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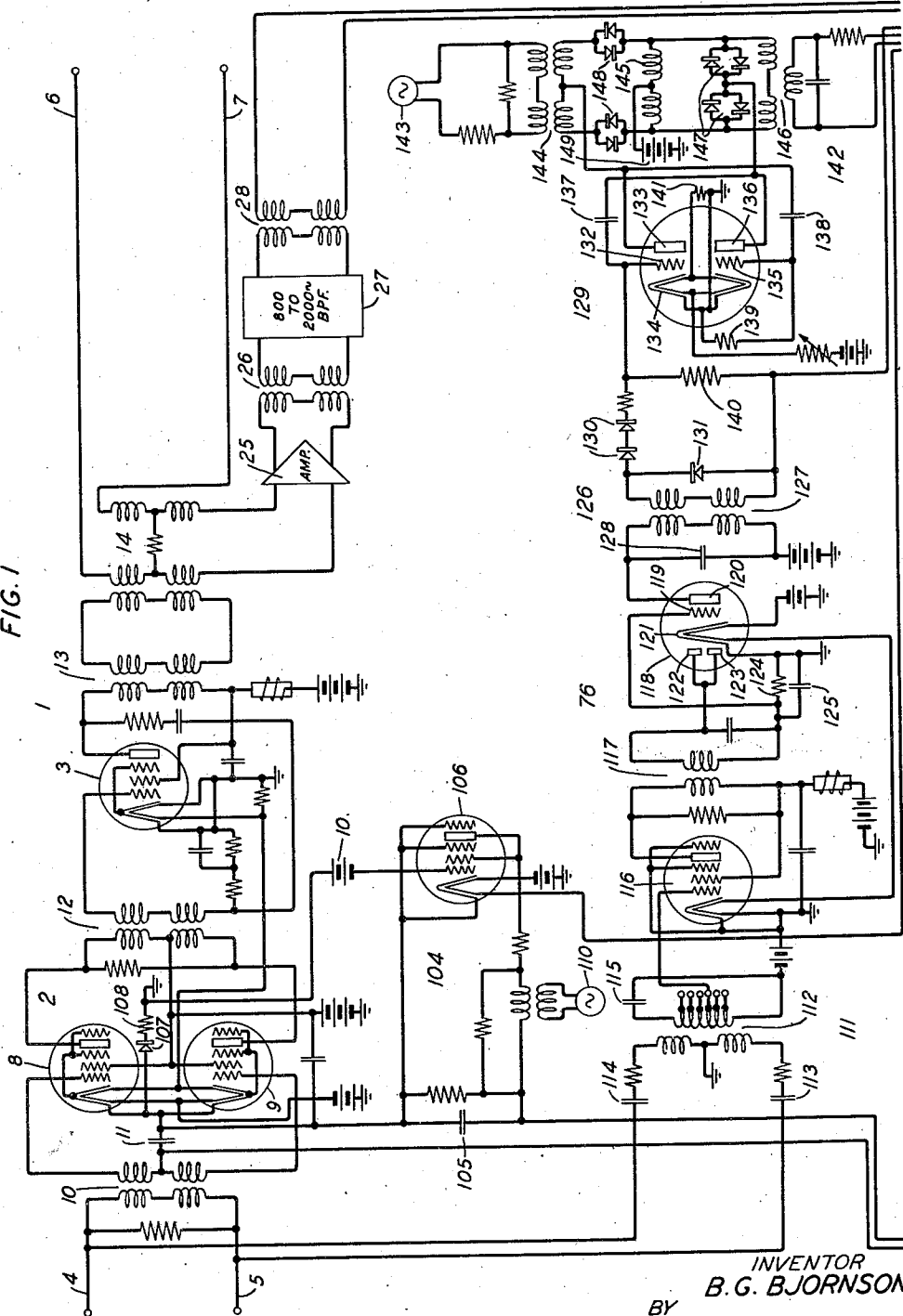
B. G. BJORNSON
VOLUME CONTROL CIRCUITS

2,228,071

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2 Sheets-Sheet 1

FIG. 1



INVENTOR
B. G. BJORNSON
BY
Wayne B. Wells
ATTORNEY

Jan. 7, 1941.

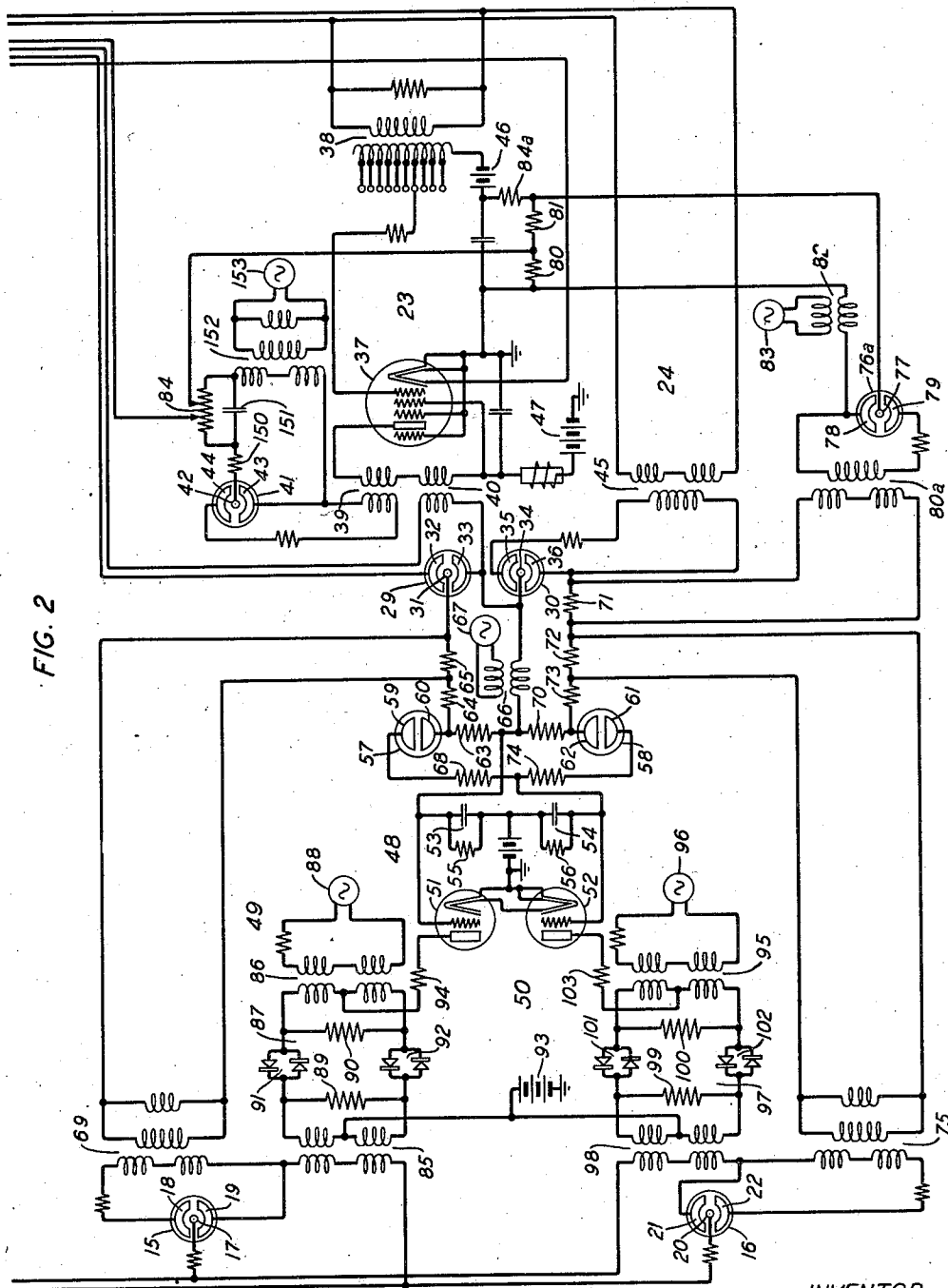
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2 Sheets-Sheet 2



INVENTOR
B. G. BJORNSON

Wayne B Wells

ATTORNEY

UNITED STATES PATENT OFFICE

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VOLUME CONTROL CIRCUITS

Bjorn G. Bjornson, New York, N. Y., assignor to
Bell Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application October 11, 1939, Serial No. 298,887

15 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 average the weak and strong peaks of speech signals in an improved manner for controlling the speech signals to maintain constant volume.

Another object of the invention is to provide a transmission line with high and low sensitivity control circuits having cold cathode tubes therein that shall have the outputs from the tubes weighed for controlling the strength of the signals on the line to hold the signals at constant volume.

A further object of the invention is to provide volume control circuits for a signal transmission line with high and low sensitivity circuits having cold cathode tubes therein that shall have the outputs from the tubes weighed for controlling the strength of the signals on the transmission line and that shall control the tube in the high sensitivity circuit by a syllabic circuit connected to the transmission line in case the signals on the transmission line have strengths below that required to operate the high sensitivity circuit.

In certain types of signal transmission systems it is desirable to hold the speech signals at substantially constant volume. Thus in radio broadcasting systems it is desirable to hold the speech signals at constant volume in order to prevent overloading of the apparatus in the transmitter. The volume range between the very loud talker and the 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 of 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.

In volume control circuits constructed in accordance with the invention the weak and the strong amplitudes in speech signals are weighed against each other and proper balance obtained which can be employed to adjust the strengths of the speech signals. The constant volume circuits employed to disclose the invention are of the type shown in the patent to B. G. Bjornson No. 2,173,816, September 26, 1939. In the present invention no moving parts such as electromagnetic relays are employed.

In the arrangement employed to describe the invention a vario-repeater in the form of two push-pull tubes of the variable mu type are inserted in the signal transmission line for controlling the strength or amplitudes of the speech signals. A control condenser is provided for controlling the negative bias on the control grids of the variable mu tubes according to the charge on the condenser.

A high sensitivity detector circuit and a low sensitivity detector circuit are connected to the transmission line beyond the vario-repeater therein. A three-element cold cathode detector tube is inserted in each of the sensitivity circuits. The high sensitivity circuit preferably includes an amplifier in order to render this circuit more sensitive than the low sensitivity circuit. The two sensitivity circuits are operated by signals of different strengths and in order to maintain a constant volume on the signal transmission line it is necessary to obtain a predetermined relation between the high and low signals.

A gain increaser cold cathode tube is associated with the high sensitivity circuit and a gain decreaser cold cathode tube is associated with the low sensitivity circuit. The gain increaser tube and the gain decreaser tube control the charge which is impressed on the control condenser. Upon operation of the tube in the high sensitivity circuit an enabler circuit is completed across two electrodes of the gain increaser tube. Igniting of the gain increaser tube prepared this tube for operation under control of a balancing circuit. The gain decreaser tube is operated in a like manner upon operation of the tube in the low sensitivity circuit. The gain increaser and gain decreaser cold cathode tubes serve to insure against any change in the gain by the vario-repeater except when signals are on the transmitting line.

The balancing circuit which is connected to the output circuits of the tubes in the two sensitivity circuits serves to average the outputs from the detector tubes to effect control of the gain increaser tube and gain decreaser tube. Two balancing condensers in the balancing circuit are charged in one direction when the high sensitivity circuit is in operation and are charged in an opposite direction when the low sensitivity circuit is in operation. When the two balancing condensers are charged for a predetermined length of time under control of the high sensitivity circuit, the resistance of a pad in the operating circuit of the gain increaser tube is reduced to effect charging of the control condenser

in a direction to reduce the negative potential on the grids of the tubes in the vario-repeater.

If the two balancing condensers are charged for a predetermined period of time by a predetermined number of signal beats of high strength under control of the low sensitivity circuit, then a pad in the operating circuit of a gain decreaser tube is reduced sufficiently to effect operation of the gain decreaser tube. The gain decreaser tube when operated charges the control condenser in a direction to increase the negative potential on the control grids of the tubes in the vario-repeater. This operation of the vario-repeater serves to reduce the gain on the transmission line.

Upon operation of the tube in the low sensitivity circuit a disabler path is completed for blocking the amplifier in the high sensitivity circuit and thus prevent operation of the high sensitivity circuit when the low sensitivity circuit is in operation. The balancing condensers are discharged during idle periods through leakage resistances in order to allow the charge from isolated impulses to be dissipated.

A syllabic circuit connected to the transmission line before the vario-repeater is provided for controlling the detector tube in the high selectivity circuit when a weak talker has insufficient strength to operate the high sensitivity circuit. It is undesirable to increase the sensitivity of the high sensitivity circuit to insure operation by very weak talkers in order to prevent operation by noise. The syllabic circuit may be operated by very weak talkers to increase the gain. Means are provided for disabling the syllabic circuit when either the high sensitivity or the low sensitivity circuit is in operation.

The syllabic circuit comprises a filter having a predetermined frequency range within the voice frequency band. The currents of the selected frequencies are amplified and then rectified by the diode portion of a diode-triode. The diode portion of the diode-triode controls the triode portion and the output from the triode portion is supplied to a filter tuned to six or eight cycles so that syllabic frequencies are selected. The syllabic filter is connected to a pulsing device by means of rectifiers of the copper oxide type so that the pulsing device is only controlled by the rising portion of a syllabic impulse. The pulsing device is intended to insure that all syllables which operate the syllabic detector circuit produce an equal gain action, thus making the rate of gain increase independent of the syllabic amplitude and duration. The pulsing device controls a path comprising resistance elements having a non-linear resistance voltage characteristic and inserted in series and parallel circuit relation. The pulsing device controls the path in a manner to supply spurts of low frequency current to the detector tube in the high sensitivity circuit. The detector tube under control of the spurts of low frequency current effects operation of the gain increaser tube to increase the gain on the transmission line.

The sheet of the drawings containing Fig. 1 when placed above the sheet of the drawings containing Fig. 2 discloses a system constructed in accordance with the invention.

Referring to Figs. 1 and 2 of the drawings, a gain control station 1 comprising a vario-repeater 2 and an amplifier tube 3 is shown on a transmission line having input conductors 4 and 5 and output conductors 6 and 7. The vario-repeater comprises two pentode tubes 8 and 9 which are

effectively connected in series with the transmission line. The input circuits of the pentode tubes 8 and 9 are connected to the input conductors 4 and 5 by means of a transformer 10. A control condenser 11, which is charged in a manner to be hereinafter set forth, serves to impress variable negative bias on the control grids of the pentode tubes 8 and 9. The output circuits of the pentode tubes 8 and 9 are connected by transformer 12 to the input circuit of the amplifier tube 3 which is of the feedback type. The output circuit of the amplifier tube 3 is connected by transformer 13 and a hybrid coil 14 to the output conductors 6 and 7.

The charge on the control condenser 11 is governed by a gain increaser tube 15 and a gain decreaser tube 16. The gain increaser tube 15 is of the cold cathode type and comprises electrodes 17, 18 and 19. The gain decreaser tube 16 is of the cold cathode type and comprises electrodes 20, 21 and 22. The gain increaser tube 15 is controlled according to the operation of a high sensitivity circuit 23 and the gain decreaser tube 16 is controlled according to the operation of a low sensitivity circuit 24. The high sensitivity circuit 23 and the low sensitivity circuit 24 are connected to the hybrid coil 14 by means of an amplifier 25, a transformer 26, a filter 27, and a transformer 28. The amplifier 25 may be of any suitable type and the filter 27 preferably transmits currents having frequencies between 800 and 2000 cycles.

The high sensitivity circuit 23 and the low sensitivity circuit 24 respectively control detector tubes 29 and 30 of the cold cathode type. The tube 29 comprises electrodes 31, 32 and 33. The tube 30 comprises electrodes 34, 35 and 36. The high sensitivity circuit 23 comprises an amplifier 37 of the pentode type, a transformer 38 connected to the input circuit of the amplifier 37, and transformer 39 and 40 connected to the output circuit of the amplifier 37. The transformer 38 is directly connected to the transformer 39. The secondary winding of the transformer 39 is connected to a syllabic disabler tube 41. The disabler tube 41 is of the cold cathode type and comprises electrodes 42, 43 and 44. The secondary winding of the transformer 40 is connected in circuit with the electrodes 32 and 33 of the cold cathode detector tube 29. A transformer 45 in the low sensitivity circuit 24 directly connects electrodes 35 and 36 of the cold cathode tube 30 to the transformer 28. A battery 46 is provided for supplying negative bias to the control grid of the tube 37. A battery 47 is provided for supplying plate potential to the amplifier tube 37. The high sensitivity circuit 23 is operated by a signal of low strength on the transmission line whereas the low sensitivity circuit 24 is only operated by signals of high strength. Upon operation of the high sensitivity circuit 23 the detector tube 29 is ignited across the electrodes 32 and 33. Upon operation of the low sensitivity circuit 24 the detector tube 30 is ignited across the electrodes 35 and 36.

The detector tubes 29 and 30 control a balancing circuit 48. The balancing circuit 48 controls driver circuits 49 and 50. The driver circuits 49 and 50 respectively effect operation of the gain increaser tube 15 and the gain decreaser tube 16. The balancing circuit comprises two amplifier tubes 51 and 52 which are preferably of the three-element type, two condensers 53 and 54 which are respectively shunted by resistance elements 55 and 56, and two cold cathode tubes 57 and 58. The

cold cathode tube 57 comprises electrodes 59 and 60 and the cold cathode tube 58 comprises electrodes 61 and 62. The tube 57 is operated by the potential drop across a resistance element 63 upon operation of the detector tube 29 when the high sensitivity circuit is operated. The circuit for energizing the resistance element 63 may be traced from one terminal of the resistance element 63 through a resistance element 64, resistance element 65, electrodes 31 and 33 of the detector tube 29 and the secondary winding of transformer 66 to the other terminal of the resistance element 63. The primary winding of the transformer 66 is connected to a source of alternating current 67.

Upon operation of the high sensitivity circuit 23 and breakdown of the cold cathode tube 57, a circuit is completed for charging the condensers 53 and 54. The circuit for charging the condensers may be traced from one terminal of the resistance element 63 through the condenser 53 shunted by the resistance element 55, condenser 54 shunted by the resistance element 56, resistance element 68 and electrodes 59 and 60 of the cold cathode tube 57 to the other terminal of the resistance element 63. The condensers 53 and 54 are charged with potential so as to impress a positive potential on the grid of the amplifier tube 51 and a negative bias on the grid of the amplifier tube 52. This results in operation of the driver circuit 49 to raise the gain on the transmission line while preventing operation of the driver circuit 50.

The potential drop across the resistance element 65 is employed for breaking down the tube 15 in the disabler path. The tube 15 is broken down across electrodes 18 and 19. The electrodes 18 and 19 of tube 15 are connected to the resistance elements 35 by means of a transformer 69. No increase in the gain by the vario-repeater 2 can take place until the tube 15 is ignited by the circuit connected to the electrodes 18 and 19. The gain increaser tube 15 is only ignited when the high sensitivity circuit 23 and the detector tube 29 are operated.

The cold cathode tube 58 of the balancing circuit 48 is operated by the potential drop across resistance element 70 when the detector tube 30 is operated by the low sensitivity circuit 24. The circuit for energizing the high resistance element 70 may be traced from one terminal of the resistance element through the secondary winding of the transformer 66, electrodes 34 and 36 of the cold cathode tube 30, resistance element 71, resistance element 72, and resistance element 73 to the other terminals of the resistance element 70. The cold cathode tube 58 when operated by the low sensitivity circuit 24 completes a circuit for charging the balancing condensers 53 and 54 in a direction to effect operation of the amplifier tube 52. The circuit for charging the condensers 53 and 54 may be traced from one terminal for the resistance element 70 through the condenser 53 shunted by the resistance element 55, condenser 54 shunted by the resistance element 56, resistance element 74 and electrodes 61 and 62 of the cold cathode tube 58 to the other terminal of the resistance element 70.

The balancing condensers 53 and 54 are discharged during idle circuit periods through the leakage resistance elements 55 and 56 in order to allow the charge from isolated impulses to be dissipated. The balancing condensers 53 and 54 when charged by the breakdown of the cold cathode tube 58 impress a positive potential on the grid of the amplifier tube 52. Operation of the amplifier tube 52 effects operation of the gain

decreaser tube 16 under control of the driver circuit 50 to so charge the condenser 11 as to reduce the gain on the transmission line. The potential drop across the resistance element 72 in the circuit operated by the detector tube 30 serves to ignite the gain decreaser tube 16 across the electrodes 21 and 22. The electrodes 21 and 22 are connected across the resistance element 72 by a circuit comprising a transformer 75. When the gain decreaser tube 16 is operated by the potential drop across the resistance element 72, it may then be controlled by the driver circuit 50. The gain decreaser tube 16 can only be ignited in the manner above set forth upon operation of the low sensitivity circuit 24 and operation of the low sensitivity detector tube 30.

The potential drop across the resistance element 71 controlled by the detector tube 30 is employed to block the high sensitivity circuit 23 and a syllabic control circuit 76 to be described later. The disabler circuit operated by the potential drop across the resistance element 71 comprises the cold cathode tube 76a having electrodes 77, 78 and 79. The electrodes 78 and 79 are connected across the resistance element 71 by means of a transformer 80a. The electrodes 77 and 78 are connected across two resistance elements 80 and 81 in circuit with the secondary winding of a transformer 82. The primary winding of the transformer 82 is connected to the source of alternating current 83. One terminal of the resistance element 80 is connected to the cathode of the amplifier tube 37 in the high sensitivity circuit 23 and one terminal of the resistance element 81 is connected through a resistance element 84a to the biasing battery 46 for the grid of an amplifier tube 37. The potential drop across the resistance elements 80 and 81 serves to impress a negative bias on the control grid of the amplifier tube 37 for blocking the high sensitivity circuit 23 when the low sensitivity circuit 24 is in operation. The junction point of the resistance element 80 and 81 is connected to a resistance element 84 for blocking the syllabic circuit 76 in a manner to be hereinafter set forth.

The driver circuit 49 comprises a transformer 85 having the secondary winding thereof connected in circuit with the control condenser 11 through the electrodes 17 and 19 of the gain increaser tube 15. The primary winding of the transformer 85 is connected to the secondary winding of a transformer 86 through a resistance pad 87. The primary winding of the transformer 86 is connected to a source of alternating current 88. The resistance pad 87 comprises two shunt resistance elements 89 and 90 in two series resistance arrangements 91 and 92. The resistance elements shown in the arrangements 91 and 92 are preferably composed of silicon carbide with a binder material, as disclosed in the patent to K. B. McEachron 1,822,742, dated September 8, 1931. The resistance of the arrangements 91 and 92 is varied according to the potential impressed on the resistance elements is controlled according to the operation of the amplifier tube 51 in the balancing circuit 80. The circuit for controlling the resistance arrangements 91 and 92 may be traced from one terminal of a battery 93 to the mid-tap on the primary winding of the transformer 85, resistance elements 91 and 92 in parallel to a mid-tap on the secondary winding of the transformer 86, resistance element 94, the output circuit of the amplifier tube 51 and ground return to the battery 93. Upon operation of the

amplifier tube 51 under control of the control circuit 23 the resistance of the pad 87 is lowered to such an extent that potential from the source 88 may be employed to operate the gain increaser tube 15 and charge the control condenser 11 in a direction to raise the gain on the transmission line.

The driver circuit 59 which operates the gain decrease tube 16 comprises a transformer 95 having the primary winding thereof connected to a source of alternating current 96 and the secondary winding thereof connected to a resistance pad 97. A transformer 98 connects the resistance pad 97 to the electrodes 21 and 22 of the gain decrease tube 16 and the control condenser 11.

The resistance pad 97 comprises two shunt resistance elements 99 and 100 and two series resistance arrangements 101 and 102. The resistance arrangements 101 and 102 are similar in construction to the resistance arrangements 91 and 92. The resistance elements comprising the resistance arrangements 101 and 102 have their resistance values varied in accordance with the potentials impressed on them. The resistance pad 97 is controlled by the amplifier 52 which in turn is controlled according to the operation of the low sensitivity circuit 24. The circuit controlling the resistance pad 97 may be traced from one terminal of the battery 93 to a mid-tap on the primary winding of the transformer 98, resistance arrangements 101 and 102 in parallel to a mid-tap on the secondary winding of transformer 95, resistance element 103, output circuit of the amplifier tube 52 and ground return to the battery 93.

Upon operation of the amplifier tube 52 under control of the low sensitivity circuit 24, the resistance of the pad 97 will be changed to effect operation of the gain decrease tube 16. The tube 16 charges the control condenser to impress negative bias on the control grids of the vario-repeater tubes 8 and 9.

The high sensitivity circuit 23 and the low sensitivity circuit 24 are respectively operated by signals of low strength and high strength on the transmission line. The detector tubes 29 and 30 which are respectively operated by the high sensitivity circuit and the low sensitivity circuit have their outputs averaged by the balancing circuit 43. If the low sensitivity circuit is operated for a predetermined length of time, the gain decrease tube 16 is operated to lower the gain on the transmission line. On the other hand, if the high sensitivity circuit is operated for a predetermined length of time the gain increaser tube 15 is operated to increase the gain on the transmission line. If a predetermined ratio exists between the operations of the two sensitivity circuits, no change in the gain will be effected and the signals will be at constant volume.

In case a very weak talker is transmitting over the transmission line the high sensitivity circuit 23 will be operated from the backward acting circuit connected to the hybrid coil 14. The high sensitivity circuit 23 effects operation of the detector tube 29. The detector tube 29 operates the cold cathode tube 57 to charge the balancing condensers 53 and 54. At the same time the detector tube 29 completes a circuit for igniting the gain increaser tube 15. When condensers 53 and 54 have been charged under control of the cold cathode tube 57, the amplifier tube 51 is operated for effecting operation of the driver circuit 49. The driver circuit 49 effects operation of the gain increaser tube 15 to change the charge on the

control condenser 11 and increase the gain on the transmission line.

In case a loud talker is transmitting over the transmitting line the low sensitivity circuit 24 connected to the hybrid coil 14 will effect operation of the cold cathode detector tube 30. The cathode tube 30 upon operation blocks the high sensitivity circuit 23, ignites the gain decrease tube 16 and operates the balancing circuit 48 under control of the cold cathode tube 58. The balancing condensers 53 and 54 are charged to effect operation of the amplifier tube 52. The amplifier tube 52 in turn controls the resistance pad 97 to enable the driver circuit 50 to effect operation of the gain decrease tube 16. The gain decrease tube permits charging of the control condenser 11 to decrease the gain on the transmission line.

A grid bias equalizer circuit 104 is provided to make the rate of gain change for a given voltage applied by the gain increaser tube or the gain decrease tube independent of the voltage on the control condenser 11. This is necessary because the gain changing voltage is at times small in comparison with the voltage on the control condenser 11. The grid bias equalizer circuit operates so that charging voltage from tubes 15 and 16 always faces a voltage which is close to zero. Condenser 105, which is placed in series with the charging circuit for the control condenser 11 has a charge impressed thereon which compensates for the charge impressed on the control condenser 11. The condenser 105 is charged under control of the grid bias equalizer circuit 104 according to the plate current supplied to the vario-repeater tubes 8 and 9. A pentode amplifier tube 106 has the input circuit thereof connected across a copper oxide varistor 107 and a resistance 108 in order to effect operation of the tube 106 according to the operation of the vario-repeater tubes. The copper oxide varistor 107 is employed to give the proper characteristic in operating the tube 106. A battery 109 is provided for impressing a negative bias on the control grid of tube 106 and a source of alternating current 110 is provided for supplying potential to the anode of the tube 106. The condenser 105 is charged with potential according to the operation of the tube 106 and in a direction to oppose the charge on the condenser 11.

The syllabic circuit 76 is provided for operating the detector tube 29 in case the signal impulses of the talker on the line are too weak to operate the high sensitivity circuit 23. The syllabic circuit comprises a filter 111 in the form of a transformer 112 and three condensers 113, 114 and 115 which selects a band of frequencies having a center around 1200 cycles. The filter 111 is connected to the input circuit of the pentode amplifier tube 116. The output circuit of the pentode amplifier tube 116 is connected by a transformer 117 to a diode-triode 118. The diode-triode 118 comprises a control grid 119, main anode 120, cathode 121 and two auxiliary anodes 122 and 123. The secondary winding of the transformer 117 is connected to the diode portion of the diode-triode by a circuit which may be traced from one terminal of the secondary winding through the auxiliary anodes 122 and 123, cathode 121 and resistance element 124 shunted by condenser 125 to the other terminal of the secondary winding. The potential drop across the resistance element 124 is employed for impressing a bias on the grid 119 of the triode portion of the diode-triode. A filter

126 in the form of a transformer 127 and a condenser 128 is connected to the output of the diode-triode and selects frequencies within the syllabic frequency band. Preferably frequencies between six and eight cycles are selected. The secondary winding of the transformer 127 is connected to the pulser device 129 by means of copper oxide varistors 130. The copper oxide varistors 130 are provided to prevent the impedance changes in the diode-triode from affecting the characteristic of the pulser excessively. A copper oxide rectifier 131 is connected across the secondary winding of the transformer 127 to insure that the pulser device is only operated on the rising portion of a syllabic impulse.

The pulser device 129 comprises two three-element space discharge devices enclosed in a single container. The first space discharge device comprises control grid 132, anode 133, and cathode 134. The second device comprises control grid 135 and anode 136. A condenser 137 is connected between the control grid 132 and the anode 136. A condenser 138 is connected between the control grid 135 and the anode 133. A resistance 139 is provided in the circuit between the control grid 135 and the cathode 134. A resistance 140 is provided in the circuit of the control grid 132. Normal bias for the control grid 132 is provided by the potential drop across the resistance element 141. The circuit for the control grid 132 may be traced from the grid 132 through resistance element 140, resistance element 84, resistance element 80, ground and resistance element 141 to the cathode 134. The pulser device 129 controls the operation of a driver circuit 142 which in turn controls the operation of the detector tube 29.

The driver circuit comprises a source of low frequency alternating current 143 which is connected to a transformer 144. The secondary winding of the transformer 144 is connected by series elements 148 composed of silicon carbide and a binder material to a shunt coil 145 and to the primary winding of a transformer 146. Elements 147 of silicon carbide with a binder material are shunted across the primary winding of the transformer 146. The secondary winding of the transformer 146 is connected to the electrodes 32 and 33 of the detector tube 29. The elements 148 are controlled by the device comprising the grid 132 and the anode 133 and the elements 147 are controlled by the device comprising the control grid 135 and the anode 136. Normally the lower device of the pulser is energized and supplies current to the devices 147 of the driver 142. The output circuit for the lower space discharge device of the pulser may be traced from one terminal of the battery 149 to a mid-tap of the shunt coil 145 and through a mid-tap of the shunt resistance elements 147, anode 136, cathode 134, resistance 141 and ground return to the battery 149. Current flow through the shunt resistance elements 147 increases their shunting action to prevent flow of low frequency current from the source 143. The output circuit from the upper tube comprising the control grid 132 and the anode 133 extends in series with the series resistance elements 148.

When the upper tube of the pulser device is drawing current, the resistance of the elements 148 in the driver device 142 is reduced. Initially when the syllabic circuit is not in operation, the lower device of the pulser draws current and the condenser 133 is charged. When a syllabic impulse is received the control grid 132 has the

negative bias thereon reduced to permit flow of current through the upper device of the pulser. Upon flow of space current through the upper device of the pulser the condenser 133 is discharged through a circuit which may be traced from the anode 133 through the condenser 138, resistance element 139 and cathode 134 to the anode 133. Upon discharge of the condenser 139 a potential drop across the resistance element 139 is provided for biasing the grid 135 to block the lower device of the pulser. Upon operation of the upper device of the pulser the condenser 137 takes on a charge. However, when the lower device of the pulser is blocked, the charge on the condenser 137 is discharged through the resistance element 140. The potential drop across the resistance element 140 impressed negative bias on the control grid 132 to block the upper device of the pulser.

The pulser device 129 operates to control the driver circuit 142 so that a spurt of low frequency current is supplied to the detector tube 29 of fixed strength and fixed duration irrespective of the amplitude or length of the syllabic impulse controlling the pulser. It has been found to be disadvantageous to permit control of the driver circuit 142 according to the strength and duration of the syllabic impulse. In the operation of the pulser device it may be noted that blocking of the lower element of the pulser and operation of the upper element lower the impedance of the driver circuit 142 to permit the transmission of a spurt of low frequency current to the detector device 29. The detector device 29 is controlled in the manner above set forth in discussing the operation of the high sensitivity circuit 23.

If the syllabic circuit 76 is in operation for controlling the detector tube 29 to raise the gain on the transmission line and the signals on the transmission line are raised above a predetermined level, then the high sensitivity circuit 23 takes control of the detector tube 29 for raising the gain on the transmission line. Upon operation of the high sensitivity circuit 23 the cold cathode syllabic disabler tube 41 is ignited across electrodes 44 and 43. A circuit is then completed across electrodes 42 and 43 of the tube 41. The circuit through the electrodes 42 and 43 may be traced from the electrode 42 through a resistance element 150, resistance element 84 shunted by the condenser 151 and secondary winding of a transformer 152 to the electrode 43. The primary winding of the transformer 152 is connected to a source of alternating current 153. The potential drop across the resistance element 84 is employed to impress a bias on the control grid 132 of the pulser device to prevent any operation of the pulser device. In a like manner the potential drop across the resistance element 80 when the low sensitivity circuit is in operation will prevent any operation of the pulser device.

Modifications in the system 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, control means for governing the strength of the signals on said line, two detector circuits of different sensitivity connected to said line, a cold cathode tube in each of said detector circuits, means controlled by the outputs from the tubes in the two detector circuits for operating said control means to raise and lower the strength of the signals on said line

according to which detector circuit predominates a predetermined extent, and means for insuring against simultaneous operation of the two detector circuits.

2. In combination, a signal line, a vario-repeater on said line for controlling the signal gain, two detector circuits connected to said line beyond the vario-repeater, a cold cathode tube in each of said detector circuits, means for effecting operation of one of said tubes in one detector circuit by signal peaks of one strength and for effecting operation of the second one of said tubes in the other detector circuit by signal peaks of a higher strength, a gain decreaser tube for operating said vario-repeater to reduce the gain on the line when signal peaks of low amplitude detected by the tube in one detector circuit predominate for a period of time, a gain increaser tube for operating said vario-repeater to increase the gain on the line when signal peaks of high amplitude detected by the tube in the other detector circuit predominate for a period of time, means comprising two amplifier tubes for respectively operating said gain increaser tube and said gain decreaser tube, two balancing condensers for selectively operating said amplifier tubes according to the polarity of the charge thereon, and means for selectively controlling the polarity of the charge on said condensers according to the operation of said cold cathode tubes.

3. In combination, a signal line, control means on said line for governing the amplitudes of the signals thereon, detector means comprising two cold cathode tubes connected to said line beyond the control means, means for effecting operation of one of said tubes by signal peaks of one amplitude and for effecting operation of the other tube by signal peaks of a higher amplitude, means comprising two balancing condensers for governing said control means to raise or lower the strength of the signals on said line according to the polarity of the charge on the condensers, and means for charging said condensers in one direction when signal peaks of low amplitude detected by one tube predominate for a period of time and for charging said condensers in an opposite direction when signal peaks of higher amplitude detected by the other tube predominate for a period of time.

4. In combination, a signal line, a vario-repeater on said line comprising space discharge devices having control grids, a control condenser for impressing potential on said grids according to the charge on the condenser, two control circuits of different sensitivity connected to said line beyond the vario-repeater, a cold cathode detector tube in each of said control circuits, means for effecting operation of said cold cathode tubes, respectively, by signal peaks of different strengths, two driver circuits for respectively governing the charge on the control condenser to increase and to decrease the gain by the vario-repeater, means comprising two balancing condensers for selectively operating said driver circuits according to the polarity of the charge on the balancing condensers, and means for charging said balancing condensers with polarity determined according to the operation of said cold cathode tubes.

5. In combination, a signal line, a vario-repeater on said line for controlling the gain, two detector circuits connected to said line beyond the vario-repeater, a cold cathode detector tube in each of said detector circuits, means for operating said tubes by signal peaks of different

levels, a balancing circuit connected to said detector tubes for weighing the outputs from said tubes, means comprising a driver circuit connected to said balancing circuit for operating said vario-repeater to increase the gain on said line when signal peaks of low amplitude detected by one detector circuit predominate for a period of time over the high signal peaks detected by the other detector circuit, and means comprising a second driver circuit connected to said balancing circuit for operating said vario-repeater to reduce the gain on said line when signal peaks of high amplitude detected by the detector circuit operated by high signal peaks predominate for a period of time over the low signal peaks detected by the other detector circuit.

6. In combination, a signal line, control means for governing the strength of the signals on said line, two detector circuits of different sensitivity connected to said line beyond said control means and operated according to the strengths of the signals, a cold cathode tube in each of said detector circuits, a syllabic gain increaser circuit connected to the line for controlling the cold cathode tube in the detector circuit of high sensitivity when the signal peaks on the line are of insufficient strength to operate the tube in the high sensitivity circuit, means controlled by the output from the tube in the high sensitivity circuit for operating said control means to increase the strength of the signals on the line, means controlled by the output from the tube in the detector circuit of low sensitivity for governing said control means to lower the strength of the signals on the line and means for insuring against simultaneous control of said control means by more than one of the circuits comprising the syllabic circuit, the high sensitivity circuit and the low sensitivity circuit.

7. In combination, a signal line, a vario-repeater on said line for controlling the gain, two detector circuits of different sensitivity connected to said line beyond said vario-repeater, a cold cathode tube in each of said detector circuits, a balancing circuit connected to the output circuits of said tubes for averaging the tube outputs, a syllabic gain increaser circuit connected to said line before the vario-repeater for controlling the cold cathode tube in the detector circuit of higher sensitivity when the peaks of the signals on the line beyond the vario-repeater are of insufficient strength to operate the tube in the high sensitivity detector circuit, means controlled by said balancing circuit for operating the vario-repeater to raise the gain on the line when the tube in the high sensitivity circuit is operated for a limited period by signal peaks of low strength, and means controlled by the balancing circuit when operated by the tube in the low sensitivity circuit for disabling the high sensitivity circuit and the syllabic circuit and for controlling the vario-repeater to lower the gain on the line.

8. In combination, a signal transmission line, a vario-repeater on said line for controlling the gain, two marginal detector circuits connected to said line beyond said vario-repeater, a cold cathode tube in each of said detector circuits, a balancing circuit connected to the output circuits of said tubes for weighing the tube outputs, a syllabic gain increaser circuit connected to said line before the vario-repeater for controlling the cold cathode tube in the detector circuit of higher sensitivity when the peaks of the signals on the line beyond the vario-repeater are of insufficient strength to operate the tube in the high sen-

sitivity detector circuit, said syllabic circuit having means for operating the tube in the high sensitivity circuit by spurts of low frequency current according to the number of speech syllables, means for disabling the syllabic circuit when the signal peaks on the line beyond the vario-repeater are of sufficient strength to operate the tube in the high sensitivity circuit, means controlled by the balancing circuit for operating the vario-repeater to raise the gain when the tube in the high sensitivity circuit is operated for a limited period by signal peaks of low strength, and means controlled by the balancing circuit when operated by the tube in the low sensitivity circuit for disabling the high sensitivity circuit and the syllabic circuit and for controlling the vario-repeater to lower the gain on the line.

9. In combination, a signal transmission line, a vario-repeater on said line for controlling the gain, two detector circuits of different sensitivity connected to the line beyond said vario-repeater, a cold cathode tube in each of said detector circuits, a syllabic gain increaser circuit connected to said line before the vario-repeater for controlling the cold cathode tube in the detector circuit of high sensitivity when the peaks of the signals on the line beyond the vario-repeater are of insufficient strength to operate the tube in the high sensitivity detector circuit, means controlled by the output from the tube in the high sensitivity circuit for operating the vario-repeater to raise the gain when the tube in the high sensitivity circuit is operated a predetermined greater period of time more than the other tube, means for disabling the syllabic circuit when the signal peaks on the line beyond the vario-repeater are of sufficient strength to operate the tube in the high sensitivity circuit, means controlled by the output from the tube in the low sensitivity circuit for disabling the high sensitivity circuit and the syllabic circuit and for operating the vario-repeater to lower the gain on the line.

10. In combination, a signal line, a vario-repeater on said line for controlling the signal gain, a control circuit connected to said line and comprising a cold cathode tube, means for operating said tube when the signals on the line are above a predetermined strength, a three-element gain increaser cold cathode tube for governing said vario-repeater to raise the gain on said line, means comprising a circuit for igniting a path across two of the electrodes of said gain increaser tube upon operation of said tube in said control circuit, and means effective upon a predetermined operation of the tube in the control circuit for operating said gain increaser tube to raise the gain on said line.

11. In combination, a signal transmission line, a vario-repeater on said line for controlling the signal gain, a control circuit connected to said line and comprising a cold cathode tube, means for operating said tube when the signals on the line are above a predetermined strength, a three-element gain increaser cold cathode tube for governing said vario-repeater to raise the gain on said line, means comprising a circuit for igniting a path across two electrodes of the gain increaser tube upon operation of said tube in said control circuit, a resistance pad comprising elements having a non-linear voltage-current characteristic, and means effective upon a predetermined operation of the tube in the control circuit for energizing said pad to operate said gain increaser tube and raise the gain on said line.

12. In combination, a signal transmission line,

a vario-repeater on said line for controlling the signal gain, two detector circuits of different sensitivity connected to said line, a cold cathode tube in each of said sensitivity circuits, a three-element gain increaser cold cathode tube associated with said high sensitivity circuit for operating the vario-repeater to increase the gain, a three-element gain decreaser cold cathode tube associated with the low sensitivity circuit for controlling the vario-repeater to reduce the gain, means comprising an enabling circuit for igniting a path across two electrodes of the gain increaser tube associated with the high sensitivity circuit upon operation of the tube in the high sensitivity circuit, means comprising a second enabling circuit for igniting a path across two electrodes of the gain decreaser tube associated with the low sensitivity circuit upon operation of the tube in the low sensitivity circuit, balancing means for averaging the outputs from the tubes in the sensitivity circuits, and means controlled by the balancing means for selectively operating said three-element gain increaser and decreaser tubes according to the operation of the sensitivity circuits.

13. In combination, a signal transmission line, a vario-repeater on said line for controlling the signal gain, two detector circuits of different sensitivity connected to said line, a cold cathode tube in each of said sensitivity circuits, a three-element gain increaser cold cathode tube associated with the high sensitivity circuit for controlling the vario-repeater to increase the gain, means comprising an enabling circuit for igniting a path across two electrodes of the gain increaser tube associated with the high sensitivity circuit upon operation of the tube in the high sensitivity circuit, a three-element gain decreaser cold cathode tube associated with the low sensitivity circuit for controlling the vario-repeater to reduce the gain, means comprising a second enabling circuit for igniting a path across two electrodes of the gain decreaser tube associated with the low sensitivity circuit upon operation of the tube in the low sensitivity circuit, balancing means for weighing the outputs from the tubes in the sensitivity circuits, means controlled by the balancing means for selectively operating said three-element gain tubes according to the operation of the sensitivity circuits, and means for disabling the high sensitivity circuit upon operation of the low sensitivity circuit.

14. In combination, a signal transmission line, a vario-repeater on said line for controlling the signal gain, a syllabic circuit connected to said line and comprising a diode-triode for rectifying and amplifying the signals, a filter for selecting impulses of syllabic frequency from said diode-triode output, a pulser device for supplying fixed impulses regardless of the strength and duration of the syllabic impulses, means comprising rectifier elements connecting said filter to the pulsing device to operate said pulsing device only on the rising portion of the syllabic impulses, and means controlled by the pulsing device for supplying spurts of alternating current according to the number of syllables, and means controlled by said spurts of alternating current for governing said vario-repeater.

15. In combination, a signal transmission line, a vario-repeater on said line for controlling the signal gain, a syllabic circuit connected to said line and comprising a diode-triode for rectifying and amplifying the signals, a filter for selecting

impulses of syllabic frequency from said diode-
triode, a pulser device for supplying fixed im-
pulses regardless of the strength of the syllabic
impulses, rectifier elements connecting said filter
5 to the pulser device for operating said pulsing
device only on the rising portion of the syllabic
impulses, a pad of elements having non-linear
voltage current characteristics connected in

series and parallel circuit relation, a source of
alternating current connected to said pad, and
means governed by said pulsing device for con-
trolling said pad to supply spurts of alternating
current according to the number of syllables, and
means controlled by said spurts of alternating
current for governing said vario-repeater. 5

BJORN G. BJORNSON.