the output of amplifier 1, removing the 5 decibel loss from the circuit EA and allowing west's speech currents after amplification by amplifier 1 to be transmitted with little attenuation out over the circuit EA towards the east subscriber.

When the armature of relay 7 reaches contact 57, the resistance 60 is connected across the circuit WA in the input of amplifier 2, and the input of the switching circuit 8 in the input of amplifier 9, is short-circuited through contact 57 and the armature of relay 7. This introduces a desired loss sufficient to suppress echoes in the circuit WA, but because of the resistance of the wiring and the contact 57, does not completely disable switching circuit 8, to prevent operation of the switching circuit 8 by any voice frequency voltages that may be subsequently applied thereto from the path WA. A previous desensitization of switching circuit 8 occurs when direct current first flows in the anode-cathode circuit of detector tube 5 in switching circuit 3 in response to west's speech currents from the circuit EA, since the biasing winding 21 of the polarized relay 11 in switching circuit 8 is in series with the operating winding 22 of polarized relay 6.

When the armature of polarized relay 6, in response to operation of that relay by the west's speech currents, reaches contact 55, the normal positive biasing potential on the screen grid 27 of detector tube 10 in switching circuit 8, produced by battery 31 operating through the winding 37 of relay 7 and resistance 38 in series, is removed, and the screen grid 27 is connected to ground through resistance 58, closed contact 55 and armature of relay 6. This disables the detector tube 10 and thus prevents false operation of the switching circuit 8 by speech currents impressed thereon from the transmission circuit WA during the interval between the start of operate current in the polarized relay 6 and the arrival of the armature of the polarized relay 7 at its contact 57. The loss thus produced in the switching circuit 8 by changing the bias on the screen grid of detector tube 10 is added to the loss introduced by the short circuit through contact 57 and armature of relay 7 across the input of the circuit 8 in response to operation of

relay 7, and increases the protection against false operation of the latter circuit.

This additional loss is particularly desirable to prevent false operation in systems requiring the use of very sensitive amplifier-detector switching circuits, such as, for example, the voice-operated loss control and anti-singing circuits (Volcas) used with two-way repeaters in multi-repeatered two-wire telephone circuits or in multi-way or conference interconnecting telephone circuits, as disclosed in Fracassi Patent 2,083,645, issued June 15, 1937.

The disabling of the detector tube instead of the amplifier tube in the switching circuit is advantageous in that the former does not result in the transmission of surges of current obtained in the latter case which would tend to act to produce false operation of the associated switching relays.

The transmission circuit EA will remain operative, the transmission circuit WA will remain blocked to suppress echoes and prevent singing, and the switching circuit 8 will remain disabled to prevent false operation by subsequently received speech currents from the east subscriber, as long as the west subscriber continues to talk. When the west subscriber ceases talking or pauses for a sufficient interval of time so that the amount of speech energy impressed on the control grid-cathode circuit of detector 5 falls below the cut-off value of that tube, detector tube 5 will immediately be rendered inoperative. The resultant reduction in the plate current of that tube will cause the polarized relay 6 to release so that its armature will return to the contact 39, thus again shorting through resistance 42 and the armature of relay 6 the current from battery 41 previously flowing through resistance 42 and the winding 56 of relay 7 to ground.

The breaking of contact 55 of polarized relay 6 breaks the connection of battery 31 to ground through the winding 37 of relay 7, the resistance 38, the resistance 58, contact 55 and armature of relay 6, and the current from plate battery 31 will now flow in the same direction through winding 37 of relay 7, and resistance 38 in series to the condenser 59 until that condenser is charged up to the plate battery potential. This flow of current through winding 37 will hold the polarized relay 7 operated for a desired hangover time interval after the polarized relay 6 has released, so as to prevent the unblocking of the circuit WA and the switching circuit 8 until all echoes due to west's speech currents have been dissipated in the circuit EA. Also, until condenser 59 has been charged to the potential of plate battery 31 the detector tube 10 will remain partially disabled. By proper proportioning of the values of the circuit elements, the circuit can be arranged so that the detector tube 10 is returned to practically full sensitivity at the same time that polarized relay 7 releases. At the end of this time interval all of the relay and other circuits will have returned to the normal condition indicated in the drawing, and the switching circuits are in condition to be exclusively controlled by the west subscriber's or the east subscriber's speech currents, depending on which are first to arrive at the switching point.

As the apparatus in the switching circuits 3 and 8 is identical, the manner of operation for the case when the east subscriber's speech currents arrive at the switching point over the circuit WA before speech currents are received by the switching circuit associated with the transmission circuit EA from the west subscriber, will be similar to that previously described for the opposite case, and therefore need not be described here.

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; for example, each of the one-way transmission circuits may be normally operative and adapted to be disabled under control of the switching circuit associated with the other one-way transmission circuit; one transmission circuit may be normally operative and the other normally blocked and the former adapted to be blocked by operation of the switching circuit associated with the latter circuit, and the latter rendered operative under control of the switching circuit associated therewith; the blocking and unblocking of the one-way transmission circuits may be obtained by varying the bias on the grid of an amplifier tube in each circuit under control of the associated switching circuit; the switching circuit may be modified so that the disabling of each under control of the other switching circuit is obtained solely by varying the bias on the screen grid of the detector tube in the circuit as indicated, the short-circuiting of the input of the switching circuit being eliminated. It should also be understood that the specified values for the losses inserted in the transmission paths are given by way of example only, and that they may be quite different from the values given depending on the characteristics of the signal transmission circuits with which the switching circuits are used.

What is claimed is:

1. In combination, two signal transmission paths, a switching circuit connected to each path, including an electron discharge detector tube having a cathode, an anode, a control grid and a screen grid, and circuits therefor, said switching circuit being responsive to signal transmission in the path to which it is connected to insert attenuation in the other path, and to bias the screen grid of the detector tube in the switching circuit connected to said other path, so as to disable that tube and thus prevent subsequent false operation of said other switching circuit by transmission in said other path.

2. In a two-way signaling system, a four-wire circuit comprising two oppositely directed one-way paths for the signals transmitted in opposite directions, a switching circuit including an electron discharge detector tube having a cathode, an anode, a control grid and a screen grid connected to each one-way path and responsive to signal transmission therein to switch loss out of that path and loss into the other path, and means also responsive to signal transmission in the first path to control the bias on the screen grid of the detector tube in the other switching circuit connected to said other one-way path, so as to prevent subsequent false operation of said other switching circuit in response to subsequent signal transmission in said other circuit.

3. In combination in a two-way signal transmission system, a four-wire circuit comprising oppositely directed one-way amplifying paths for repeating signals in opposite directions, a switching circuit including an electron discharge detector tube having a cathode, an anode, a control grid and a screen grid, connected to each one-way path and responsive to signal transmission therein, in the absence of prior signal transmission in the other one-way path, to switch loss into said

other path to suppress signal echoes, and to switch loss into the input of the other switching circuit connected to said other path, to reduce its sensitivity, and means to provide increased protection against false operation of said other switching circuit by applied signals from said other path after the first switching circuit has started to operate, comprising means under control of the signals applied to said first switching circuit to apply a blocking bias to the electron discharge detector tube in said other switching circuit, through its screen grid.

4. In combination, two signal transmission paths, a control circuit including an electron discharge detector tube having a screen grid, connected to each path so as to be responsive to signal transmission in that path, a chain of relays responsive to the output current of the detector tube, when operated, to switch loss into the other signal transmission path to suppress signal echoes and to switch loss into the input of the other control circuit, and means responsive to the operation of the first relay in the chain in the first control circuit by the detected current to so control the bias on the screen grid of the detector tube in said other control circuit as to block that tube, and thus to prevent false operation of said other control circuit by transmission in said other path during the time interval required to produce complete operation of said first control circuit.

5. In combination in a two-way signal transmission system, a four-wire circuit comprising two oppositely-directed one-way signal transmission paths, a control circuit including an electron discharge device having a cathode, an anode, a control grid and a screen grid, connected to each one-way path so as to be responsive to signal transmission in that path, in the absence of prior signal transmission in the other one-way path, to switch loss into said other path to suppress signal echoes, and to switch loss into the input of the other control circuit to reduce its sensitivity, means to provide increased protection against false operation of said other control circuit by applied signals from said other path after the first control circuit has started to operate, comprising means under control of the signals applied to said first control circuit to apply a blocking bias to the electron discharge device in said other control circuit, through its screen grid, means for maintaining the loss in said other path and in the input of said other control circuit for a desired hangover time interval after cessation in the supply of controlling signals to said first control circuit, and means to return the electron discharge device in said other control circuit to practically full sensitivity immediately at the end of said hangover time interval.

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