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TRANSMISSION CONTROL CIRCUITS

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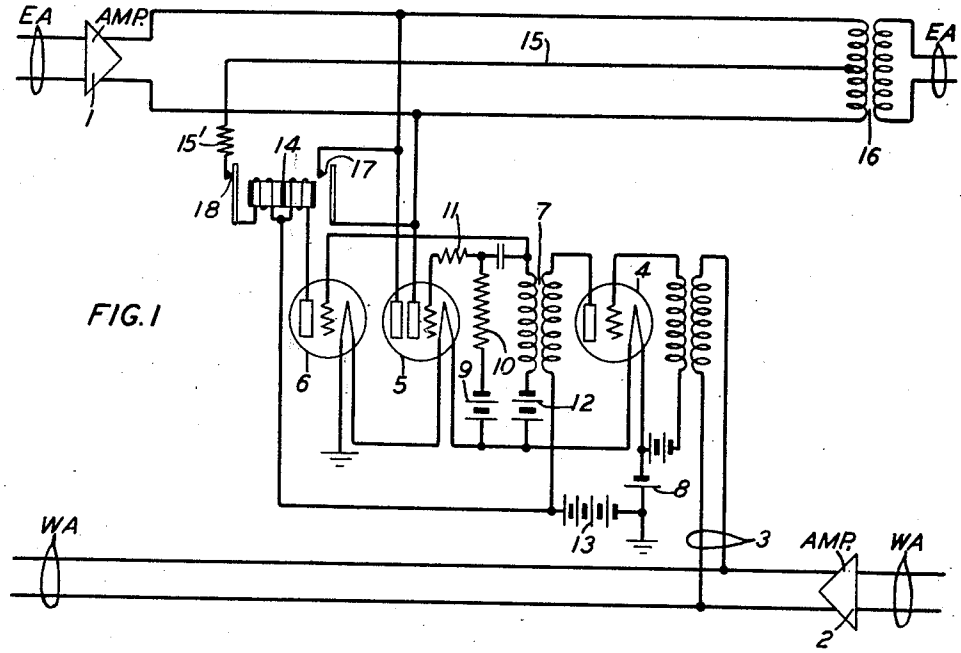

FIG. 1

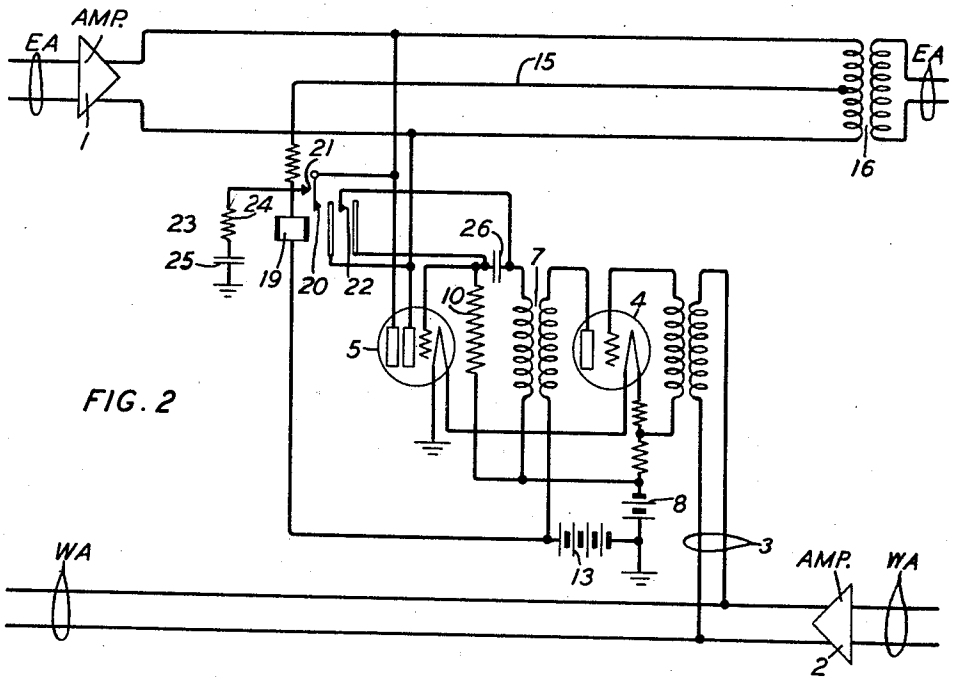

FIG. 2

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TRANSMISSION CONTROL CIRCUITS

Application filed July 15, 1931. Serial No. 551,014.

This invention relates to circuits employing electric space discharge tubes and particularly gaseous or gas-filled space discharge tubes.

The invention has particular application to signal transmission systems in which the transmission characteristics of the signal transmission paths are controlled by signals transmitted over the system. In systems of this type in the prior art it has been common to utilize a portion of the speech or other signaling energy transmitted over the system to control operation of an amplifier-detector circuit employing high vacuum tubes. The amplifier-detector circuit in turn controls the actuation of electromagnetic relays or controls directly a variable loss element associated with a signal transmission path, so as to control the transmission efficiency of the path in the desired manner. In systems of this character, among the important factors determining the proper operation, there may be mentioned the operate time, sensitivity and uniformity of response of the signal-operated control circuits. Heretofore, it has been found that the use of gaseous discharge tubes in connection with control circuits of the above mentioned type enables a more uniform response, a reduction in the operate time and a greater sensitivity to be attained without unduly complicating the circuits or increasing their cost.

An object of the invention is to improve upon circuits employing gaseous electric discharge tubes for transmission control and similar uses. A related and more specific object is to improve the construction and operation of signal-controlled apparatus in which gaseous tubes are used.

In one embodiment of the invention applied to a circuit for suppressing echoes and preventing singing in a two-way signal transmission system, the characteristics of a gaseous electric discharge device comprising two anodes are employed to give the desired control. The gaseous device is so connected to the signal transmission path as to act as a high impedance shunt across the path normally and as a low impedance shunt when alternating control currents are applied to its input so as to cause ionization of the gas in the tube. In one modification, the alternating control currents are also impressed on the input of an auxiliary three-electrode vacuum tube operating as a plate current detector to control a relay which operates to apply a metallic short circuit on the transmission path, and to disable the gaseous device. The detector tube maintains the short circuit on the signal transmission path until the input voltage drops below a critical value and then the circuit quickly restores to its normal condition.

In another modification of the invention, similar results are obtained without the use of the auxiliary three-electrode vacuum tube. The alternating control currents applied to the input of the gaseous device break down the gas so that the resulting low impedance path between the two anodes effectively short-circuits the transmission path as before. The resulting plate current energizes the winding of a relay in the plate circuit, causing operation of the relay first to apply a metallic short circuit across the transmission path, and then to modify the output circuit of the gaseous tube so that the tube will oscillate as long as the control currents are impressed substantially continuously on the input thereof, and thirdly, to short-circuit a condenser normally in the grid circuit of the gaseous device enabling the device to quickly restore to its normal condition when the control current input thereto ceases.

The invention will be more fully understood from the following detailed description thereof when read in connection with the accompanying drawing, Figs. 1 and 2 of which show portions of a four-wire repeating circuit equipped with echo suppressors embodying different modifications of the invention.

Fig. 1 shows the invention embodied in an echo suppressor applied to a four-wire repeating circuit only a portion of the circuit being shown. The four-wire repeating circuit comprises a one-way transmission path EA including the one-way amplifying device 1 for repeating signals in the direction from west to east, and the one-way transmission

path WA including the one-way amplifying device 2 for repeating signals in the direction from east to west. The one-way amplifying paths EA and WA may be connected at each end in energy transmitting relation with the two-way transmission circuits between which signals are to be repeated (not shown) and in substantial conjugate relation with each other by hybrid coil transformers and associated balancing networks or by any other suitable means.

Branched across the path WA at any suitable point, for example, in the output of the amplifying device 2 therein, is the input circuit 3 of an echo suppressor comprising the three-electrode vacuum tube amplifying device 4, and the gaseous electric discharge device 5 and the three-electrode space discharge device 6 arranged to operate as a plate current detector, fed in parallel from the output of the amplifying device 4 through the interstage transformer 7.

The gas-filled device 5 comprises a tube containing a small amount of a gas, such as argon, a cathode or filament, a control electrode or grid and two anodes or plates. The gas in the tube gives it a peculiar grid-plate current characteristic. As long as the potential of the grid with respect to the cathode remains under a certain critical value, which is usually about +5 volts, no plate current will flow and the anode to anode impedance is very high. However, as soon as the input voltage exceeds the critical value the tube breaks down, plate current starts to flow and the anode to anode impedance of the tube becomes very low.

The two anodes of the gaseous tube 5 are connected respectively to opposite sides of the transmission path EA. The filaments of the tubes 4, 5 and 6 are supplied in series with heating current from the battery 8. A sufficient negative polarizing potential is applied by battery 9 to the grid of the gaseous tube 5 through resistances 10 and 11 so that the tube 5 is normally in the inoperative condition, and, therefore, the anode to anode impedance thereof connected across the path EA is so high as to have little effect on the flow of signals over that path. Also, the rectifier tube 6 is normally maintained inoperative by a negative polarizing potential applied to the grid thereof by the battery 12 through the secondary winding of interstage transformer 7. Space current is supplied by battery 13 to the amplifying device 4 through the primary winding of interstage transformer 7. Space current is also supplied by the battery 13 to the plate of the rectifier tube 6 through the right-hand winding of the mechanical relay 14, and to the two anodes of device 5 through the left-hand winding of relay 14, normally closed contacts 18, resistance 15′, conductor 15, the respective halves of the primary winding of transformer 16 in the path EA and the line wires of transmission path EA and the connection to the two anodes of tube 5. The resistance 15′ is provided in the plate circuits of tube 5 to limit the space current of the tube to a suitable value. The normally open contacts 17 are adapted to be closed by operation of relay 11 in response to energization of its windings to connect a metallic short circuit across the path EA. The normally closed contacts 18 in the conductor 15 are also adapted by any suitable means to be opened subsequent to the closing of contact 17 by operation of relay 14 in response to energization of its windings, to open the anode circuits of the gaseous tube 5.

The operation of the circuit will now be described. When signal transmission is taking place over the repeating path WA in the direction from east to west a portion of the amplified signals in the output of the amplifying device 2 therein passes into the input circuit 3 of the echo suppressor and is amplified by the amplifying device 4 therein. The amplified signals in the output of the amplifying device 4 are impressed by interstage transformer 7 upon the input circuits of the gaseous tube 5 and the rectifier tube 6 in parallel. The amplified signal voltage impressed upon the input circuit of the gaseous tube 5 causes the gas therein to be ionized and thus the space path to become conductive to transmit space current substantially instantaneously. The anode to anode impedance of the tube 5 is thus immediately reduced to a very low value effectively short-circuiting the transmission path EA through the two anodes of the tube 5 and the now conductive space path therebetween.

The amplified signal voltage simultaneously impressed upon the input circuit of the detector tube 6 by interstage transformer 7 causes tube 6 to operate causing current to flow in the plate-filament circuit thereof through the right-hand winding of relay 14 so as to assist tube 5 in operating that relay. Relay 14 operates first to close normally open contacts 17 thus connecting the metallic short circuit across the transmission circuit EA.

The operation of relay 14 causes the normally closed contacts 18 in the conductor 15 to be opened slightly after the contacts 17 have been closed thus breaking the space current supply circuit for tube 5. The tube 5 will then return to its normal condition, that is, to the condition in which the anode to anode impedance thereof is high. The characteristic non-self-restoring properties of the gaseous tube does not have the effect of making the echo suppressor non-restoring when the signal input thereto ceases, for the gaseous tube 5 is only used to initially suppress the transmission path and the tube 5 is then allowed to return to its normal condition when the metallic short circuit is placed on the path

under control of detector tube 6. The suppression of path EA by the metallic short circuit is maintained under control of the three-electrode vacuum tube detector tube 6.

The plate-filament current of the detector tube 6 will maintain the relay 14 operated as long as the amplified signal currents are being substantially continuously impressed upon the input circuit of the tube. When transmission of signals over the path WA ceases the amplified signal voltage applied to the input of the tube 6 will rapidly fall off. When the input voltage to the tube 6 drops below the critical operative value of that tube, the plate filament current of the tube will have decreased sufficiently to cause the relay 14 to release causing contacts 17 to return to their normal open position and contacts 18 to return to their normally closed position. The metallic short circuit across the transmission path EA is thereby broken and the plate-filament circuit of gaseous tube 5 closed. The restoration of the echo suppressor to its normal condition with the cessation of the control voltage thereto is rapid due to the well-known quick restoring characteristics of a three-electrode vacuum tube detector. The circuit is now in condition to be again actuated in response to signal currents over the transmission path WA.

Fig. 2 shows a modification of the echo suppressor of Fig. 1 which does not require the use of the additional vacuum tube for restoring the circuit quickly to its normal condition when the input thereto is withdrawn. The circuit of Fig. 2 differs essentially from the circuit of Fig. 1 merely in that a specially designed relay 19, having its winding in the anode-filament circuits of the gaseous tube 5, replaces the detector tube 6 and the relay 14 shown in the latter figure. As in the case of the circuit of Fig. 1, the amplified signal voltage impressed on the input circuit of the gaseous tube 5 through interstage transformer 7 causes tube 5 to break down causing the path EA to be substantially instantaneously short-circuited through the low impedance path between the anodes of the tube. The resultant large plate current of tube 5 flowing through the winding of relay 19 causes the operation of that relay to close normally open contacts 20, 21 and 22 in order. The closing of contacts 20 connects a metallic short circuit across the transmission path EA. The closing of contacts 21 connects the circuit 23 between one anode and the filament circuit of tube 5. The closing of contacts 22 short-circuits the condenser 26 normally in the grid-filament circuit of the gaseous tube 5. The circuit 23 may comprise a resistance 24 and condenser 25 of such value with respect to the constants of the circuits of the gaseous tube 5 as to form therewith an oscillating circuit thus maintaining relay 19 continuously energized and therefore contacts 20, 21 and 22 closed as long as the amplified signaling currents are impressed substantially continuously upon the input circuit of tube 5.

The short-circuiting of the condenser 26 in the grid-filament circuit of the gaseous tube 5 provides through the circuit comprising the closed contacts 20, the secondary winding of interstage transformer 7 and the battery 8, a low resistance path to ground from the grid of the tube 5. Thus, when the signal current input to tube 5 ceases, the potential charge on the grid leaks off quickly through the low resistance path to ground thus enabling the gaseous tube to be restored to its normally inoperative condition substantially instantaneously.

Although in the circuits of Fig. 1 and Fig. 2 only the echo suppressor for suppressing the west to east amplifying path EA when the signal currents are transmitted over the east to west amplifying path WA, has been shown, it is to be understood that another echo suppressor similar to that shown in Figs. 1 or 2 having its input connected across the amplifying path EA may be arranged to suppress the amplifying path WA when signal currents flow in the path EA. The suppressor circuits may be connected near the middle of the four-wire repeating circuit, at the terminals thereof, or at any other points.

The circuits of the invention as illustrated and described employ a particular type of gaseous electric discharge device having two anodes for controlling the transmission characteristics of a signal transmission path as it has been found that such a device in operation does not produce objectionable "click" disturbances in associated telephone receivers. However, it is to be understood that the invention is applicable as well to circuits employing other types of gaseous electric discharge devices normally having a high impedance between the output electrodes which is changed to a low impedance when alternating currents are impressed on the input electrodes thereof, for example, the type of gaseous device disclosed in the copending application of G. H. Rockwood and W. B. Lodge, Serial No. 514,931, filed February 11, 1931. Other modifications which may be made in the circuit of the invention without departing from the spirit and scope of the invention as defined in the appended claims will occur to persons skilled in the art.

What is claimed is:

1. In combination, a transmission circuit, a source of alternating current waves, a gaseous electric space discharge device having a pair of anodes and normally having a high anode to anode impedance, said anode to anode impedance being connected effectively in shunt with said transmision circuit, and means automatically responsive to alter-

nating current waves received from said source for decreasing the anode to anode impedance of said device.

2. In combination in a signal transmission system, two signal transmission paths, a gas-filled electric space discharge tube having input electrodes and a pair of anodes normally having a high anode to anode impedance, said anode to anode impedance being connected effectively in shunt with one of said paths, and means responsive to flow of signals in the other of said paths for applying a potential to said input electrodes in such manner as to appreciably reduce the value of said anode to anode impedance of said tube.

3. In a signal transmission system, a signal transmission path and a circuit for controlling the transmission efficiency of said path comprising a gas-filled electric space discharge tube having input electrodes and a pair of anodes, connections from each anode to a different side of said path, said device normally having such a high anode to anode impedance as to have little effect on the transmission of signals over said path, means responsive to alternating current control waves supplied to said circuit for operating said device to so reduce the anode to anode impedance thereof as to effectively short-circuit said path, and means also responsive to said control waves for maintaining said path short-circuited during the duration of said waves while conditioning the control circuit so that it will return to its normal condition substantially instantaneously with cessation of the supply of control waves thereto.

4. The system of claim 3 and in which the last mentioned means comprises means responsive to the supplied alternating current control waves for connecting a low impedance shunt across said path and for subsequently increasing the anode to anode impedance of said gaseous device to its normal value, and means responsive substantially instantaneously to cessation in the supply of the control waves to said circuit for removing said low impedance shunt from said path.

5. The system of claim 3 and in which the last mentioned means comprises a relay which when energized independently short-circuits said path and causes the anode to anode impedance of said gaseous device to be subsequently increased to its normal value, and means responsive to said control waves for energizing said relay, and responsive substantially instantaneously to cessation of said control waves to deenergize said relay.

6. The system of claim 3 and in which the last mentioned means comprises a relay which when energized applies a metallic short circuit across said path and breaks the anode circuit of said gaseous device so as to restore it to its normal condition, a vacuum tube device supplied with a portion of said control currents and responsive thereto to energize said relay, said relay being designed to release substantially instantaneously when the input voltage to said vacuum tube device falls below a critical value.

7. The system of claim 3 and in which the last mentioned means comprises a relay in the anode circuit of said gaseous device, and operatively responsive to the current flowing therein when said device is operated by the control waves applied to its input to apply and maintain a metallic short circuit across said path as long as said control waves are substantially continuously supplied thereto, and to modify the circuit of said gaseous device so that said device will be restored to its normal condition substantially simultaneously with cessation in the supply of control waves thereto.

In witness whereof, we hereunto subscribe our names this 8th & 2nd days of July, 1931.

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