

Oct. 30, 1934.

H. W. DUDLEY
TRANSMISSION SYSTEM

1,979,101

Filed Feb. 6, 1929

2 Sheets-Sheet 1

FIG. 1.

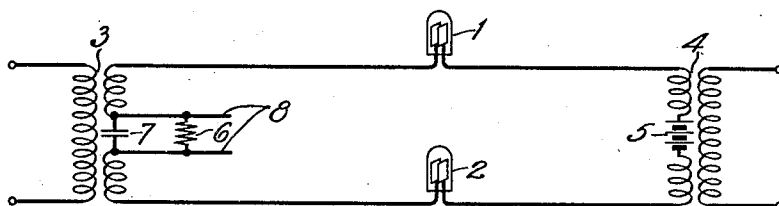


FIG. 2.

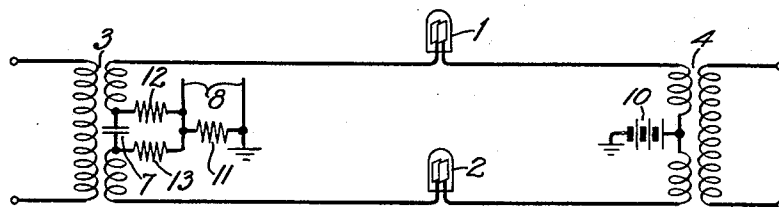


FIG. 4.

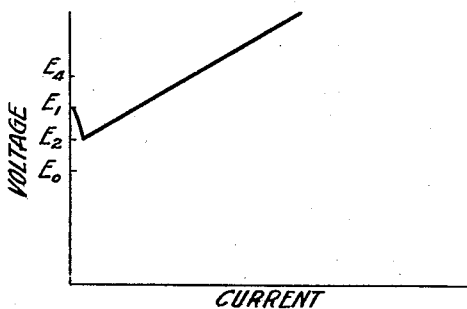
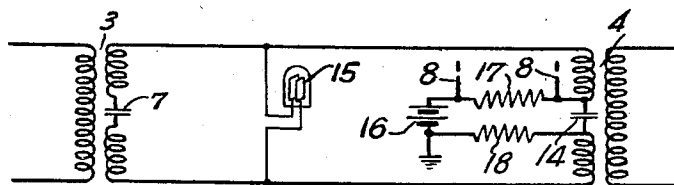


FIG. 3.



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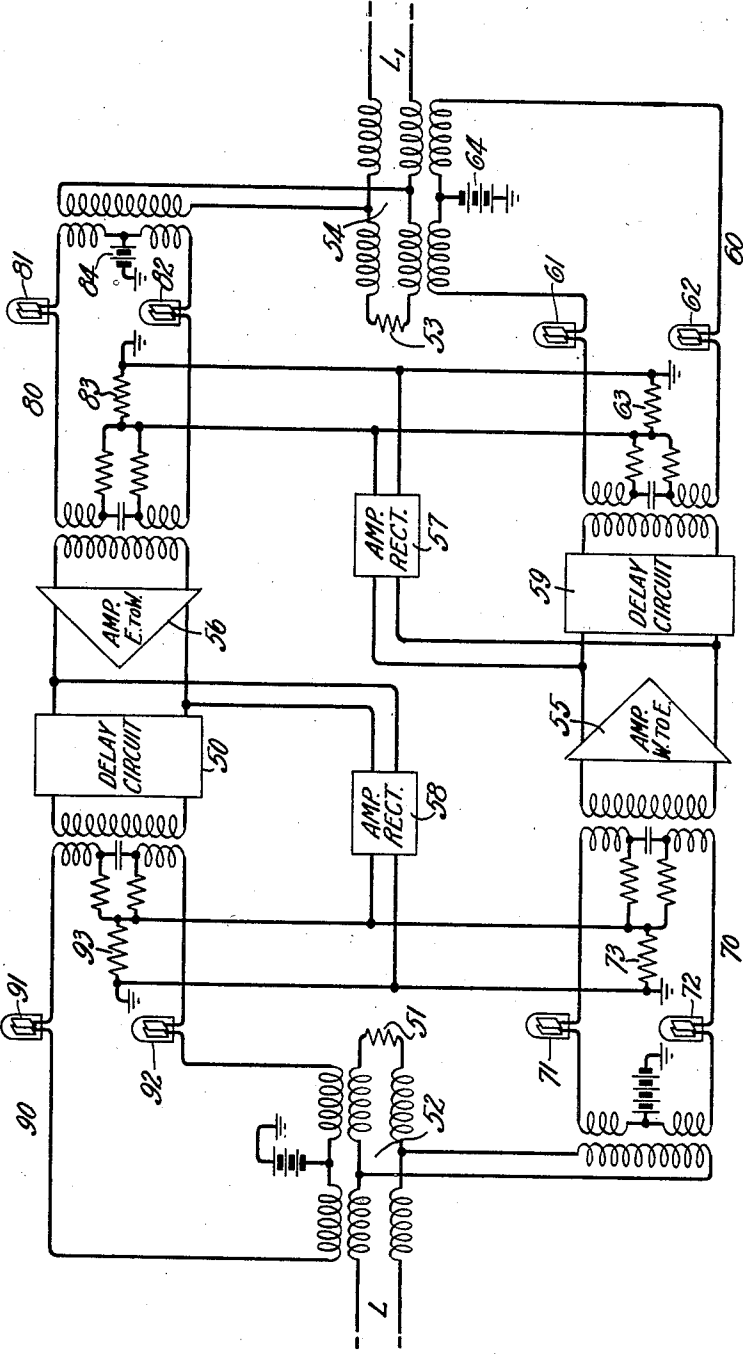
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FIG. 5.



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TRANSMISSION SYSTEM

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Application February 6, 1929, Serial No. 337,810

13 Claims. (Cl. 179—170)

This invention relates to transmission circuits and more particularly to those employing neon or similar gas disruptive discharge tubes as a means of controlling the transmission there-
5 through.

An object of the invention is to control transmission through a circuit by means of the signals being transmitted thereover; that is, to change it from a non-conductive to a conductive condition or vice-versa.

A further object of the invention is to increase the speed of signal transmission in a two-way repeater equipped with echo suppressing and singing prevention devices above that which is
15 obtained in similar circuits using electromechanical elements, such as relays which require appreciable time to operate.

Another object of the invention is the elimination of distortion which results during the transmission from a transmission to a non-transmission condition of a repeater thus equipped.

Still another object of the invention is to eliminate noise and other disturbances which may occur in circuits of this type due to relay contacts
25 which may cause chattering or become of high resistance.

Another object of the invention is to provide a margin against interfering voltages which tend to prevent proper operation of the repeater system.

A feature of the invention resides in utilizing neon or other flashing tubes for controlling the operation of a two-way repeater to prevent singing and to eliminate interference in the transmitted signals from echoes or reflection voltages
35 which tend to be transmitted back through the oppositely directed branch of the circuit. In general, tubes having a critical voltage which must be applied before transmission occurs and which thereafter have substantially linear transmission characteristics may be used. In accordance with the invention, tubes of this type are connected in both branches of a two-way repeater and are provided with a steady biasing component to place them in the necessary state of conduction for proper operation of the circuit. A further biasing voltage, under the control of the speech being transmitted through one of the paths, is impressed upon the tubes;
45 the polarity of said voltage being such that the conduction through the speech transmitting path is increased, while that through the oppositely directed path is prevented.

A better understanding of the invention may be had from the following description together with

the accompanying drawings of which Figs. 1 to 3 show various types of loss circuits which may be used in accordance with this invention in a repeater circuit; Fig. 4 shows the transmission characteristic of the most suitable type of tube; 60 and Fig. 5 shows an application of one of the loss elements in a repeater circuit.

The loss circuits illustrated in Figs. 1 to 3 all employ neon or other gas disruptive discharge tubes, the impedance conditions of which are regulated to determine the loss condition of the circuit. The transmission characteristic of the neon tube, which is the most desirable type for use in this invention, is shown in Fig. 4. These tubes are non-conductive or opaque to currents
70 until a critical voltage is impressed on their electrodes which ionizes the gas causing it to become conductive. This critical break-down voltage is shown in Fig. 4 as E_1 . When the tube has once become conductive the voltage upon its electrodes must fall to E_2 before it is extinguished. In the loss circuits of this invention it may be desired to bias the tubes so that they are either normally conductive or normally extinguished. A control voltage, derived from the signal current in the
80 associated circuit, is then impressed upon the tubes; the polarity of said control voltage having been selected with respect to the fixed biasing voltage so as to reverse the transmission conditions of the tubes. A margin against interfering voltages in the circuit may be provided by properly selecting the value of the steady biasing voltage.

One of several types of loss circuits which may be used in a repeater circuit in accordance with this invention employs series elements as shown in Fig. 1. The circuit is connected in the line by means of the transformers 3 and 4. In series with the transformer windings are the neon tubes 1 and 2; the biasing battery 5; and the resistance 6 across which the control voltage is impressed through the leads 8, said control voltage being derived from the current transmitted over the circuit in a manner hereinafter described in connection with Fig. 5. One tube is
100 connected in each line; and the battery 5 and resistance 6 at the midpoint of the transformer windings give the circuit symmetry. A condenser 7 is connected in shunt to the resistance 6 to provide a path of low impedance for alternating currents.

When the tubes 1 and 2 are extinguished the loss circuit presents infinite impedance to alternating currents and when in the break-down condition small impedance thereto. If the circuit 110

conditions require that the loss circuit be opaque when no control voltage is applied across the resistance 6, a biasing voltage from the battery 5 slightly smaller than E_2 is impressed upon the tube. This value is selected in order to insure extinguishing the tube when the control voltage falls to zero. The control voltage applied across the resistance 6 is poled to aid the battery 5 and when sufficiently large causes break-down and conduction through the tube. If the circuit conditions require that the loss circuit be transparent when no control voltage is applied, the voltage of battery 5 is initially in excess of the break-down voltage E_1 and the control voltage when applied opposes this to extinguish the tube.

The biasing voltages may be somewhat larger or smaller than E_1 or E_2 as the case may be, as for instance E_4 or E_0 to provide a margin against interfering voltages.

Fig. 2 is another type of series loss element which permits a grounded biasing battery 10 to be employed. In this circuit, the control voltage, which is derived similar to that of Fig. 1, is impressed across the resistance 11 through the leads 8; and branch resistances 12 and 13 are provided around the condenser 7 so that the conduction through one tube does not unduly limit the voltage across the other tube and prevent it from conducting. Here again the control voltage across the resistance 11 may be additive or subtractive in accordance with circuit requirements. The remaining circuit elements are similarly numbered and function the same as the correspondingly numbered elements of Fig. 1.

A shunt type of loss circuit is illustrated in Fig. 3. The circuit is connected in the repeater or transmission path by means of the transformers 3 and 4 as in the case of the series loss circuits and a neon tube 15, or similar flashing tube, is shunted across the conducting paths. A biasing voltage is applied to the tube by means of the grounded battery 16. A resistance 17 is connected in series with the battery 16, across which is applied a control biasing voltage through the leads 8, said control voltage being derived from the current in the transmission path, as hereinafter described in connection with Fig. 5. The resistance 18, which is equal in value to resistance 17, serves to balance the circuit. Condensers 7 and 14 are inserted at the midpoint of the secondary and primary winding of the transformers 3 and 4 respectively to prevent short circuiting of the biasing battery 16 and at the same time to present a symmetrical path of low impedance to alternating or signal currents. When the tube 15 is extinguished it presents infinite impedance to alternating currents and the loss circuit as a whole is transparent or readily transmits current.

When sufficient bias is applied to produce break-down the tube 15 presents a short-circuit path of small impedance to alternating current, and the loss circuit as a whole is opaque or of high impedance to the signal current.

The tube 15 operates similarly to that described in connection with the series circuit. If the circuit conditions require that the loss circuit be opaque when no control voltage is applied across the resistance 17, the biasing voltage 16 must be in excess of the tube break-down voltage to insure a conducting path through the tube. As can be seen by referring to Fig. 4, this biasing voltage must be in excess of E_1 . When the control voltage across the resistance 17 is poled to oppose the biasing voltage 16 in order

to reduce it sufficiently to extinguish the tube when the transparent condition of the loss circuit is desired.

If circuit conditions require that the loss circuit be transparent when no control voltage is applied across the resistance 17, the biasing voltage 16 is small enough so that the tube is normally extinguished (slightly smaller than E_2 Fig. 4). To produce the opaque condition of the loss circuit, a control voltage is applied across the resistance 17 through the leads 8, said control voltage being derived from the current in the line in a manner described in connection with Fig. 5. This voltage is poled to increase the value of the tube biasing voltage above the value at which break-down occurs.

A voice controlled repeater circuit in which the invention may be used is shown in Fig. 5. This is a two-way repeater having separate paths for repeating signals in opposite directions. The line L is terminated in the balancing network 51 and the hybrid coil 52 which aids in separating the waves received from and impressed upon the line L. The line L_1 is similarly terminated by the network 53 and the hybrid coil 54. Amplifiers 55 and 56 of the usual type are connected respectively in the oppositely directed paths for amplifying, respectively, the west to east and the east to west signals. The west to east and the east to west paths are equipped, respectively, with the voice controlled loss circuits 60 and 70 and 80 and 90 which are similar to the series loss element circuit described in Fig. 2, although any of the other loss circuits heretofore described or which may be equivalent thereto may be employed. The impedance which these circuits present to the signals traversing their respective paths is dependent upon the condition of conductivity of the tubes 61, 62, 71, 72, 81, 82, 91 and 92. Conductivity of tubes 61 and 62 and 81 and 82 is controlled by the amplifier-rectifier 57 which rectifies a portion of the signal current traversing the west to east path, while that of the tubes 91 and 92 and 71 and 72 is controlled by the corresponding amplifier-rectifier 58 when transmission is through the opposite path.

It has previously been stated that the purpose of the invention is to prevent singing of the repeater and to suppress echo effects which may be produced. For example, if some of the amplified energy from one path should get into the oppositely directed path due to poor balancing of networks against lines or other impedance irregularities, the loss circuits 60 and 90 would be in the high loss condition being non-conductive to signaling energy during periods of non-transmission over their respective paths and the loss circuits 70 and 80 would be in the low loss condition.

However, when energy to be amplified is impressed upon either path, a portion of said energy is rectified and applied to the loss circuits of both paths to render the one in the signaling path, which is normally opaque to signals, transparent and that in the other path, which is normally transparent to signals, opaque.

Thus, for example, when signals from the line L are impressed upon the west to east path, a portion of their energy is rectified by the rectifier 57 and applied to the resistances 63 and 83. This produces a biasing voltage for the tubes 61 and 62, making them conductive so that signals are readily repeated to the line L_1 .

At the same time the voltage drop across the resistance 83 is poled so as to extinguish the tubes

81 and 82 which are normally conductive. This places infinite impedance in the east to west path, insuring that none of the west to east signals find their way back over the east to west path. During transmission over the west to east path, the loss circuit 90 is in the high loss or opaque condition while loss circuit 70 is transparent to signals. When signals are being transmitted in the east to west direction over the other path, the loss control circuits 90 and 70 are controlled by the amplifier-rectifier 58.

In order that the loss circuits be in the proper transmission condition at the beginning of the signaling period, it may be necessary to delay the signals slightly until the rectifiers place the loss circuits in the proper transmission conditions. The delay circuits 59 and 50, similar to those disclosed in Patent 1,607,687 to H. Nyquist, issued November 23, 1926, may be used for this purpose, although these circuits are not always essential.

Circuit conditions may not require as much loss as may be obtained by the use of four loss elements, in which case the elements 70 and 80 may be dispensed with, and only elements 60 and 90 used.

For purposes of illustration the loss elements 60, 70, 80, and 90 have been shown as adaptations of the loss circuit of Fig. 2, although any of the types of circuits illustrated in Figs. 1 to 3 or any others within the spirit of the invention may be used. The tubes 61 and 62 are similar to the corresponding tubes 1 and 2 in Fig. 2. A battery 64 supplies a biasing voltage to the tubes 61 and 62 which is smaller than the extinguishing voltage by a margin which is sufficient to prevent operation by crosstalk voltage. A control voltage is obtained from the rectifier 57 which rectifies a portion of the signal energy and applies it to the resistance 63. The polarity of this potential and that from the battery 64 are additive and sufficiently large to produce "break-down" of the tubes 61 and 62 when signals are being transmitted over the path.

The loss element 80 is normally in the conductive condition. Under these circumstances a biasing battery 84 is sufficiently large to maintain the tubes 81 and 82 in the break-down or conductive condition. The control voltage for the tubes 81 and 82 is obtained by the potential drop across the resistance 83. This resistance is in parallel with the resistance 63 and likewise is supplied with current from the amplifier-rectifier 57 which rectifies a portion of the west to east signal energy. The potential drop across the resistance 83 is opposed to the battery 84 so that during transmission of signals over the west to east path, the voltage drop across this resistance is sufficient to extinguish tubes 81 and 82 making them of infinite impedance. The elements 90, 70, 58, 50 and 56 correspond, respectively, to the elements 60, 80, 57, 59, and 55, which have already been described.

The operation of the circuit may be illustrated by considering the case of signals on line L, said signals being transmitted in a west to east direction. The hybrid coil 52 directs these signals into the west to east branch of the repeater to be amplified and impressed upon the line L₁ through the hybrid coil 54. If the line L₁ is not exactly balanced by the network 53, or if there are other unbalanced conditions, or impedance irregularities in the circuit, a portion of the west to east energy may (in the absence of the protective provisions of the invention) be transmitted back over the east to west branch, amplified by

the amplifier 56, and impressed upon the line L through the hybrid coil 52 thereby producing undesirable echo effects and possibly also causing singing of the repeater. These contingencies can be obviated by the use of the loss circuits in accordance with the invention, because the lower branch of the repeater in Fig. 5, amplifying in the direction of the signals, is rendered transparent and the upper branch, repeating in the opposite direction, is made opaque to these signals thus eliminating the undesired effects above mentioned.

During periods of non-transmission in either direction, the loss circuits 70 and 80 are in the break-down or transmission condition, and the loss circuits 60 and 90 are extinguished or in the opaque condition. When signals are transmitted from the line L over the west to east branch of the repeater, a portion of the energy is rectified by the amplifier-rectifier 57 and applied across the resistances 63 and 83. The voltage drop across the resistance 63 augments the biasing voltage from battery 64 upon the tubes 61 and 62 sufficiently to place them in the break-down condition in which the resistance offered to speech signals is small, and readily permits transmission of the signals to line L. The voltage drop across the resistance 83 opposes the biasing voltage of battery 84 and decreases the bias upon the tubes 81 and 82, heretofore in the break-down condition, sufficiently to extinguish them. In this condition they present infinite impedance to any energy of the west to east signals which may tend to be transmitted back in the reverse direction. The loss circuits 90 and 70 operate in a similar manner when signals are being repeated in the east to west direction.

Although but one circuit has been shown in which the various types of loss circuits may be utilized, the invention is not to be restricted thereto, but is to be limited only by the scope of the appended claims.

What is claimed is:

1. In a transmission system, a transmission path having a gas disruptive discharge tube connected thereto to render said path normally non-conductive, and means controlled by the signals in said path for changing the conductivity of said tube so as to permit the transmission of signals over said path, said means comprising a circuit for deriving a unidirectional voltage from said signals and applying it to said tube.

2. In a transmission system, a transmission path, a gas disruptive discharge tube connected thereto to determine the conductivity of said path, and means controlled by the signals in said transmission path for applying a controlling voltage upon said tube to change said path from a non-transmission to a transmission condition when signaling currents are being transmitted thereover, said means comprising a circuit for deriving as the controlling voltage a unidirectional voltage from said signals.

3. In a transmission system, a transmission path, a neon tube connected thereto for determining the conductivity of said path, said tube having a critical break-down voltage above which conduction through said tube occurs, a source of fixed biasing voltage for said tube, and means for deriving an additional voltage from the signals transmitted over said path, the additional voltage necessary to produce break-down being sufficiently large to provide a margin against operation by small disturbing currents in said path.

4. In combination with a transmission path having means for impressing signals thereon, a neon tube in shunt to said path for controlling the transmission of currents thereover, said neon tube in effect providing a short circuit path for undesirable currents but a path of high impedance for desirable currents, the conductivity of said tube being determined by biasing means controlled by signals traversing said transmission path.
5. The combination with a transmission line of a loss circuit for controlling the transmission of signals over said line, transformer means for connecting said loss circuit in said line, a plurality of neon lamps connected in said loss circuit symmetrically with respect to both sides of said line, and means connected to the electrical midpoint of said transformer for impressing biasing voltages on said lamps controlled by the signals in said line, said loss circuit presenting at all times a balanced impedance to said signals.
6. In combination with a transmission circuit having means for impressing signals thereon, means for preventing the transmission of noise or cross-talk currents thereover during periods of non-transmission, said means comprising a neon tube connected in series in said transmission circuit normally non-conductive during periods of non-transmission, and means controlled by the signals transmitted over said circuit for rendering said tube conductive, said means operative only when currents in excess of a predetermined value are transmitted.
7. In combination with a speech transmission circuit having means for impressing speech signals thereon, means for preventing the transmission of undesirable currents thereover, said means comprising a neon tube connected in series in said transmission circuit, and means for impressing a controlling voltage on said tube derived from the speech signals being transmitted over said circuit to render the conductivity of said tube such that the transmission of undesirable currents through said circuit is prevented.
8. In a transmission system, a path for the transmission of signals thereover, a tube associated with said path having infinite impedance when voltages impressed thereon are below a critical break-down value, but of a small impedance after break-down occurs, and means for impressing a steady voltage upon said tube above said critical value to render said path capable of transmitting signal currents, said means comprising a circuit for deriving said steady voltage from the signals traversing the system.
9. In a transmission system, two one-way transmission paths for transmitting signals in opposite directions, and means in said paths comprising devices having linear transmission characteristics upon the application of voltages above a critical break-down value for regulating the transmission of signals through said paths.
10. In a transmission system, two one-way transmission paths for transmitting signals in opposite directions, means in said paths comprising devices having linear transmission characteristics when impressed with voltages above a critical break-down value, and means under the control of signals in one of said paths for rendering the devices in said other path opaque to signals.
11. In a transmission system, two one-way transmission paths for transmitting signals in opposite directions, a plurality of neon tubes connected in said paths and adapted to operate upon the application of a given voltage, and means responsive to signals in one of said paths for applying voltages to said tubes in said paths, the voltage so applied to the tubes in said one path causing said tubes in said one path to offer less loss to the transmission of signals along that path, and the voltage so applied to the tubes in the other path causing said tubes in said other path to offer increased loss to the transmission of signals along said latter path.
12. In a transmission system, two one-way paths for transmitting signals in opposite directions, means in said paths for regulating the transmission of signals therethrough comprising tubes having infinite impedance for voltages impressed thereon below a critical break-down value but small impedance after said break-down occurs, means for applying a biasing voltage to said tubes to render those in one path opaque to current and those in said other path transparent thereto, said means being controlled by the signal currents in one of said paths.
13. In a transmission system, two one-way transmission paths for transmitting signals in opposite directions, a tube in one of said paths having a critical biasing voltage below which infinite impedance is presented to signal currents and above which break-down occurs rendering said tube readily capable of transmitting signal current, said tube having a biasing voltage thereon for maintaining said path of infinite impedance, a similar tube associated with said oppositely directed path having a biasing voltage thereon for placing said tube in the break-down or low impedance condition, and means for rectifying a portion of the signal current of said first path to produce an additional biasing voltage for said tubes, and means for applying said voltage to said tubes to reverse the transmission conditions of said paths.

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