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SIGNAL TRANSMISSION SYSTEM

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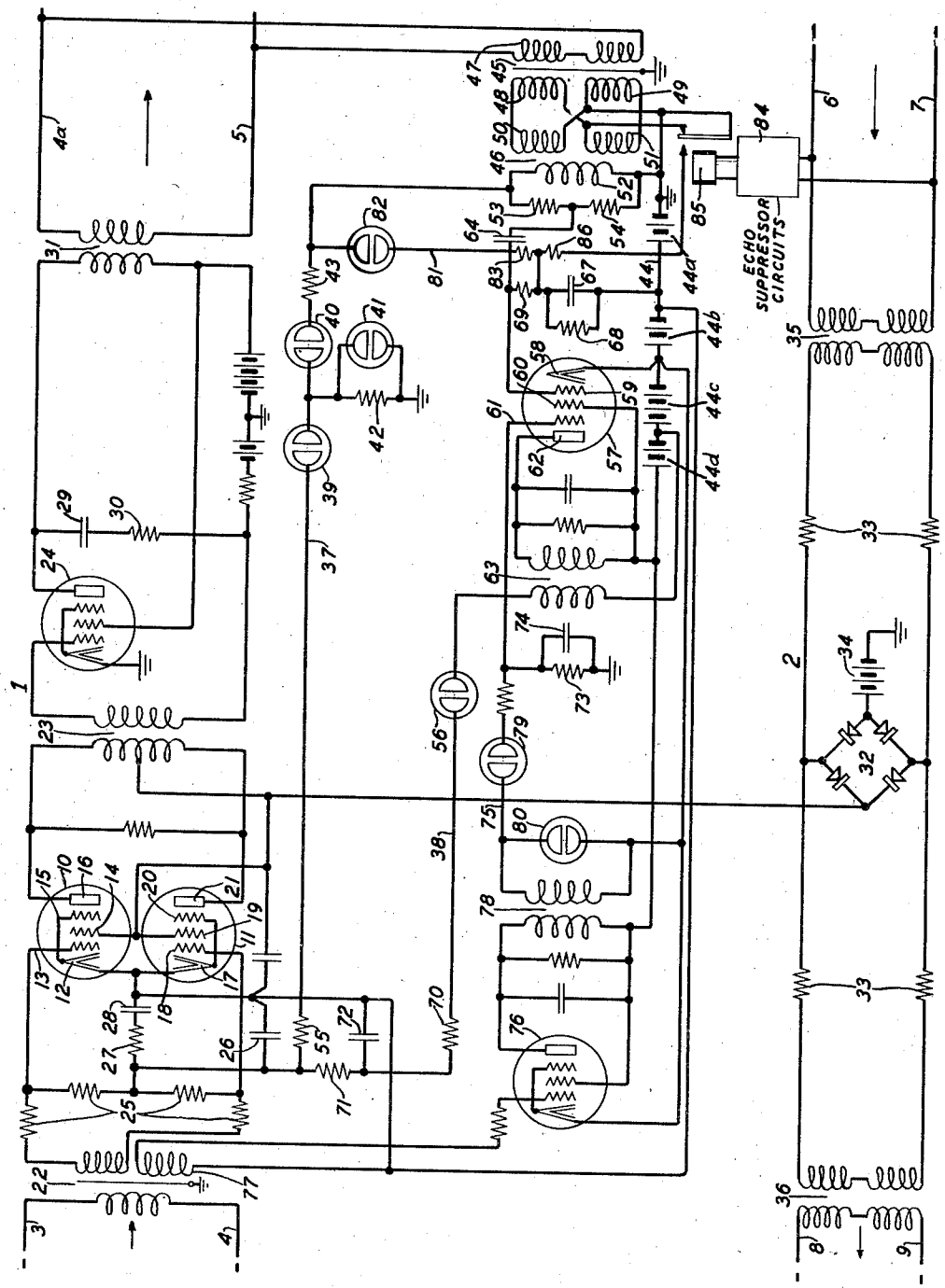

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SIGNAL TRANSMISSION SYSTEM

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16 Claims. (178—44)

This invention relates to signal transmission systems and particularly to circuits for controlling the energy volume of signals on transmission systems.

One object of the invention is to provide a signal transmission system with voice-operated gain control circuts that shall be operated in an improved manner to control the gain of the signals.

Another object of the invention is to provide a signal transmission system with a transmitting channel having a variable gain control device therein that shall govern the device in the channel by a backward-acting gain increaser circuit and by a backward-acting gain decreaser circuit to control the volume of the signals while preventing operation of the gain increaser circuit until the signals in the transmitting channel before the device have a volume above that of the weakest talker.

Another object of the invention is to provide a transmitting channel having a variable gain control device therein that shall have a gain increaser circuit, a gain decreaser circuit, a gain increase enabler circuit and a gain increase disabler circuit provided with marginal-acting cold-cathode lamps for controlling said device to maintain constant volume on the transmitting channel.

A further object of the invention is to provide a four-wire signaling system having a gain control space device in the transmitting channel and a loss device connected across the receiving channel that shall control the space discharge device in the transmitting channel to maintain constant volume on the transmitting channel and that shall vary the loss device in the receiving channel according to the plate current for the device in the transmitting channel to vary the impedance on the receiving channel oppositely to the change of gain on the transmitting channel. When a radio transmission station is connected to a telephone system it is desirable to supply the telephone currents to the radio transmitter at constant volume in order to prevent overloading the apparatus in the radio transmitter. Furthermore, when constant volume signals are supplied to the radio transmitter, it is simpler to effect amplification and override the noise level encountered in radio systems.

In a telephone system voice currents controlled by different types of talker are transmitted. In one extreme may be the very loud talker and in the other extreme may be the very weak talker. The volume range between the very loud talker and the very weak talker may be such as to cause overloading of the apparatus in a radio transmitter by the strong talkers when the weak talkers are raised to 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. When constant volume signals are supplied to the radio transmitter it is possible to effect higher amplification and more easily override the noise level. One type of voice-operated gain adjusting device is disclosed in the patent to S. Doba, Jr. 2,012,810, August 27, 1935.

In the voice-operated gain adjusting circuits employed to describe the invention two pentode space discharge devices are effectively connected in series with the transmitting channel of a four-wire system and a bridge formed by elements having a non-linear volt-current characteristic is connected across the receiving channel. The space discharge devices in the transmitting channel are controlled by a gain increaser circuit, a gain decreaser circuit, a gain increase enabler circuit and a gain increase disabler circuit to maintain constant volume signals on the transmitting channel. The bridge across the receiving channel which may be formed by copper-oxide rectifiers or elements composed of silicon carbide crystals and a binder material of the type disclosed in the patent to K. B. McEachron 1,822,742, September 8, 1931, is controlled according to the plate current supplied to the space discharge devices in the transmitting channel. The transmitting channel may be connected to a radio transmitter and the receiving channel may be connected to a radio receiver.

A relatively small condenser shunted by a resistance element and a relatively large condenser are provided for impressing a variable bias on the control grids of the two pentode space discharge devices in the transmitting channel. The two condensers are charged according to the energy level of the signals on the transmitting channel beyond the pentode devices therein for controlling the devices. The small condenser is charged and discharged quickly and takes care of sudden changes in energy. The larger condenser is charged and discharged by prolonged changes in energy.

The gain decreaser circuit prevents the outgoing signals on the transmitting channel from exceeding a maximum value by impressing a negative charge on the condensers which control the two pentode tubes in the transmitting channel.

In the circuit under consideration the gain decreaser circuit will operate when the transmitted signals are above +18 decibels. The gain increaser circuit tends to increase the gain whenever the output signals are greater than a predetermined minimum. The gain increaser circuit will operate when the transmitted signals are above −17 decibels. The gain increase disabler circuit prevents operation of the gain increaser circuit whenever the output signals are above +8 decibels. The gain increaser enabler circuit prevents operation of the gain increaser circuit except when the signals before the gain control device in the transmitting channel are above that of the weakest talker in order to prevent operation solely on noise. The gain decreaser circuit, the gain increaser circuit and the gain increase disabler circuit are backward-acting, whereas the gain increase enabler circuit is forward-acting. Marginal operation in each of the above-mentioned circuits is effected by means of cold-cathode lamps which are preferably filled with neon gas. A receiving disabler circuit is also provided to prevent any gain adjustments of the gain control circuits by speech incoming on the receiving channel.

The single figure in the accompanying drawing is a diagrammatic view of a signal transmission system provided with gain adjusting circuits constructed in accordance with the invention.

Referring to the drawing, a four-wire signal system comprising a transmitting channel 1 and a receiving channel 2 is provided for connection to a radio transmitter and a radio receiver (not shown). The transmitting channel 1 is provided with input conductors 3 and 4 and output conductors 4a and 5. The receiving channel is provided with input conductors 6 and 7 and output conductors 8 and 9.

A variable repeater comprising two pentode space discharge devices 10 and 11 is provided in the transmitting channel 1. The pentode space discharge device 10 is provided with a cathode 12, a control grid 13, a screen grid 14, a suppressor grid 15 and an anode 16. The pentode 11 is provided wtih a cathode 17, a control grid 18, a screen grid 19, a suppressor grid 20 and an anode 21. The pentode devices 10 and 11 which are connected in push-pull relation are connected to the input conductors 3 and 4 by means of a transformer 22 and are connected by transformer 23 to an amplifier space discharge device 24. The devices 10 and 11 are of the variable mu-type and are characterized by low distortion and high gain. A resistance pad comprising resistance elements 25 is connected in the input circuits to the devices 10 and 11. The gain effected by the devices 10 and 11 is controlled according to the charge on a relatively small condenser 26 which is shunted by a resistance element 27 and a relatively large condenser 28.

The space discharge device 24 is preferably in the form of a pentode and is provided with a negative feedback by means of a condenser 29 and a resistance element 30. The feedback circuit is provided in order to reduce the effective output impedance of the pentode device 24. The amplifier device 24 is connected to the output conductors 4a and 5 in the transmitting channel 1 by means of a transformer 31.

A bridge circuit 32 comprising elements having a non-linear voltage-current characteristic is provided for controlling the impedance of the receiving channel 2 according to changes of gain in the transmitting channel 1. The elements in the bridge circuit 32 may be copper-oxide rectifiers or elements composed of silicon carbides and a binder material. Two opposite vertices of the bridge 32 are connected across the receiving channel 2 between resistance elements 33. The other two vertices of the bridge 32 are connected in the plate potential circuit for the pentode devices 10 and 11. Anode potential for the devices 10 and 11 is supplied by a battery 34. The impedance pad in the receiving channel comprising the bridge 32 and the resistance elements 33 is connected to the input conductors 6 and 7 by means of a transformer 35 and to the output conductors 8 and 9 by means of a transformer 36.

The charge on the control condensers 26 and 28 which controls the bias on the grids 13 and 18 of the devices 10 and 11 is controlled by a gain decreaser circuit 37 and a gain increaser circuit 38. The gain decreaser circuit 37 and the gain increaser circuit 38 are backward-acting in their control of the devices 10 and 11. The gain decreaser circuit 37 comprises three cold-cathode lamps 39, 40 and 41. A resistance element 42 is connected in shunt to the lamp 41 and a resistance element 43 is connected in series with the lamp 40. A biasing battery comprising a section 44a of a grounded battery 44, which in the circuit under consideration is assumed to be 28.5 volts, is connected to the cold-cathode lamp 39. The grounded battery 44 is divided into sections 44a, 44b, 44c and 44d. The potentials to ground of the different sections 44d, 44c, 44b and 44a are respectively 135 volts, 54 volts, 30.5 volts and 28.5 volts. In the circuit under consideration the lamps 41 and 39 are assumed to ignite at approximately 60 volts, whereas the lamp 40 is assumed to ignite or break down at approximately 190 volts. The gain decreaser circuit 37 is connected to the output conductors 4a and 5 of the transmitting channel 1 by means of transformers 45 and 46. The transformer 45 comprises a primary winding 47 and secondary windings 48 and 49. Transformer 46 comprises primary windings 50 and 51 and a secondary winding 52. The secondary winding 52 of the transformer 46 is shunted by resistance elements 53 and 54.

The cold-cathode lamp 40 serves to provide a greater marginal action than would be provided by the cold-cathode lamp 39 alone. The cold-cathode lamp 41 serves solely as a voltage limiter to prevent reversal in the operation of the lamp 39. The lamp 41 breaks down when a potential of 60 volts is impressed across it.

If the condensers 28 and 26 are discharged, no charging action by the lamp 39 will take place until a potential of at least 31.5 volts is impressed across the resistance element 42. This is apparent because the lamp 39 is biased by the 28.5-volt battery section 44a and a 60-volt potential is required to break down the lamp 39. The potential across the resistance element 42 is obtained by a circuit extending from ground through the secondary winding 52 of the transformer 46, resistance element 43, cold-cathode lamp 40 and resistance element 42 to ground. The lamp 40 as before set forth, has a breakdown potential of 190 volts. A potential of 221.5 volts is required across the primary windings 50 and 51 of transformer 46 in order to produce at least a potential of 31.5 volts across the resistance element 42 for breaking down the lamp 39. If the control condensers are to be charged to approximately 20 volts for a gain reduction of 30

decibels, the drop across the resistance element 42 must be increased to 51.5 volts and the potential across the primary windings 50 and 51 of the transformer 46 must be approximately 241.5 volts.

In order to reduce the gain on the transmitting channel the grain decreaser circuit 37 must impress a charge on the condensers 26 and 28 which will impress negative bias on the control grids 13 and 18. The bias on the lamp 39 provided by the battery section 44a insures correct charging of condensers 26 and 28 by the gain decreaser circuit. The lamp 41 which shunts the resistance element 42 insures that the drop across the resistance element 42 will not overcome the bias of the battery section 44a and reverse the charging effect of the gain decreaser circuit. The lamp 41 limits the voltage drop across the resistance element 42 to 60 volts. The circuit for charging the condensers 26 and 28 by the gain decreaser circuit 37 may be traced from ground through the resistance element 42, lamp 39, resistance element 55, condenser 26 shunted by the resistance 27 and the condenser 28 and the battery section 44a to ground.

The gain increaser circuit 38 comprises a gas-filled cold-cathode lamp 56 and a pentode space discharge device 57. The pentode device 57 comprises a cathode 58, a control grid 59, a screen grid 60, a suppressor grid 61 and an anode 62. The input circuit of the pentode device 57 is connected to the output conductors 4a and 5 of the transmitting channel 1 by means of the transformers 46 and 45. The output circuit of a device 57 is connected to the lamp 56 by means of a transformer 63.

The input circuit for the pentode device 57 extends from ground, through the resistance element 54, condenser 64, the control grid 59, cathode 58 and battery sections 44b and 44a to ground. The battery section 44b in the system under consideration is assumed to have a potential of 30.5 volts. Potential is impressed from battery section 44a on the grid 59 of the pentode device 57. The battery section 44a is assumed to have a potential of 28.5 volts. Battery section 44a is connected to the grid 59 through a condenser 67 and a resistance element 68 in parallel, and a resistance element 69. Battery sections 44b and 44a provide a negative bias of 2 volts on the grid 59 with respect to cathode 58.

The cold-cathode lamp 56 in the gain increaser circuit 38 is biased by a potential of 25.5 volts. The circuit through the cold-cathode lamp 56 for charging the control condensers 26 an 28 may be traced from the grounded battery sections 44b and 44c through the lamp 56, resistance element 70, resistance element 71, condenser 26 in parallel with the resistance element 27 and the condenser 28 to the battery section 44b. A condenser 72 cooperates with the resistance elements 70 and 71 to provide a filter in the charging circuit for the condensers 26 and 28. The gain increaser circuit upon breakdown of the lamp 56 tends to charge the control condensers 26 and 28 positively so as to increase the gain effected by the pentode devices 10 and 11 in the transmitting channel 1. The filtering action by the resistance elements 70 and 71 and the condenser 72 is desirable whenever bias on the control grids 13 and 18 of the devices 10 and 11 is made positive because a rapid discharge of the control condensers would tend to introduce distortion.

The purpose of having the gain increaser circuit 38 backward-acting is to provide a gain increase function which is nearly independent of the input volume. This arrangement has the disadvantage that with the high sensitivity needed for a 30-decibel range the possibility of noise operation is increased beyond that obtained with a forward-acting gain increaser circuit. In order to overcome the above difficulty, the gain of the space discharge device 57 is normally held at a very low value by returning the suppressor grid 61 to ground through a resistance element 73 shunted by a condenser 74. This ground connection is 30.5 volts negative with respect to the cathode 58. In order to raise the gain of the device 57 to normal value, a forward-acting gain increase enabler circuit 75 is provided.

The gain increase enabler circuit 75 comprises a pentode space discharge device 76 having the input circuit thereof connected to a secondary winding 77 of the transformer 22 in the transmitting channel 1 and the output circuit coupled by a transformer 78 to a cold-cathode lamp 79. The secondary winding of the transformer 78 is shunted by a cold-cathode lamp 80 which serves to limit the potential supplied to the cold-cathode lamp 79. The lamps 79 and 80 in the circuits under consideration are assumed to ignite or break down at 60 volts. The plate of the device 76 is connected to the 135-volt battery section 44d and the cathode of the device is connected to the grounded 30.5-volt battery section 44b. The lamp 79 is biased by the battery section 44b with a potential of 30.5 volts. The breakdown or ignition of the lamp 79 takes place when the volume on the input conductors 3 and 4 is above that of the weakest talker. Breakdown of lamp 79 raises the potential on the suppressor grid 61 of the device 57 to approximately the same potential as that of the cathode 58. The blocking effect on the device 57 is thus removed to permit operation of the gain increaser circuit 38.

The lamp 80, as above set forth, limits the potential supplied to the lamp 79 and insures against any reversal in the direction of the current flow through the lamp 79. The time constant provided by the resistance element 73 and the condenser 74 should be great enough to hold over between syllables of the weakest talker, but should be short enough to prevent excessive gain increase in silent intervals immediately following the talking time. In the circuit under consideration with the values given in the specification it has been found that a hangover time of about .5 second provides an effective compromise.

A gain increase disabler circuit 81 is provided with a cold-cathode lamp 82 and serves to block the operation of the gain increaser circuit 38 when the energy level on the output conductors 4 and 5 of the channel 1 is raised above a predetermined value. The breakdown circuit for the lamp 82 may be traced from ground, through the secondary winding 52 of transformer 46, lamp 82, resistance element 83, resistance element 68 shunted by condenser 67 and battery section 44a to ground. The drop across the resistance element 68 impresses a negative bias on the control grid 59 of the device 57 for blocking purposes. The lamp 82 in the gain increase disabler circuit will operate when the strength of the signals on the transmitting channel beyond the gain control device therein is about +8 decibels. The hangover time provided by the condensers 67 shunted by the resistance element 68

is approximately .5 second. To compensate for this short hangover in the gain increase disabler circuit, the sensitivity of the lamp **62** has been made 10 decibels greater than the sensitivity of the lamp **39** in the gain decreaser circuit. The gain decreaser circuit will operate at +18 decibels, whereas the gain increase disabler circuit will operate at +8 decibels.

A relay **85** controlled by an echo suppressor circuit **84** connected to the receiving channel **2** serves in its operated position to block transmission over the output conductors **4a** and **5** of the transmission channel **1**. In its operated position bias is impressed across the resistance element **68** for blocking the gain increaser circuit **38** and prevent any change in the control circuits. The biasing circuit may be traced from ground, through the armature of the relay **85**, a resistance element **86**, resistance element **68** shunted by the condenser **67** and battery section **44a** to ground.

In a gain control arrangement of the above-disclosed type for obtaining constant volume on the transmission channel means are provided by the bridge **32** for insuring against any singing condition. The bridge **32** has its impedance varied oppositely to a change in the gain on the transmitting channel so that no tendency to sing will be produced.

Assuming the condensers **26** and **28** are discharged and conversation takes place over the transmitting channel **1**, the gain increase enabler circuit **75** which is a forward-acting circuit will be operated to break down the cold-cathode lamp **79**. Breakdown of the cold-cathode lamp **79** places potential on the suppressor grid **61** in order to insure the potential of this grid to be substantially the same as the potential on the cathode **58**. The blocking action of the device **57** is thus removed and upon breakdown of the lamp **56** in the gain increaser circuit **38** the condensers **26** and **28** will be charged positively to insure a positive bias on the grids **13** and **18** of the devices **10** and **11**. The gain on the transmitting channel is thus increased. When the gain is raised to a predetermined point, the lamp **82** in the gain increase disabler circuit is broken down to place sufficient negative bias on the grid **59** of the device **57** to prevent any further operation of the gain increaser circuit **38**.

Where the energy level is raised above a predetermined point on the transmitting channel **1** beyond the gain control devices therein, the lamp **39** is broken down or ignited to impress a negative charge on the condensers **26** and **28** and reduce the gain effected by the pentode devices **10** and **11**.

Modifications in the circuits and in the arrangement and location of parts may be made in 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 a signal system, a transmitting channel having a variable gain device therein, means comprising a backward-acting gain decreaser circuit for controlling said device to set an upper limit to the volume of the signals on said channel, means comprising a backward-acting gain increaser circuit for controlling said device to insure a lower limit to the volume of the signals on said channel, and means comprising a forward-acting gain increase enabling circuit for preventing operation of the gain increaser circuit until the volume on the channel before said device is above that of the weakest talker.

2. In a signal system, a transmitting channel having a variable gain device therein, means comprising a backward-acting gain decreaser circuit for controlling said device to control the volume of the signals on said channel, a marginal-acting cold-cathode lamp in said decreaser circuit which is ignited to control said device and lower the gain when the energy level on the channel is above a predetermined upper level, means for enabling ignition of said lamp at a lower energy level in one direction, means for insuring operation of said lamp in only one direction, means comprising a backward-acting gain increaser circuit for controlling said device to insure a lower limit to the volume of the signals on said channel, a marginal-acting cold-cathode lamp in said increaser circuit which is ignited to control said device when the energy level on the channel is below a predetermined lower level, and means for enabling ignition of said lamp in the decreaser circuit at a lower energy level in one direction and for insuring operation of the lamp in the decreaser circuit in only one direction.

3. In a signal system, a transmitting channel having a variable gain device therein, means comprising a backward-acting gain decreaser circuit for controlling said device to control the volume of the signals on said channel, a biased marginal-acting cold-cathode lamp in said decreaser circuit which is ignited to control said device when the energy level on the channel is above a predetermined upper level, means comprising a backward-acting gain increaser circuit for controlling said device to insure a lower limit to the volume of the signals on said channel, a biased marginal-acting cold-cathode lamp in said increaser circuit which is ignited to control said device when the energy level on the channel is below a predetermined lower level, and means comprising a forward-acting gain increase enabling circuit for preventing operation of the gain increaser circuit until the volume on the channel before said device is above that of the weakest talker.

4. In a signal system, a transmitting channel having a variable gain device therein, means for controlling said device to set an upper limit to the volume of the signals on said channel, means comprising a backward-acting gain increaser circuit for controlling said device to increase the gain on said channel and insure a lower limit to the volume of the signals on said channel, means comprising a forward-acting gain increase enabling circuit for preventing operation of the gain increaser circuit until the volume on the channel before said device is above that of the weakest talker, and a backward-acting gain increase disabler circuit for preventing operation of the gain increaser circuit when the energy level of the signal on said channel is above a predetermined level.

5. In a signal system, a transmitting channel having a variable gain device therein, means comprising a normally blocked backward-acting gain increaser circuit for controlling said device to increase the gain on the channel and to insure a lower limit to the volume of the signals on the channel, a forward-acting gain increase enabler circuit for rendering said increaser circuit operative when the volume on the channel before said device is above that of the weakest talker, and a gain increase disabling circuit for preventing operation of the increaser circuit

when the energy level on said channel is raised above a predetermined value.

6. In a signal system, a transmitting channel having a variable gain device therein, means comprising a backward-acting gain increaser circuit for controlling said device to increase the gain on said channel and to insure a lower limit to the volume of the signals on said channel, a biased marginal-acting cold-cathode lamp and a normally blocked space discharge device in said increaser circuit to control said first-mentioned device, a forward-acting gain increase enabler circuit for rendering said second-mentioned device conducting when the volume on the channel before the first-mentioned device is above that of the weakest talker, and a backward-acting gain increase disabling circuit for blocking said second-mentioned device to prevent operation of the increaser circuit when the energy level on said channel is raised above a predetermined value.

7. In a signal system, a transmitting channel having a variable gain device therein, means comprising a backward-acting gain increaser circuit for controlling said device to increase the gain on said channel and to insure a lower limit to the volume of the signals on said channel, means for normally blocking said increaser circuit, a forward-acting gain increase enabler circuit for rendering said blocking means in the gain increaser circuit inoperative when the volume on the channel before said device is above that of the weakest talker, and a gain increase disabling circuit for blocking said gain increaser circuit when the energy level on said channel is raised above a predetermined level.

8. In a signal system, a transmitting channel having a variable gain device therein, means comprising a gain increaser circuit for controlling said device to increase the gain on said channel and to insure a lower limit to the volume of the signals on said channel, a biased marginal-acting cold-cathode lamp in said increaser circuit which is ignited to control said device when the energy level on the channel is below a predetermined level, means for normally blocking said increaser circuit, a forward-acting gain increase enabler circuit for rendering said blocking means in the gain increaser circuit inoperative when the volume on the channel before said device is above that of the weakest talker, and a gain increase disabling circuit for blocking said gain increaser circuit when the energy level on said channel is raised above a predetermined level.

9. In a signal system, a transmitting channel having a variable gain device therein, means comprising a backward-acting gain increaser circuit for controlling said device to increase the gain on said channel and insure a lower limit to the volume of the signals on said channel, a biased marginal-acting cold-cathode lamp and a normally blocked space discharge device having a plurality of grids in said increaser circuit to control said first-mentioned device when the energy level on the channel beyond said first-mentioned device is below a lower limiting value, a gain increase enabler circuit for controlling a grid of said second-mentioned device to render the second device conducting when the volume on the channel before the first-mentioned device is above that of the weakest talker, and means comprising a backward-acting gain increase disabler circuit for controlling a grid of said second-mentioned device to disable the second-mentioned device and prevent any increase in gain when the energy level on the channl is above a predetermined value.

10. In a signal system, a transmitting channel having a variable gain device therein, means comprising a backward-acting gain decreaser circuit for controlling said device to set an upper limit to the volume of the signals on said channel, a biased marginal-acting cold-cathode lamp in said decreaser circuit which becomes ignited to control said device when the energy level on the channel beyond said device is above an upper limit, means comprising a gain increaser circuit for controlling said device to insure a lower limit to the volume of the signals on said channel, a biased marginal-acting cold-cathode lamp in said increaser circuit which becomes ignited to control said device when the energy level on the channel beyond said device is below a lower limiting value, and means comprising a forward-acting gain increase enabling circuit for preventing operation of the increaser circuit until the volume on the channel before said device is above that of the weakest talker.

11. In a signal transmission system, a transmission channel, a gain control device connected to said channel, means comprising a relatively small condenser shunted by a relatively large condenser and a resistance element for governing said device to control the volume range of the signals on said channel, the smaller condenser correcting for brief changes in gain and the larger condenser correcting for prolonged changes in gain, and means controlled according to the energy level of the signals on the transmission channel for impressing a charge of one polarity on said condensers to raise the gain and for impressing a charge of opposite polarity on said condensers to lower the gain so as to control said device and maintain the volume of the signals on the transmission channel constant.

12. In a signal system, a transmission line, a gain control space discharge device having a control grid, two condensers of different sizes in shunt circuit relation for governing the potential on said control grid, the smaller condenser correcting for short changes in signal volume and the larger condenser correcting for prolonged changes in signal volume, means comprising a gain decreaser circuit controlled according to the energy level on the line beyond said device for charging said condensers to reduce the gain when the energy level goes beyond a predetermined upper limit, means comprising a gain increaser circuit controlled according to the energy level on the line beyond said device for charging said condensers to increase the gain when the energy level goes below a predetermined lower limit and means comprising a forward acting gain increase enabling circuit for preventing operation of the gain increaser circuit until the signal volume on the line is above that of the weakest talker.

13. In a signal system, a transmission line, a gain control device connected to said line, means comprising a relatively small condenser shunted by a relatively large condenser and a resistance element for governing said device to control the volume range of the signals on the line, a gain decreaser circuit comprising a cold-cathode lamp for charging said condensers to control said device and lower the gain on the line, said lamp in the decreaser circuit being ignited when the energy level of the signals on the transmission line goes above an upper limit, and means com-

prising a gain increaser circuit for charging said condensers in a direction to increase the gain on the line, a cold-cathode lamp in said increaser circuit, and means for igniting said lamp in the increaser circuit to increase the gain on the line when the energy level on the line goes below a lower limit.

14. In a signal system, a transmission channel, a gain control device connected to said channel, means comprising a relatively small condenser shunted by a relatively large condenser and a resistance element for governing said device to control the gain of the signals on said channel, the small condenser correcting for brief changes in gain and the larger condenser correcting for prolonged changes in gain, means comprising a backward-acting gain decreaser circuit for charging said condensers to reduce the gain when the energy level on the channel beyond said device rises above a predetermined upper limit, means comprising a backward-acting gain increaser circuit for charging said condensers to increase the gain when the energy level on the channel beyond said device falls below a lower limit, and means comprising a forward-acting gain increase enabler circuit for preventing operation of said gain increaser circuit until the volume of the signals on the channel before said device are above that of the weakest talker.

15. In a four-wire signal system, a transmission channel, a gain control space discharge device connected effectively in series with said channel for controlling the signal volume on the transmission channel and having a control grid, a plate current circuit for said device, a condenser for governing the potential on said control grid, a receiving channel, a bridge composed of solid elements having non-linear voltage-current characteristics having two opposite vertices connected across said receiving channel, means for connecting the other two vertices of said bridge in the plate current circuit of said device to vary the receiving channel impedance oppositely to any change in the transmission channel gain by said device, and means controlled according to the energy level of the signals on the transmission channel for governing the charge on said condenser to control said device and maintain the volume of the signals on the transmission channel constant.

16. In a four-wire signal system, a transmitting channel, a receiving channel, a gain-control space-discharge device connected effectively in series with said transmitting channel and having a control grid, a plate circuit for said device, a bridge composed of solid elements having non-linear voltage-current characteristics with two opposite vertices thereof connected across said receiving channel, means for connecting the other two vertices of said bridge in the plate circuit of said device to vary the impedance of the receiving channel oppositely to any change in the transmitting channel impedance by said device, a condenser for controlling the potential on the control grid of said device, means comprising a gain decreaser circuit operated when the energy level on the transmitting channel goes above a predetermined upper limit for charging said condenser to reduce the gain of said device, and means comprising a gain increaser circuit controlled according to the energy level of the signals on the transmitting channel for discharging said condenser to increase the gain by said device when the energy level goes below a predetermined lower limit.

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