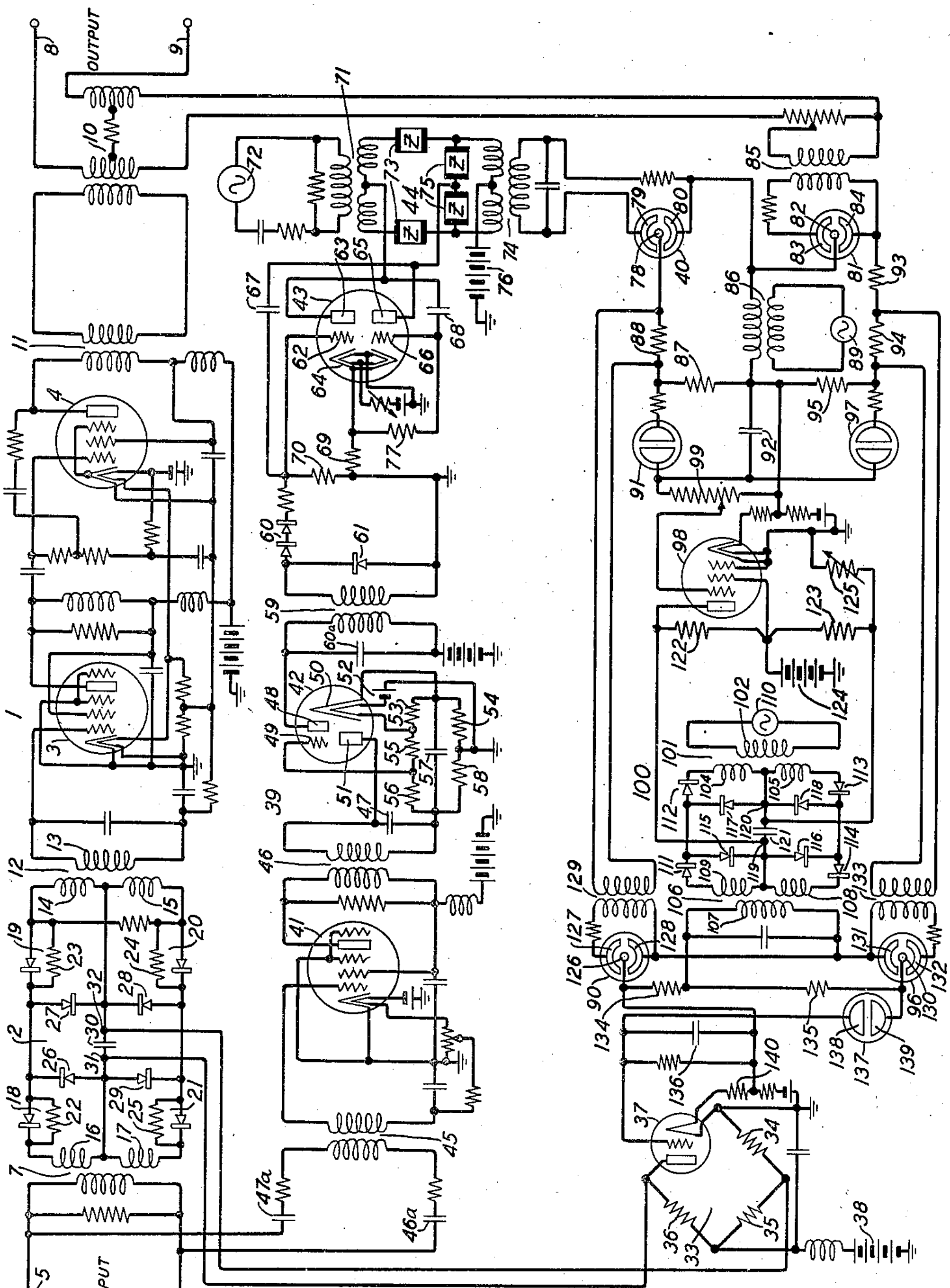
Jan. 14, 1941. B. G. BJORNSON 2,228,866

VOLUME CONTROL CIRCUITS

Filed Oct. 11, 1939



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Patented Jan. 14, 1941

2,228,866

UNITED STATES PATENT OFFICE

2,228,866

VOLUME CONTROL CIRCUITS

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Application October 11, 1939, Serial No. 298,888

16 Claims. (Cl. 178—44)

This invention relates to volume control circuits and particularly to volume control circuits for maintaining speech signals at constant volume.

One object of the invention is to provide volume control circuits that shall weigh the time a given voltage is exceeded and the number of syllables on a transmission line in an improved manner for controlling the volume of the speech signals.

Another object of the invention is to provide volume control circuits that shall maintain a constant relation between the time a given voltage is exceeded on a signal transmission line and the number of syllables.

Another object of the invention is to provide volume control circuits that shall weigh the time a given voltage is exceeded and the number of syllables for controlling the volume on a transmission line and that shall maintain the rate of gain change constant.

A further object of the invention is to provide volume control circuits having a control condenser for governing the speech volume on a transmission line according to the charge thereon that shall impress a variable charging potential on the control condenser according to the time a given voltage is exceeded and the number of syllables which is high relative to the charge on the condenser to maintain an even rate of gain change.

In transmitting signals, for example, speech signals over certain types of transmission systems it is desirable to hold the signals at substantially constant volume. It is desirable in the "Transatlantic Radio System" to hold the speech signals at constant volume in order to prevent overloading of the apparatus in the transmitter. The volume range between a very loud talker and a very weak talker may be such as to cause overloading of the apparatus in the radio transmitter by the strong talker when the weak talker is raised to a satisfactory level. In order to prevent overloading the apparatus in the radio transmitter, the signal currents produced by the weak talker and the strong talker are controlled by a voice-operated gain adjusting device so that constant volume is supplied to the radio transmitter.

The volume control circuits disclosed are an improvement on the volume control circuits disclosed in the application of B. G. Bjornson Serial No. 298,887 filed October 11, 1939. In volume control circuits of the type under consideration, the time a given voltage is exceeded and the number of syllables in speech signals are weighed against each other and proper balance obtained which can be employed to adjust the strengths of the speech signals.

In the circuits employed to describe the invention a vario-losser comprising series and parallelly arranged resistance elements is inserted in a signal transmission line for controlling the strength or amplitudes of the speech signals. The resistance elements in the vario-losser preferably are in the form of copper oxide rectifier elements having non-linear resistance current characteristics. A bridge circuit having one arm in the form of a gain control tube is provided for governing the resistance value of the resistance elements in the vario-losser. The gain control tube is governed according to the ratio of the time a given voltage is exceeded and the number of syllables on the signal transmission line. When no signals are on the transmission line the vario-losser has a resistance value to obtain a mean gain on the transmission line.

A syllabic amplifier detector circuit which is connected to the transmission line before the vario-losser is provided with means whereby it may be operated by signals above a certain value. The syllabic detector circuit includes a pulser device which is operated by low strength syllabic impulses. Means are provided whereby the pulsing device is only operated on the rising portion of a syllabic impulse. Means are also provided whereby the pulser device operates for a predetermined time irrespective of the strength or duration of a syllabic impulse. The pulser device operates a driver circuit for supplying spurts of low frequency alternating current to operate a syllabic cold-cathode detector tube. A high strength cold cathode detector tube is connected to the transmission line beyond the vario-losser by means of a hybrid coil.

The two detector tubes are each of the three-element type having an ignition circuit and an operating circuit. The ignition circuits are broken down by the syllabic detector circuit and the backward acting circuit connected to the hybrid coil. The operating circuits for the two detector tubes are supplied with current from a low frequency alternating current source so that the two tubes receive opposite half-waves. Thus the two detector tubes operate 180 degrees out of phase with respect to each other. Two cold cathode balancing tubes are respectively broken down by the two detector tubes for charging a balancing condenser to weigh the operations of the two detector tubes. The balancing condenser is charged in one direction or the other according to which detector tube predominates in the control thereof. No means is provided for blocking the syllabic detector circuit when the backward acting circuit controlling the high frequency detector tube is in operation because the two detector tubes do not operate in phase with each other. Resistance means is provided in the operating circuit of the high strength detector tube to compensate any effect on the balancing condenser that may be made by the syllabic detector tube. The detector tubes respectively ignite two enabler tubes when operated. The enabler tube ignited by the syllabic detector tube may be called the gain increaser tube and the enabler tube operated by the high strength detector tube may be called the gain decreaser tube. The gain increaser tube and the gain decreaser tube, respectively, operate in phase with the syllabic detector tube and the high strength detector tube.

The balancing condenser impresses positive or negative potential on the grid of a gain rate control tube which in turn controls a driver arrangement having two separate paths. An output transformer connected to the driver arrangement has two primary windings respectively associated with the two paths. The secondary winding is connected to the operating circuits of the gain increaser tube and the gain decreaser tube. The two primary windings of the output transformer are wound oppositely so that when equal currents flow through the two paths no current will be supplied to the secondary winding of the output transformer. An input transformer connected to a source of low frequency alternating current is provided for supplying the two paths with a low frequency current. The gain rate control tube varies the resistance value of resistance elements in the two paths so that the current flow through one or the other of the paths predominates according to whether low strength signals or high strength signals are on the transmission line.

The gain control tube is governed by the driver arrangement according to whether the output therefrom is above a certain value and in phase with the gain increaser tube or the gain decreaser tube. If the driver arrangement output is above a certain value and in phase with the gain increaser tube the gain control tube is operated to raise the gain in the transmission line. If the driver arrangement output is above a certain value and in phase with the gain decreaser tube, then the gain control tube is operated to lower the gain in the transmission line. A marginal isolator tube of the cold cathode type is provided for preventing any change in the gain on the transmission line until the output from the driver arrangement is raised above a predetermined point.

The single figure in the accompanying drawing is a diagrammatic view of a system constructed in accordance with the invention.

Referring to the drawing, a gain control station 1 is shown comprising a vario-losser 2 and two space discharge amplifier tubes 3 and 4. Input conductors 5 and 6 are connected to the vario-losser 2 by means of a transformer 7 and output conductors 8 and 9 are connected to the amplifier tube 4 by means of a hybrid coil 10 and a transformer 11. The vario-losser 2 is connected to the amplifier tube 3 by means of a transformer 12. The transformer 12 is provided with a secondary winding 13 and two primary windings 14 and 15. The transformer 7 which connects the vario-losser to the input conductors 5 and 6 is provided with two secondary windings 16 and 17. Four series arranged resistance elements 18, 19, 20 and 21 in the form of copper-oxide rectifiers are positioned between the transformers 7 and 12 and are respectively shunted by resistance elements 22, 23, 24 and 25. Shunt resistance elements 26, 27, 28 and 29 in the form of copper-oxide rectifier elements are connected between the elements 18 and 21 and the elements 19 and 20. A condenser 30 provides low alternating current impedance between a tap from the secondary windings 16 and 17 of the transformer 7 and a tap from the primary windings 14 and 15 of the transformer 12.

The amplifier tube 3 and the feedback amplifier tube 4 perform no special function in the operation of the circuits other than that of the amplification and a detailed description of these parts is deemed unnecessary.

Two contact members 31 and 32 on the vario-losser 2 are connected to opposite vertices on the bridge circuit 33. The bridge circuit comprises three resistance arms 34, 35, and 36 and the space current path of a three-element tube 37. The tube 37 which may be designated as the gain control tube varies the bridge 33 to control the vario-losser 2. Battery 38 is connected to the other two vertices of the bridge 33. The gain control tube 37 is governed according to the strength of the signals on the transmission line for governing the bridge 33 which in turn controls the potentials impressed on the contact members 31 and 32 of the vario-losser 2. If positive potential is impressed on the contact member 32 and negative potential is impressed on the contact member 31 the vario-losser has low loss to increase the gain on the transmission line. If the contact member 32 has negative potential impressed on it and the contact member 31 has positive potential impressed on it the resistance value of the vario-losser will be increased to lower the gain on the transmission line.

Assume positive potential is impressed on the contact member 32, a circuit is completed from the terminal 32 through the secondary winding 14, resistance elements 19 and 18 and the primary winding 16 to the contact member 31. A second circuit is completed from the contact member 32 through secondary winding 15, resistance elements 20 and 21 and the primary winding 17 to the contact member 31. A third circuit is completed from the contact member 32 through the resistance elements 27 and 26 to the contact member 31. A fourth circuit is completed from the contact member 32 through the resistance elements 28 and 29 to the contact member 31. In the circuits above traced it may be noted that the series resistance elements 18, 19, 20 and 21 have current flow therethrough in a direction to reduce the resistance values greatly whereas the parallel resistance elements 26, 27, 28 and 29 have very little current flow therethrough, accordingly their resistance values are reduced very little. Thus the parallel resistance elements have great resistance value and the series resistance elements have little resistance value so that the opposition to current flow by the vario-losser is greatly reduced. An opposite effect takes place in case negative potential is impressed on contact member 32 and positive potential is impressed on contact member 31. In the latter case the resistance values of the parallel to shunt resistance elements 26, 27, 28 and 29 are reduced greatly, whereas the resistance values of the series elements 18, 19 20 and 21 are changed very little.

A syllabic detector circuit 39 which is connected to the input conductors 5 and 6 before the vario-losser 2 is provided for igniting a syllabic detector tube 40. The syllabic detector circuit comprises a pentode amplifier 41, a diode triode 42, a pulser device 43 and a driver circuit 44. The input circuit of the amplifier tube 41 is connected to the input conductors 5 and 6 by means of a transformer 45. Two condensers 46*a* and 47*a* are associated with the transformer 45 to form a band-pass filter which passes frequencies having a center about 1200 cycles. The output circuit of the amplifier tube **41** is connected by the transformer **46** to the diode of the diode-triode **42**. A condenser **47** is associated with the transformer **46** for tuning the same to a frequency of approximately 1000 cycles. The diode-triode device **42** comprises an anode **48**, a control grid **49**, a cathode **50** and auxiliary anode **51**. The filament for heating the cathode **50** is energized by a battery **52**. The circuit for heating the filament may be traced from the battery **52** through the filament, resistance element **53** and resistance element **54** to the battery **52**. The drop across the resistance element **53** is employed to impress a negative bias on the grid **49**. In order to provide a normal bias on the grid **49** without changing the circuit of the diode, the resistance elements **53** and **54** are symmetrically placed with respect to the diode circuit and the bias taken across the resistance element **53**.

The diode circuit which is connected to the secondary winding of the transformer **46** may be traced from one terminal of the secondary winding through the auxiliary anode **51**, cathode **50**, resistance element **53** and resistance elements **55** and **56** to the other terminal of the secondary winding. A condenser **57** and two resistance elements **58** and **54** are connected in shunt to the resistance elements **53**, **55** and **56**. The resistance element **58** is equal in value to the resistance elements **55** and **56**. The resistance element **53** is equal in value to the resistance element **54**. The potential drop across the resistance elements **53** and **55** when varied by the signals on the transmission line is employed for inserting a variable negative bias on the control grid **49** of the triode portion. The triode portion of the diode-triode normally has only a small negative potential impresed on the grid **49** so that space current flows through the tube. When signals are on the transmission line the negative potential impressed on the grid **49** is increased and in case of very strong signals the triode portion of the diode triode will be blocked so that the syllabic detector circuit **39** is rendered inoperative.

The triode portion of the diode triode **42** is connected by a transformer **59** to the pulser device **43**. The condenser **60a** in the circuit of the primary winding of the transformer **59** tunes the transformer to a syllabic frequency. Preferably the transformer is tuned to a frequency between 6 and 8 cycles. The secondary winding for the transformer **59** has a copper-oxide rectifier element **61** in shunt therewith so that the pulser device **43** can only be operated on the rising portion of a syllabic impulse. The copper-oxide elements **60** in series with the secondary winding of transformer **59** prevent the impedance changes of the diode-triode from affecting the characteristic of the pulser device **43** excessively.

The pulser device **43** comprises an upper element having a control grid **62**, an anode **63** and a cathode **64**, and a lower device having an anode **65**, control grid **66** and the cathode **64**. Two condensers **67** and **68** and two resistance elements **69** and **70** are provided for governing the operation of the pulser device as will be explained later.

The driver circuit **44** comprises a transformer **71**, connected to a source **72** of low frequency alternating current. The secondary winding of the transformer **71** is connected through resistance elements **73** to a transformer **74**. The secondary winding of the transformer **74** is connected to the ignition circuit of the low strength detector tube **40**. The resistance elements **73** are preferably composed of silicon carbide and a binder material. Elements of this type are disclosed in the patent to K. B. McEachron 1,822,742, dated September 8, 1931. Resistance elements **75** of the same type as the resistance elements **73** are connected across the connection between elements **73** and the primary winding of the transformer **74**. A battery **76** is connected to a mid-point on the primary winding of the transformer **74**, the anode **63** of the upper device in the pulser is connected to a mid-tap on the secondary winding of the transformer **71** and the anode **65** of the lower device of the pulser is connected to a mid-tap on the resistance elements **75**. When potential is impressed on the resistance elements **73** the series impedance of the driver circuit is lowered, whereas if the potential is impressed on the resistance elements **75** the shunt impedance of the driver circuit is increased.

Normally when the pulser device **43** is not operated the lower device is energized and the condenser **68** is charged. The output circuit of the lower device may be traced from the battery **76** to the mid-tap of the primary winding of the transformer **74** in parallel through the primary winding sections in parallel through the resistance devices **75**, anode **65**, cathode **64**, resistance **69** and ground return to the battery **76**. The potential drop across the resistance element **69** is employed to impress a negative bias on the control grid **62** of the upper device in the pulser.

In case the pulser is operated by a syllabic impulse, the negative bias on the control grid **62** is reduced to permit current flow through the upper device. The output circuit of the upper device in the pulser may be traced from the grounded battery **76** to a mid-tap on the primary winding of the transformer **74**, sections of the primary winding for the transformer **74**, resistance elements **73** and sections of the secondary winding of the transformer **71** in parallel to the anode **63**, cathode **64**, resistance element **69** and ground return to the battery **76**. Upon operation of the upper device in the pulser, the condenser **68** is discharged through a circuit which may be traced from one terminal of the condenser through the anode **63**, cathode **64** and resistance element **77** to the other terminals of a condenser **68**. The potential drop across the resistance element **77** impresses a negative bias on the control grid **66** of the lower device in the pulser to block the lower device. Upon operation of the upper device of the pulser, the condenser **67** is charged. However, when the lower device of the pulser is blocked the charge on the condenser **67** is discharged through the resistance element **70**. The discharge circuit for the condenser **67** may be traced from one terminal in the condenser through the anode **65**, cathode **64**, resistance element **69**, and resistance element **70** to the other terminal of the condenser **67**. The potential drop across the resistance element **70** due to the discharge of the condenser **67** impresses a negative bias on the control grid **62** to block the operation of the upper device in the pulser.

The pulser device operates the driver circuit **44** to supply spurts of low frequency current from the source **72** to ignite the detector tube **40**. The spurts of low frequency current are the same irrespective of the strength or duration of the syllabic impulses which control the pulser devices. The syllabic detector tube **40** which is operated by the syllabic detector circuit **39** comprises electrodes

78, 79 and 80. The electrodes 79 and 80 are connected to the secondary winding of the transformer 74 in the driver circuit 44.

A high strength detector tube 81 comprising electrodes 82, 83, and 84 is ignited by a backward acting circuit connected to the hybrid coil 10. The electrodes 83 and 84 are connected to the hybrid coil 10 by means of a transformer 85. The operating circuit for the detector tube 40 may be traced from the electrode 80 through the secondary winding of transformer 86, resistance element 87 and resistance element 88 to the electrode 78 of the detector tube 40. The primary winding of the transformer 86 is connected to a source 89 of low frequency current which energizes the operating circuit of the detector tube. The potential drop across the resistance element 88 serves to ignite a gain increaser cold cathode 90. The potential drop across the resistance element 87 serves to break down a balancing cold-cathode tube 91 to charge a balancing condenser 92 in one direction.

The operating circuit for the high strength detector tube 81 may be traced from the electrode 84 through resistance elements 93, 94 and 95 and the secondary winding of the transformer 86 to the electrode 82 of the detector tube 81. The potential drop across the resistance element 94 is employed to ignite the gain decreaser cold-cathode tube 96. The potential drop across the resistance element 95 is employed to ignite a balancing cold-cathode tube 97 to charge the balancing condenser in an opposite direction to that in which it was charged by ignition of the tube 91. By reason of the connection of the source 89 of low frequency current to the detector tubes 40 and 81 it is apparent that the two detector tubes are operated by opposite half cycles so that the two detector tubes operate 180 degrees out of phase with respect to each other. Likewise, the gain increaser tube 90 and the gain decreaser tube 96 are ignited out of phase with respect to each other.

The balancing condenser 92 averages or weighs the operations of two detector tubes 40 and 81 to control a gain rate control tube 98. The circuit controlling the high strength detector tube 81 does not block the syllabic circuit or the detector tube 40 by reason of the two detector tubes having operating circuits 180 degrees out of phase with respect to each other. The effect of the detector tube 40 on the balancing condenser 92 during the operation of the detector tube 81 is taken care of by the resistance elements in the operating circuit of the high strength detector tube 81.

The potential drop across a portion of a resistance element 99 which is connected in shunt to the balancing condenser 92 serves to impress a positive or negative potential on the control grid of the gain rate control tube 98. If the syllabic detector tube 40 predominates in the charging of the balancing condenser 92 then a negative potential is impressed on the control grid of the tube 98. However, if the high strength detector tube 81 predominates in the charging of a balancing condenser 92 then a positive potential is impressed on the control grid of the tube 98.

The gain rate control tube 98 governs the operation of a driver circuit 100. The driver circuit comprises an input transformer 101 having a primary winding 102 and two secondary windings 104 and 105 and an output transformer 106 having a secondary winding 107 and two primary windings 108 and 109. The primary winding 102 of the transformer 101 is connected to a source 110 of low frequency alternating current. The primary windings 108 and 109 of the transformer 106 are oppositely wound and are respectively inserted in two different paths of the driver circuit. Series resistance elements 111, 112, 113 and 114 of the copper-oxide type are provided in circuit between the secondary windings 104 and 105 of the transformer 101 and the primary windings 108 and 109 of the transformer 106. Resistance elements 115, 116, 117 and 118 of the copper-oxide type are connected in shunt across the circuit between the secondary windings of the transformer 101 and the primary windings of the transformer 106. Two contact terminals 119 and 120 separated by condenser 121 are connected to resistance elements 122 and 123. Direct current potential is supplied to the contact members 119 and 120 of the driver circuit 100 for controlling the copper-oxide resistor elements in accordance with the operation of the gain rate control tube 98.

One terminal of each of the resistance elements 122 and 123 is connected to a grounded battery 124. The other terminal of the resistance element 122 is connected to the anode of the gain rate control tube 98 so that the resistance element 122 has current flow therethrough according to the operation of the tube 98. The other terminal of the resistance element 123 is connected through a resistance element 125 to the other terminal of the grounded battery 124. The potential drop across the two resistance elements 122 and 123 oppose each other and under normal conditions when no signals are being transmitted over the transmission line, no potential will be impressed between the contact members 119 and 120 of the driver circuit 100.

If the detector tube 40 predominates in the operation of the balancing condenser 92 then the current flow through the gain rate control tube 98 is reduced to impress positive potential on the contact member 119 and negative potential on the contact member 120 of the driver circuit 100. If the high strength detector tube 81 predominates in controlling the balancing condenser 92, then current flow through the gain rate control tube 98 is increased to impress negative potential on the contact member 119 and positive potential on the contact member 120 of the driver circuit 100.

When positive potential is impressed on the contact member 119 a circuit is completed from the contact member 119 through the primary winding 109, series resistance elements 111 and 112 and secondary winding 104 to the contact terminal 120. The copper-oxide elements 111 and 112 have their resistance values greatly reduced to permit the flow of alternating current from the transformer secondary winding 104 to the primary winding 109 of the transformer 106. A second circuit is completed from the contact member 119 through the copper-oxide element 115 and the copper-oxide element 117 to the contact member 120. The copper-oxide elements 115 and 117 will have their alternating current impedance increased due to the flow of direct current. This will increase the flow of alternating current through the winding 109. A third circuit may be traced from the contact terminal 119 through the primary winding 108, copper-oxide resistance elements 114 and 113 and secondary winding 105 to the contact terminal 120. In this circuit, the copper-oxide elements 114 and 113 will have their alternating current impedance increased to reduce the alternating current flow through the winding 108. A fourth circuit is completed from the contact member 119 which may be traced from the contact member 119 through copper-oxide element 116 and the copper-oxide element 118 to the contact terminal 120. The elements 116 and 118 permit the free flow of direct current through them so that the elements effect considerable shunting action across the secondary winding 105 and the primary winding 108. Consequently little alternating current is transmitted from the source 110 through the secondary winding 105 to the primary winding 108.

In the example above taken the primary winding 109 predominates over the primary winding 108 and accordingly controls the secondary winding 107 of the transformer 106. This is always the case when the low strength detector tube 40 controls the balancing condenser 92. If the high strength detector tube 81 controls the balancing condenser 92 an opposite effect will take place and the primary winding 108 of the transformer 106 will predominate over the primary winding 109 in controlling the secondary winding 107.

The gain increaser cold cathode tube 90 comprises three electrodes 126, 127 and 128. The electrodes 127 and 128 are connected across the resistance element 88 by means of a transformer 129. The gain decreaser cold cathode tube 96 comprises three electrodes 130, 131 and 132. The electrodes 131 and 132 are connected across the resistance element 94 by means of the transformer 133. The operating circuit for the gain increaser tube 90 may be traced from the electrode 128 through secondary winding 107 of the transformer 106 and resistance element 134 to the electrode 126. The operating circuit of the gain decreaser tube 96 may be traced from the electrode 131 through secondary winding 107 of the transformer 106 and resistance element 135 to the electrode 130. The tubes 90 and 96 are ignited in phase with the detector tubes 40 and 81. Moreover, the secondary winding 107 is energized in opposite phases according to whether the primary winding 108 or the primary winding 109 predominates. Consequently, the secondary winding 107 has current therein in phase with the operation of the enabler tube 90 or the enabler tube 96.

A gain control condenser 136 is provided for controlling the potential on the grid of the gain control tube 37 according to the charge thereon. The charge on the condenser 136 is governed according to the operation of the enabler tubes 90 and 96 in combination with the driver circuit 100. If the driver circuit 100 and the enabler tube 90 are operated by the syllabic detector tube 40, then the condenser 136 is charged to impress a negative potential on the control grid of the tube 37. If the driver circuit 100 and the enabler tube 96 are controlled by the high strength detector tube 81 then the condenser 136 is charged to impress positive potential on the control grid of the gain control tube 37.

The gain control condenser 136 is connected across the resistance elements 135 and 134 in series with a marginal isolator tube 137. The isolator tube 137 is of the cold cathode type and comprises electrodes 138 and 139. The isolator tube 137 being marginal in operation prevents changing of the charge on the gain control condenser 136 until the driver circuit 100 is operated above a predetermined point. The resistance 140 is included in the filament heating circuit for the tube 37. The charge impressed on the condenser 136 under control of the driver circuit 100 is always large with respect to the normal charge so that the same rate of gain change is effected at all times during the operation of the gain control circuits.

If low strength signals are on the transmission line the syllabic detector circuit 39 is operated for supplying spurts of low frequency alternating current from the source 72 to the low strength detector tube 40. The detector tube 40 is ignited and the operating circuit therefore breaks down and ignites the gain increaser tube 90 and the balancing tube 91. The balancing tube 91 permits charging of the balancing condenser 92. If low strength signals predominate over high strength signals for a period of time the balancing condenser 92 operates the gain rate control tube 98 which in turn controls the driver circuit 100 to supply the secondary winding 107 of the transformer 106 with current from the primary winding 109 which under the conditions above set forth predominates over the primary winding 108. The transformer winding 107 in combination with the gain increaser tube 90 charges the condenser 136 to reduce the current flow through the gain control tube 137. The gain control tube 137 so controls the bridge circuit 33 as to impress positive potential on the contact member 32 and negative potential on contact member 31 of the vario-losser 2. Positive potential on the contact member 32 changes the impedances of the vario-losser as above set forth to increase the gain on the transmission line.

In case high strength signals predominate on the signal transmission line, the high strength detector tube 81 effects ignition of the gain decreaser tube 96 and ignition of the balancing tube 97. The balancing tube 97 permits charging of the balancing condenser 92. The balancing condenser 92 if charged predominantly by the operation of the detector tube 81, operates the gain rate control tube 98 to impress positive potential on the contact member 120 and negative potential on contact member 119 of the driver circuit 100. Such operation of the driver circuit insures that the primary winding 108 predominates over the primary winding 109. The secondary winding 107 in transformer 106, when energized by the primary winding 108, is in phase with the gain decreaser tube 96. The gain control condenser 136 is then charged to impress positive potential on the control grid of the gain control tube 137. The gain control tube 137 governs the operation of the bridge 33 to impress negative potential on the contact member 32 and positive potential on the contact member 31 of the vario-losser. Such operation of the vario-losser insures a change in the impedances of the vario-losser to reduce the gain on the transmission line. If the detector tubes 40 and 81 have operated according to a predetermined ratio, constant volume may be maintained on the transmission line.

Modifications in the circuits and in the arrangement and location of parts may be made within the spirit and scope of the invention and such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In combination, a signal line, gain control means for controlling the strength of the signals on said line, means comprising a control condenser for governing said control means according to the charge on the control condenser, said control means being adjusted to hold the gain at a fixed average value when no signals are

on the line, and means controlled according to the ratio between the time a given voltage is exceeded and the number of syllables on the line for charging said condenser with a potential which is high relative to the charge thereon to govern the gain control means and maintain the line signals at constant volume.

2. In combination, a signal line, a vario-losser on said line for controlling the strength of the signals, a bridge circuit for controlling the resistance values of said vario-losser, a gain control tube having a control grid and forming one arm of said bridge, a control condenser for impressing a bias on said control grid according to the charge thereon, and means controlling according to the ratio between the time a given voltage is exceeded and the number of syllables on the line for charging the control condenser to govern the gain control tube and maintain the signals at constant volume, said vario-losser being adjusted to bring the gain to a mean normal value when no signals are on the line.

3. In combination, a signal line, a vario-losser on said line for controlling the strength of the signals, two cold cathode detector tubes, means for operating said tubes respectively according to the time a given voltage is exceeded and the number of syllables on said line, balancing means for weighing the outputs from said detector tubes, and means controlled by said balancing means for governing the resistance values of said vario-losser to maintain the signals on the line at constant volume, said vario-losser being adjusted to bring the gain to a mean value when no signals are on the line.

4. In combination, a signal line, a vario-losser on said line for controlling the strength of the signals, and means controlled according to the ratio between the time a given voltage is exceeded and the number of syllables on the line for varying the resistance value of said vario-losser to maintain constant volume, said vario-losser being adjusted to bring the gain to a mean value when no signals are on the line.

5. In combination, a signal line, a gain varying device for controlling the signals on said line, and means controlled according to the ratio between the time a given voltage is exceeded and the number of syllables in the signals on the line for governing said device to control the volume of the signals on the line.

6. A signal line having a gain varying device therein, a balancing condenser, means for charging said condenser with potentials of different polarity according to the ratio between the time a given voltage is exceeded and the number of syllables in the signals on the line, and means controlled according to the polarity of the charge on said condenser when charged above a predetermined level for governing said device to maintain the signals on said line at substantially constant volume.

7. A signal line having a gain varying device therein, a balancing condenser, means comprising a forward-acting circuit operated according to the number of syllables in the signals on the line, means comprising a backward-acting circuit operated according to the time the voltage on the line exceeds a predetermined value, means for charging said condenser constantly according to ratio between the operations of said forward-acting circuit and said backward-acting circuit when signals are on the line, and means controlled according to the charge on said condenser for governing said device to maintain the signals on the line at substantially constant value.

8. In a signal transmission system, a driver circuit having two normally balanced paths, a transformer having one output secondary winding and two primary windings respectively connected to said paths, a source of alternating current for energizing each of said paths, said two primary windings being wound oppositely so that no alternating current is supplied to said secondary winding, a source of direct current for jointly energizing said two paths, means in said paths for unbalancing said paths when energized with direct current, the path which predominates in energizing the primary secondary winding being determined according to the polarity of said direct current, two three-element cold cathode tubes in circuit with said secondary winding, and means for igniting said cold cathode tubes respectively in synchronism with the currents in said primary windings.

9. In combination, a signal line, two cold-cathode tubes, means for operating said tubes respectively by high strength signals and the number of syllables on the line, means for effecting operation of the tubes a substantial amount out of phase with respect to each other, means for weighing the effective operations of said tubes, two enabler cold cathode tubes respectively operated when the detector tubes are operated, means comprising a driver circuit controlled by said weighing means and operating in phase with the detector which predominates in operating the weighing means, means for controlling the strength of the signals on the line jointly by the driver circuit and the enabler tubes and for determining the direction of gain according to the enabler tube in phase with the driver circuit.

10. In combination, a signal line, two cold cathode tubes, means for insuring operation of said tubes, a substantial amount out of phase with respect to each other, a syllabic circuit connected to said line for operating one of said tubes according to the number of syllables on the line, said syllabic circuit comprising a diode-triode tube, means transmitting signals through the diode-triode when low strength signals are on the line, means for selecting syllabic frequencies from the diode-triode output, a pulser device operated by the syllabic frequency currents, means for effecting operation of the pulser device only on the rising portion of a syllabic impulse and means controlled by the pulser device for supplying spurts of alternating current, said pulser device operating to insure equal spurts of current irrespective of the strength and duration of the controlling syllabic impulses, means for operating the other cold cathode tube by high strength signals, means for weighing the effective operations of said tubes, and means controlled by said weighting means to maintain substantially constant volume on said line.

11. In combination, a signal line, two cold cathode tubes, means for insuring operation of said tubes a substantial amount out of phase with respect to each other, a syllabic circuit connected to said line for controlling one of said cold cathode tubes according to the number of syllables on said line, said syllabic circuit comprising a diode-triode, means for transmitting signals through the diode-triode when low strength signals are on the line, means for selecting syllabic impulses from the diode-triode output and means for transmitting spurts of al-

ternating current under control of the syllabic impulses, said last-mentioned means transmitting a fixed spurt of current irrespective of the strength and length of the controlling syllabic impulse, means for operating the other cold cathode tube by high strength signals, means for weighing the effective operation of said tubes, and means controlled by said weighing means to maintain substantially constant volume on said line.

12. In combination, a signal line, control means for raising and lowering the strength of the signals on the line to hold the signals at constant volume and means comprising a syllabic circuit for governing said control means to raise the gain on the line, said syllabic circuit comprising amplifying and filtering means connected to the line, a diode-triode tube connected to the amplifying filtering means, means for impressing a normal negative bias on the grid of the triode which limits current flow through the triode portion of the diode-triode, means for rectifying signals by the diode to increase the bias on triode grid so that weak signals vary the triode output, a transformer tuned to syllabic frequency connected to the output circuit from the triode, a source of alternating current connected to a resistance pad, means comprising a pulser device for varying the resistance of said pad to permit transmission of spurts of alternating current to operate said control means, said pulser device operating to insure spurts of current of fixed duration irrespective of the strength and duration of the operating syllabic impulse, and means insuring operation of the pulser device only on the rising portion of a syllabic impulse.

13. In combination, a signal line, means comprising a gain control tube for governing the strength of the signals on the line, two cold cathode detector tubes, means for operating said detector tubes respectively by the syllables and the high strength signals on the line, each of said detector tubes having an ignition circuit and an operating circuit, means for effecting operation of the detector tubes a substantial amount out of phase with respect to each other, balancing means for weighing the effective operations of said detector tubes, driver means selectively operated by said balancing means according to which of said detector tubes predominates in operating the balancing means and in synchronism with the predominating detector tube, a gain increaser tube and a gain decreaser tube respectively ignited in synchronism with the operation of said detector tubes, and means for operating said gain control tube to vary the strength of the line signals according to the synchronous operation of the driver means with the gain decreaser tube and the gain increaser tube.

14. In combination, a signal line, means comprising a gain control tube for governing the strength of the signals on the line, two cold cathode detector tubes, means for operating said detector tubes respectively by high strength signals on the line and the syllables of the signals, each of said detector tubes having an ignition circuit and an operating circuit, a source of alternating current connected to the operating circuits of said detector tubes to effect operation of the tubes by opposite half waves, balancing means or weighing the effective operations of said detector tubes, driver means selectively operated by said balancing means according to which of said detector tubes predominates in operating the balancing means and in synchronism with the predominating detector tube, a gain increaser tube and a gain decreaser tube respectively ignited in synchronism with the currents in the output circuits of the detector tubes, and means for operating said gain control tube to vary the strength of the line signals according to the synchronous operation of the driver means with the gain decreaser tube and the gain increaser tube.

15. In combination, a signal line, means comprising a gain control tube for governing the strength of the signals on the line, two cold cathode detector tubes, means for operating said detector tubes respectively by high strength signals on the line and the syllables of the signals, each of said detector tubes having an ignition circuit and an operating circuit, means for effecting operation of the detector tubes a substantial amount out of phase with respect to each other, balancing means for weighing the effective operations of said detector tubes, means comprising a driver circuit selectively operated by said balancing means according to which of said detector tubes predominates in operating the balancing means and in synchronism with the predominating detector tube, a gain increaser tube and a gain decreaser tube respectively ignited in synchronism with the operation of said detector tubes, means for operating said gain control tube to vary the strength of the line signals according to the synchronous operation of the driver circuit with the gain decreaser tube and the gain increaser tube, and marginal means for preventing operation of the gain control tube until the output from the driver circuit is above a predetermined level.

16. In combination, a signal line, a vario-losser on said line for controlling the signal volume, a cold cathode low strength detector tube having an ignition circuit and an operating circuit, a cold cathode high strength detector tube having an ignition circuit and an operating circuit, a syllabic circuit connected to said line before said varistor for energizing the ignition circuit of said low strength detector tube, means for energizing the ignition circuit of the high strength detector tube from said line beyond the vario-losser therein when high strength signals are on the line, a source of alternating current connected to the operating circuits of said detector tubes to effect operation of the tubes by opposite half waves, means comprising a gain control tube for governing said vario-losser, balancing means for weighing the effective operations of said detector tubes, driver means selectively operated by said balancing means according to which of said detector tubes predominates in operating the balancing means and in synchronism with the predominating detector tube, a gain increaser tube and a gain decreaser tube respectively ignited in synchronism with the currents in the output circuits of the detector tubes, and means for operating said gain control tube to vary the strength of the line signals according to the synchronous operation of the driver means with the gain decreaser tube and the gain increaser tube.

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