

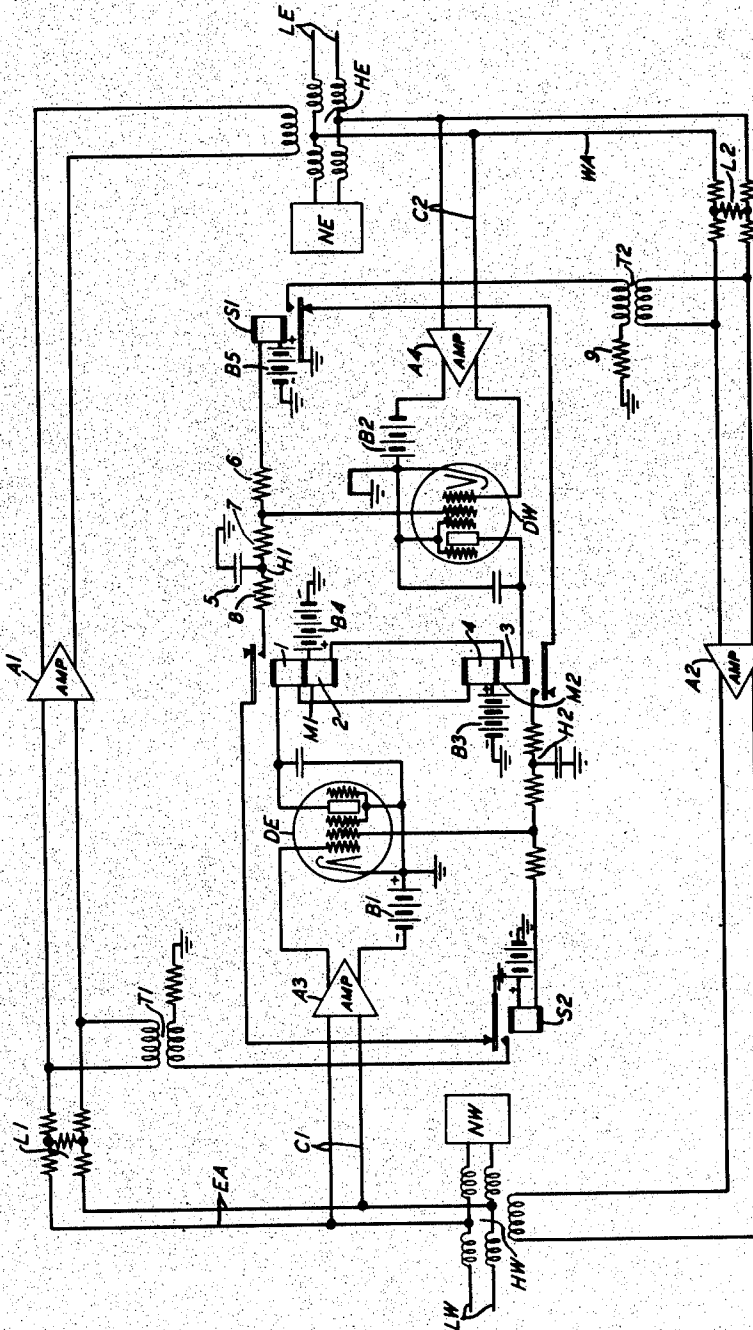
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TWO-WAY SIGNAL TRANSMISSION SYSTEM

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TWO-WAY SIGNAL TRANSMISSION
SYSTEM

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The invention relates to two-way signal transmission systems, such as two-way telephone systems, and particularly to the signal-controlled switching circuits used with such systems to directionally control signal transmission therein while suppressing echoes and preventing singing.

Such signal-controlled switching circuits usually employ two switching branches respectively connected to each of two oppositely-directed one-way signal transmission paths at a terminal or repeater point of the two-way system, each including an amplifier and detector for amplifying and detecting the applied signal waves, and electromagnetic relays or other switching devices, operated by the detected signals to insert or remove losses in the transmission paths and to disable the other switching branch, to provide the desired directional control with suppression of echoes and singing. Such circuits may be of the differential type, such as disclosed, for example, in Dickieson et al. Patent No. 2,153,040, issued April 4, 1939, or Smethurst Patent No. 2,226,952, in which the subscriber who first starts to talk gets complete control of the switching circuits and a listening subscriber is unable to break in unless the first subscriber pauses for a time longer than the hang-over time of his switching circuit.

An object of the present invention is to improve the operation of such switching circuits particularly from the standpoint of facilitating break-ins by a listening subscriber when a talking subscriber has obtained control of the system.

This object is attained in accordance with the invention by a differential circuit in which the echo suppression and disabling functions are separated and in which the various control circuits are interlocked in such manner as to enable a listening subscriber to break in on a talking subscriber and seize complete control of the circuit, whether or not the first talker pauses, by talking louder than the latter for a time interval greater than the hang-over time of the suppressor.

The various objects and features of the invention will be understood from the following detailed description thereof when read in conjunction with the accompanying drawing, the single figure of which shows the invention applied to a two-wire telephone repeater. The control circuits of the drawing except for the modifications for facilitating break-in to be described, are similar to those disclosed in the aforementioned Dickieson et al. patent.

The two-wire repeater of the drawing comprises an east-to-west one-way transmission path EA including the loss pad L1 and the one-way amplifier A1, and the west-to-east one-way transmission path WA including the loss pad L2 and the one-way amplifying device A2, coupled at their west and east terminals in substantially conjugate relation with each other and in energy transmitting relation with a west two-way line LW and an east two-way line LE by the hybrid coil HW and associated balancing network NW, and the hybrid coil HE and associated balancing network NE, respectively.

The echo suppressor and break-in control circuit of the invention includes one control branch C1 having its input connected across the path EA at a point in front of the loss pad L1, and a control branch C2 having its input connected across the path WA at a point in front of the loss pad L2. The control branch C1 includes the one-way amplifying device A3; a detector DE comprising a single electron discharge tube of the pentode type normally biased to cut-off by the negative biasing voltage applied to its control grid by grid battery B1; a polarized master relay M1 having an operating winding 1 connected in the plate-cathode circuit of the detector tube DE, and an opposing biasing winding 2; and a switching relay S1 and associated hang-over circuit H1 controlled by operation of the master relay M1. Similarly, the identical control circuit C2 connected to the path WA includes a one-way amplifying device A4; a detector DW comprising a single electron discharge tube of the pentode type normally biased to cut-off by the negative voltage applied to its control grid by the battery B2; the polarized master relay M2 having an operating winding 3 connected in the plate-cathode circuit of the detector tube DW, and an opposing biasing winding 4; and a switching relay S2 and associated hang-over circuit H2, controlled by operation of the master relay M2. Plate current is supplied to the plate of the detector tube DE from plate battery B3 through the biasing winding 4 of the master relay M2 and the operating winding 1 of the master relay M1 in series. Similarly, plate current is supplied to the plate of the detector tube DW from plate battery B4 through the biasing winding 2 on the master relay M1 and the operating winding 3 of the master relay M2 in series.

The other elements of the circuits of the invention and their functions will be described in connection with the following complete descrip-

tion of the operation of the circuits of the drawing.

In the idle condition of the circuit with no speech currents being transmitted in either direction, the repeating paths EA and WA are normally operative. The small loss pad L1 and the secondary winding connected across the path EA between loss pad L1 and amplifier A1, of the switching transformer T1 having a normally open-circuited primary winding, normally provides but a small loss in the path EA, and the small loss pad L2 and the secondary winding shunted across the path WA between loss pad L2 and amplifier A2, of the switching transformer T2 having a normally open-circuited primary winding, normally provided but a small loss in the path WA.

Let it be assumed that the west subscriber associated with the two-way line LW is speaking. His speech waves received over the line LW will divide in the west hybrid coil HW, the portion impressed on the path WA being dissipated in the output of amplifier A2, and the useful portion passing into the input of the path EA over which it will be transmitted through loss pad L1, amplifier A1, and the east hybrid coil HE to the east line LE over which it will be transmitted to the east subscriber.

In the meantime, the portion of west's speech waves diverted into the control branch C1 connected across the path EA at a point in front of loss pad L1, will be amplified in amplifier A3 and will then operate the biased detector DE. The resulting output current of the detector DE will flow through the operating winding 1 of master relay M1 tending to operate that relay, and through the biasing winding 4 of the master relay M2 of the switching branch C2, tending to bias the latter relay against operation. The resultant operation of relay M1 will cause condenser 5 in hang-over circuit H1, which is normally charged by battery B5 through the winding of the switching relay S1 and the resistances 6 and 7 in series, to be discharged to ground through resistance 8, the made front contacts of relay M1 and the normally made back contacts of the unoperated switching relay S2. This will cause quick operation of the switching relay S1 by charging current to condenser 5 flowing from battery B5 through the winding of the latter relay, and the relay S1 will stay operated after relay M1 releases when the west subscriber ceases talking or pauses for a sufficient time to reduce the output current of detector DE below the operate value of the relay M1, by a time interval determined by the time constants of the condenser 5 and the combination of the resistances 6 and 7. By suitable selection of the values of the latter elements of the hang-over network H1, this time may be made sufficient to suppress any delayed echoes in the path WA. At the same time, the reduction of voltage to ground at the junction of the resistances 6 and 7, connected to the screen grid of the detector tube DW in control branch C2, due to the operation of relay M1, will reduce the voltage on the screen grid of detector tube DW, thereby allowing the latter detector to overload sooner and limiting its maximum output current.

Operation of the relay S1 does two things. In the first place, in breaking its back contact it removes ground from the armature of the relay M2 thus effectively disabling relay S2, so that even if the master relay M2 operates later on delayed echoes in the path WA, the relay S2 will

not be operated. The operation of relay S1 also through the closing of its front contacts shorts the primary winding of the switching transformer T2 through the resistance 9, thereby providing a partial short across the path WA through resistance 9 and the transformer. The transformer T2 and the value of resistance 9 are selected such as to make the loss thus inserted into the input of the path WA sufficiently great to suppress the echoes of the west speech, the loss pad L2 preventing this short circuit from having any appreciable effect on the input to the amplifier A4 in control circuit C2.

Operation when the east talker associated with the line LE speaks, is similar to that as described above for the west subscriber speaking except that the lower relay chain comprising master relay M2 and switching relay S2 is operated instead of the upper relay chain, to apply an echo suppression loss in the path EA through the transformer T1, to bias the master relay M1 of the upper relay chain against operation to effectively disable the switching relay S1 and to lower the positive bias on the screen grid of the detector tube DE in control circuit C1 to reduce its gain.

Let it now be assumed that the east talker has obtained control of the switching circuits in the manner described above but that the west talker is attempting to break in, and that the latter is talking louder than the east talker. Unless the east talker is speaking so loud that the reduction in the positive grid bias produced in the detector tube DE is such as to practically disable that tube, the west talker will then have a good chance of producing a greater space current in his detector tube DE than the east talker will produce in the latter detector tube DW. When this occurs, the master relay M2 will be released due to the excessive bias from the space current of the detector tube DE produced in the biasing winding 4 of the latter relay, and relay M1 will be operated since its operate current will then exceed the bias produced in its biasing winding 2 by the space current from the detector tube DW. The hang-over time of relay S2 will then start to expire and, if the west talker maintains this condition for a time even slightly greater than the hang-over time of the switching relay S2, the relay S2 will release and relay S1 will immediately operate. The resultant removal of the echo suppression loss in the path EA will allow the speech currents of the west talker to get through and thus let the east talker know that the west talker is attempting to interrupt. Of course, the west talker's speech current will get through to the east talker's receiving circuit with considerable loss even before the west talker obtains control of relay S1, but with the amount of switching loss which is necessary to satisfactorily suppress echoes the amount of through current will not be sufficient to provide breaking of any value.

The reason for providing that the positive screen grid bias in each detector tube DW or DE be reduced slightly when the upper or lower relay chain is respectively operated under control of the west or east talker's speech current, may be explained as follows. If this were not done, there might be an extremely loud talker at the west station, for example, who would overload, not only the detector tube DE by his direct transmission diverted from path EA but also the detector tube DW by means of his echo currents transmitted into the path WA, and since no

two tubes ordinarily overload exactly the same, this might result in false operation. Reducing the bias on the opposite detector tube insures that for a very loud talker the opposite detector tube will always overload a little sooner than the one which it is desired to operate.

Although the circuits of the invention have been described in connection with a two-wire repeater, they may be employed to provide echo suppression and break-in at the terminals or intermediate points of a four-wire repeating circuit, as well. Other methods of desensitizing one of the control circuits under control of the other in place of the particular one described and illustrated may be used; for example, the circuit may be modified to cause a short circuit including a small resistance pad of properly selected value to be connected across the input of the amplifier-detector in one control circuit when the other control circuit is operated. Various other modifications of the circuits which have been illustrated and described within the spirit and scope of the invention will be apparent to persons skilled in the art.

What is claimed is:

1. In a two-way telephone system including two oppositely-directed one-way transmission paths for the telephone signals transmitted in opposite directions, an echo suppressor unit connected to each path, including a signal detector, a master relay having an operating winding energized from the detector output when signals are applied to its input from the connected path, switching means responsive to operation of said master relay to insert a disabling loss in the other one-way path and means to maintain said switching means operated for a desired hang-over time interval after the master relay releases, each master relay having an opposing biasing winding in circuit with the operating winding of the other master relay so that when one relay is energized for operation, the other is biased against operation by an amount deter-

mined by the level of the signals controlling energization of said one relay, the echo suppressor unit supplied with the stronger signals thereby being operated and the other echo suppressor unit being held unoperated, means to facilitate breaking by one talker when another talker has thus obtained control of the two echo suppressor units, comprising auxiliary means responsive to operation of the master relay in each suppressor unit to disable the switching means controlled by the other master relay and means to prevent the disabling of each path from affecting the input to the suppressor unit connected to that path, whereby each talker can gain control of said suppressor units and thus of transmission in said system by talking louder than the other talker for a time interval longer than the hang-over time of the suppressor unit controlled by the latter's voice currents.

2. The system of claim 1, in which said switching means in each suppressor unit comprises a switching relay adapted to be operatively energized to insert said disabling loss in said other path by operation of the master relay in that unit, and said auxiliary means comprises means respectively controlled by the operation of the switching relay in each suppressor unit for preventing the energizing circuit of the switching relay in the other suppressor unit from being completed by operation of the master relay in the latter unit.

3. The system of claim 1, in which the last-mentioned means comprise a loss pad of suitable value in each path between the disabling point therein and the input of the suppressor unit connected thereto.

4. The system of claim 1, in which the master relay of each suppressor unit when released after operation causes the gain of the detector in the other suppressor unit to be decreased during the hang-over operating time of the first suppressor unit.

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