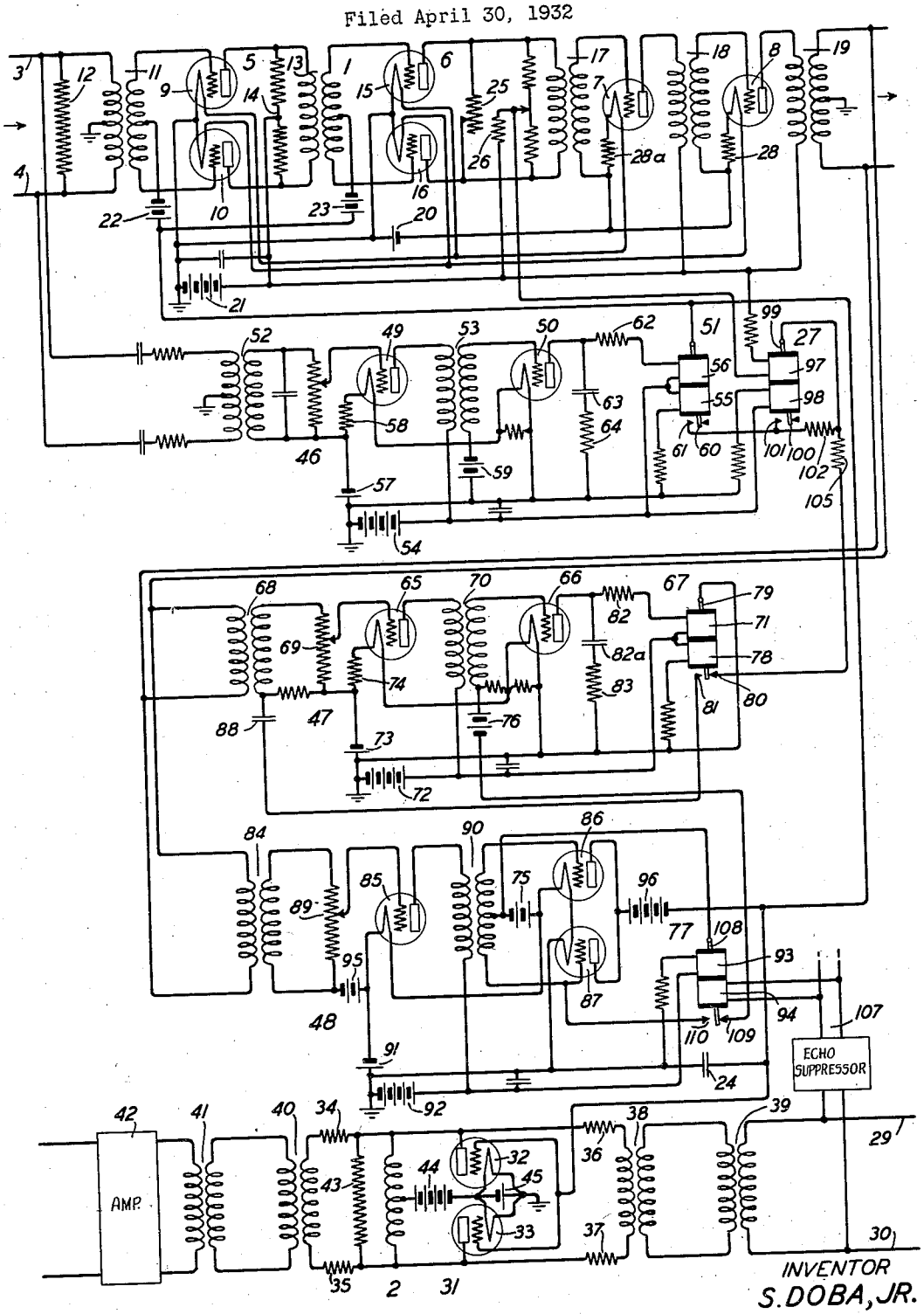
Aug. 27, 1935. S. DOBA, JR 2,012,810

TRANSMISSION SYSTEM

Filed April 30, 1932



INVENTOR
S. DOBA, JR.
BY Wayne B. Wells.
ATTORNEY

Patented Aug. 27, 1935

2,012,810

UNITED STATES PATENT OFFICE

2,012,810

TRANSMISSION SYSTEM

Stephen Doba, Jr., New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application April 30, 1932, Serial No. 608,362

19 Claims. (Cl. 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 line with a gain control device connected thereto that shall be governed by a marginal device controlled according to the energy peaks of signals on the line to raise the energy volume of the signals on the line.

Another object of the invention is to provide gain control means for a signal transmission line that shall be governed by marginal means having a hangover in the operation thereof to raise the energy gain on the transmission line and by a second marginal means having a hangover in the operation thereof to limit the increase of the energy gain on the transmission line.

Another object of the invention is to provide a transmission system having gain control means in a receiving channel and gain control means in a transmitting channel with a control device that shall jointly operate the two gain control means according to the energy peaks of the signals on one of the channels while limiting the gain variations in one of said channels with respect to the gain variations effected in the other channel.

Another object of the invention is to provide a transmission system having gain control means connected to a transmission line that shall control the gain control means to raise the energy gain on the line according to the peaks of the transmitted signals and that shall control the rate at which the energy gain is effected.

A further object of the invention is to provide a transmission system having gain control means in a transmitting channel and gain control means in a receiving channel with gain increasing means for controlling said gain control means to raise the gain in the transmitting channel while lowering the gain in the receiving channel, means for preventing operation of the gain increasing means varying the energy level on said channels beyond predetermined limits and gain decreasing means for controlling the gain control means to lower the energy gain in the transmitting channel and to raise the energy gain in the receiving channel that shall insure operation of the gain preventing means and prevent operation of the gain decreasing means when the receiving channel is in operation.

In signal transmitting systems it is desirable and in some cases essential to control the energy volume of the transmitted signals. In transmitting radio broadcast programs over transmission lines it is essential to control the volume of the transmitted programs to prevent overloading the various apparatus on the lines such as repeaters. In the transatlantic radio system, it is necessary to hold the energy volume on the system in front of the radio transmitter within a limit which will not overload the transmitter. This application is an improvement over the transmission system disclosed in the patent to John L. Hogg and Stephen Doba, Jr. No. 1,853,974, dated April 12, 1932.

In the system employed to describe the invention a gain control device which may be called a variorepeater is connected to the transmitting channel and another gain control device is connected to the receiving channel. The gain control device in the transmitting channel comprises two three-element space discharge devices in push-pull relation and connected effectively in series with the transmitting channel. The gain control device in the receiving channel comprises two three-element space discharge devices connected across the receiving channel. A resistance element is connected across the space discharge devices connected to the receiving channel to limit the gain variation that may be effected in the receiving channel. The gain control devices in the transmitting and receiving channels are jointly operated so that a gain in one channel will be accompanied by a loss in the other channel. The gain control device in the transmitting channel is so controlled as to maintain a constant volume on the transmitting channel beyond the gain control device.

The potential on the grids of the space discharge devices comprising the gain control devices in the transmitting and receiving channels is controlled in accordance with the charge on a condenser. When the condenser is charged to any extent the gain effected by the gain control device in the transmitting channel is lowered as set forth in the above mentioned patent to John L. Hogg and Stephen Doba, Jr. At the same time the gain effected by the gain control device in the receiving channel is raised.

The charge on the condenser is controlled by three separate circuits, a gain increaser circuit, a gain increase disabler circuit and a gain decreaser circuit. The gain increaser circuit is operated at the commencement of communication when the peaks of speech current on the transmitting channel beyond the gain control device are below a lower limiting value and the peaks of the speech on the transmitting channel before

the gain control device are above the peaks of speech for a weak talker. The gain increaser circuit includes a gas-filled tube which operates in a manner of a marginal device for controlling a relay which in turn establishes a circuit for discharging the condenser. In the output circuit of the gas-filled tube are connected means comprising capacity and resistance elements for producing a hangover action in the operation of the relay controlled by the gas-filled tube. The gain increaser circuit is controlled from the transmitting channel at a point before the gain control device.

The gain increase disabler circuit is controlled from the transmitting channel at a point beyond the gain control device. The gain increase disabler circuit comprises a gas-filled tube which operates in the manner of a marginal device for controlling a relay which prevents discharge of the condenser by the gain increaser circuit so that further increase in the gain on the transmitting channel is prevented. Hangover means comprising capacity and resistance elements are provided in the output circuit of the gas-filled tube in the gain increase disabler circuit for establishing a hangover in the operation of the relay controlled by the gas-filled tube. The gas-filled tube in the gain increase disabler circuit is operated or triggered off when the peaks of the speech current on the transmitting channel beyond the gain control device are above a lower limiting value.

The relay in the gain increaser circuit, which controls the discharge of the condenser, effects discharge of the condenser through a number of resistance elements. The number of resistance elements included in the discharge circuit for the condenser is varied by a rate control relay in order to vary the rate at which the gain on the transmitting channel is effected. The rate control relay is operated in accordance with the space current flow through the space discharge devices comprising the gain control device on the transmitting channel. Without variation in the amount of resistance in the condenser discharge circuit the gain in the transmitting channel would be very rapid at first and then become relatively slow. In order to insure a more uniform rate of gain in the transmitting channel, the resistance elements included in the condenser space discharge circuit are varied by the rate control relay in accordance with the space current flow through the space discharge devices comprising the gain control device on the transmitting channel.

The gain decreaser circuit is controlled from the transmitting channel at a point beyond the gain control device and serves to charge the above mentioned condenser when the peaks of speech current beyond the gain control device in the transmitting channel rise above an upper limiting value. The gain decreaser circuit comprises a highly biased push-pull detector having the output circuit thereof permanently connected across the control condenser. Whenever the output on the transmitting channel exceeds a predetermined upper limiting value the gain decreaser circuit is actuated and the control condenser is charged to impress a negative bias to the grids of the gain control device in the transmitting channel and a similar negative biasing potential is impressed on the grids of the gain control device in the receiving channel. This results in a continually decreasing gain in the transmitting channel until the output in such channel falls below the operating value for the gain decreaser circuit. In operation the gain decreaser circuit is operated by the peaks of voice current.

Means are provided for preventing operation of the gain decreaser circuit and to insure operation of the gain increase disabler circuit whenever the receiving channel is in use. A relay which preferably is operated by the echo suppressor circuits (not shown in detail) serves, when operated, to establish a short circuit around one-half the transformer secondary winding connected to the two detector tubes in the gain decreaser circuit thus to disable the gain decreaser circuit and prevent any increase in the charge on the control condenser when the receiving channel is in use. The relay controlled from the receiving channel when operated from the receiving channel also serves to remove the bias on the gas-filled tube in the gain increase disabler circuit so that the gas-filled tube is operated to effect operation of the relay controlled thereby and thus prevent any discharge of the control condenser by the gain increaser circuit.

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

Referring to the drawing a two-wire system (not shown) is connected in any suitable manner to a four-wire system comprising a transmitting channel 1 and receiving channel 2. The transmitting channel 1 comprising conductors 3 and 4 has a vario-repeater connected thereto for controlling the gain in energy and accordingly the volume of the transmitted signals. The vario-repeater comprises a gain control device 5, a second control device 6, an amplifier 7 and an amplifier 8. The gain control device 5 comprises two three-element space discharge tubes 9 and 10 which are connected in push-pull relationship and in series with the line. The input circuit of the gain control device 5 is connected to a transformer 11. Impedance means 12 is connected across the primary winding of the transformer 11. The output circuit of the gain control device 5 is connected by transformer 13 to the gain control device 6. Divided impedance means 14 is connected across the primary winding of the transformer 13.

The gain control device 6 comprises two space discharge tubes 15 and 16 which are connected in push-pull relationship and in series with the transmitting channel. The output circuit of the gain control device 6 is connected to the input circuit of the space discharge amplifier 7 by a transformer 17. The amplifier 7 is connected to the amplifier 8 by means of a transformer 18 and the amplifier 8 is connected to the transmission line by means of a transformer 19.

A battery 20 is provided for supplying heating current to the filaments of the tubes 9, 10, 15 and 16 and the amplifiers 7 and 8. A battery 21 is provided for supplying space current to all the space discharge devices in the transmitting channel. Batteries 22 and 23 are provided for impressing negative grid potential on the tubes 9 and 10 and 15 and 16 which comprise the gain control devices 5 and 6. The potential impressed upon the grids of the gain control devices 5 and 6 is also controlled in accordance with the charge on a control condenser 24 as will be described hereinafter. An adjustable impedance means 25 is connected across the output circuit of the gain control device 6 for adjusting the gain in the

transmitting channel at will. An impedance means 26 is connected in the space current path for the tubes comprising the gain control device 6. The drop across the impedance means 26 is utilized for controlling the operation of a gain rate relay 27 to govern the rate at which the gain increase takes place, as will be described hereinafter. Although two gain control devices 5 and 6 are shown in the transmitting channel 1, it is to be understood that only one or more than two gain control devices may be used if so desired. Furthermore, although the gain rate relay 27 is illustrated as controlled by an impedance means connected in circuit with the gain control device 6, it may also be controlled in accordance with the space current flow through the gain control device 5, if so desired. Resistance elements 28a and 28 in the filament heating circuits for the amplifiers 7 and 8 are provided for impressing biasing potential on the grids of the amplifiers 7 and 8.

The receiving channel 2 comprising conductors 29 and 30 includes a gain control device 31. The gain control device 31 comprises two three-element space discharge tubes 32 and 33 which are connected across the conductors of the receiving channel. The gain control device 31 is connected to the receiving channel between resistance elements 34, 35, 36 and 37. Two transformers 38 and 39 are provided in the receiving channel before the gain control device 31 and two transformers 40 and 41 are provided in the receiving channel after the gain control device. The transformer 41 is connected to a suitable amplifier 42. An impedance element 43 preferably in the form of a resistance element is connected across the gain control device 31 in order to limit the increase or decrease in gain effected in the receiving channel. A battery 44 is provided for supplying plate current to the space discharge tubes 32 and 33 and a battery 45 is provided for heating the filaments of the tubes 32 and 33. The potential on the grids of the tubes 32 and 33 comprising the gain control device 31 is controlled in accordance with the charge on the control condenser 24 in the same manner as the potential on the grids of the tubes in the gain control devices 5 and 6 is controlled from the condenser 24.

The charge on the control condenser 24 is governed by a gain increaser circuit 46, a gain increase disabler circuit 47 and a gain decreaser circuit 48. The gain increaser circuit comprises an amplifier space discharge device 49, a three-element gas-filled tube 50 and a relay 51. The input circuit of the amplifier 49 is connected to the conductors 3 and 4 of the transmitting channel at a point before the gain control devices 5 and 6 by means of a transformer 52. Capacity and resistance elements are preferably connected to the windings of the transformer 52 for tuning the circuit to audio frequency currents. The output circuit of the amplifier 49 is connected by a transformer 53 to the input circuit of the gas-filled tube 50. The gas-filled tube 50 is preferably filled with an inert gas and operates as a marginal device to effect operation of the relay 51 when predetermined peaks of energy are transmitted over the transmitting channel.

A battery 54 is provided for supplying plate potential to the amplifier 49 and the gas-filled tube 50. The battery 54 also supplies current for energizing the two windings 55 and 56 of the relay 51. A battery 57 provides heating current for the filaments of the amplifier 49 and the gas-filled tube 50. Biasing potential for the grid of the amplifier tube 49 is provided by the drop across a resistance element 58. A battery 59 supplies biasing potential for the grid of the gas-filled tube 50.

The winding 55 of the relay 51 is connected across the battery 54 for biasing the armature 60 of the relay 51 away from the contact member 61 and to the position shown in the drawing. The winding 56 of the relay 51 is connected across the battery 54 in circuit with a resistance element 62 and the gas-filled tube 50. Accordingly, the winding 56 of the relay 51 which moves the armature 60 into engagement with the contact member 61 is controlled in accordance with the impedance of the gas-filled tube 50. The gas-filled tube is marginal in operation and triggers off when predetermined peaks of energy are impressed upon the transmitting channel conductors 3 and 4. A hangover circuit comprising a condenser 63 and a resistance element 64 is connected across the gas-filled tube 50 in order to provide a hangover in the operation of the relay 51 by the gas-filled tube. The condenser 63 is charged from the battery 54 by the circuit including the winding 56. Upon operation of the gas-filled tube 50 the condenser 63 is discharged through the space discharge path provided by the tube. When the impedance of the gas-filled tube is raised and current flowing therethrough is stopped, the relay 51 is not immediately released, but a hangover in the operation thereof is provided according to the time required to recharge the condenser 63.

The gain increase disabler circuit 47 comprises an amplifier 65 preferably of the three-element thermionic type, a gas-filled tube 66 which is preferably of the three-element type and a relay 67. The amplifier 65 is connected to the transmitting channel 1 at a point beyond the amplifier 8 by means of a transformer 68. A potentiometer 69 is provided in the input circuit of the amplifier 65 for adjusting the operation of the gain increase disabler circuit. The output circuit of the amplifier tube 65 is connected to the input circuit of the gas-filled tube 66 by means of a transformer 70. The output circuit of the gas-filled tube 66 is connected to a winding 71 of the relay 67. A battery 72 is provided for supplying plate potential to the amplifier 65 and the gas-filled tube 66. Battery 73 is provided for supplying heating current to the filaments of the amplifier 65 and the gas-filled tube 66. Biasing potential for the grid of the amplifier tube 65 is provided by the drop across the resistance element 74 in the filament heating circuit.

Biasing potential for the grid of the gas-filled tube 66 is provided by a battery 75 in the gain decreaser circuit which is opposed by a battery 76. The battery 75 is assumed to supply negative potential of approximately 67 volts and the battery 76 to supply a positive potential of approximately 22 volts, so that substantially negative biasing potential of 45 volts is impressed on the grid of the gas-filled tube 66. The circuit of the batteries 75 and 76 for supplying biasing potential to the grid of the gas-filled tube 66 is controlled by a receiving relay 77 in a manner to be hereinafter disclosed.

The relay 67 comprises not only the operating winding 71 but a biasing winding 78. The biasing winding 78 is connected across the terminals of the battery 72 and serves to hold the armature 79 in engagement with a contact member 80. When the operating winding 71 is energized the armature 79 is moved into engagement with the con-

tact member 81. The operating winding 71 is connected across the battery 72 in circuit with a resistance element 82 and the gas-filled tube 66. The gas-filled tube 66 is marginal in its operation the same as the gas-filled tube 50 in the gain increaser circuit 46. The gas-filled tube 66 in the gain increase disabler circuit is assumed to operate or trigger off when the peaks of speech in the transmitting channel beyond the gain control devices are above a lower limiting value. The gas-filled tube 50 in the gain increaser circuit is assumed to operate or trigger off when the peaks of speech in the transmitting channel before the gain control devices are above those of a very weak talker. A hangover circuit comprising a condenser 82a and a resistance element 83 is provided in the output circuit of the gas-filled tube 66 for effecting a hangover in the operation of the relay 67. This hangover circuit operates in a manner similar to the hangover circuit described when reference was made to the gas-filled tube 50.

The gas-filled tube 66 in the gain increase disabler circuit is operated not only according to the peaks of energy on the transmitting channel beyond the gain control devices, but may be operated by the relay 77 which is controlled from the receiving channel. When the relay 77 is operated the circuit from the batteries 75 and 76 for supplying potential to the grid of the gas-filled tube is opened. Accordingly, the strong negative bias on the grid of the gas-filled tube 66 is removed to permit operation of the gas-filled tube and operation of the relay 67.

The gain decreaser circuit 48 comprises an amplifier 85 preferably of the three-element thermionic type and two detector tubes 86 and 87. A transformer 84 is provided for connecting the input circuit of the amplifier 85 to the transmitting channel at a point beyond the gain control devices 5 and 6 and the amplifier 8. A potentiometer 89 is provided in the input circuit of the amplifier 85 for adjusting the operation of the gain decreaser circuit. The output circuit of the amplifier 85 is connected to the input circuit of the detector tubes 86 and 87 by means of a transformer 90. Heating current for the filaments of the amplifier 85 and the detectors 86 and 87 is provided by means of the battery 91. A battery 92 is provided for supplying plate potential to the amplifier 85 and for supplying current to the biasing winding 93 of the relay 77. The operating winding 94 of the relay 77 is controlled from the receiving channel in a manner to be hereinafter set forth. Biasing potential for the grid of the amplifier 85 is supplied by battery 95. Biasing potential for the grids of the detector tubes 86 and 87 is supplied by a battery 75 which also controls the biasing potential for the grid of the gas-filled tube 66 in the gain increase disabler circuit 47. Plate potential for the detector tubes 86 and 87 is supplied by a battery 96. The output circuit of the detector tubes 86 and 87 is directly connected to the control condenser 24 for impressing a charge on the control condenser 24 in accordance with the operation of the detector tubes.

The gain rate relay 27 which is controlled according to the potential drop across the resistance element 26 in the plate circuit of the space discharge devices 15 and 16 comprises an operating winding 97 and a biasing winding 98. The biasing winding is energized from the battery 54 and normally holds the armature 99 in engagement with the stop member 100 and away from a contact member 101. The operating winding 97 which is energized according to the drop across the resistance element 26 serves to move the armature into engagement with the contact member 101. When the armature 99 of the relay is in engagement with the contact member 101, a resistance element 102 is excluded from the discharge circuit of the control condenser 24 as will be set forth hereinafter.

Assume a charge on the control condenser 24 and conversation to be started on the transmitting channel so that the peaks of speech before the gain control devices 5 and 6 are above the peaks of the weakest talker and the energy peaks beyond the gain control devices are below the lower limiting value. Under such circumstances, the gas-filled tube 50 in the gain increaser circuit 46 is triggered off for completing a circuit through the operating winding 56 of the relay 51. The condenser 63 in the hangover circuit is discharged, the relay 51 is operated and the armature 60 is moved into engagement with the contact member 61. The engagement between the armature 60 and the contact member 61 serves to complete a discharge circuit for the control condenser 24 through the resistance element 102 and a resistance element 105. The circuit of the control condenser 24 for impressing potential on the grids of the gain control device 5 may be traced from the grid of the space discharge device 9 through portion of the secondary winding of the transformer 11, battery 22, condenser 24 and ground to the filament of the space discharge device 9. Similar circuits may be traced for the discharge devices 10, 15 and 16. The condenser 24 is also connected to control the potential on the grids of the space discharge devices 32 and 33 in the receiving channel.

The circuit completed by the relay 51 extends from one terminal of the control condenser 24 through the armature 60 of the relay 51, contact member 61, resistance elements 102 and 105, contact member 80, armature 79 of the relay 67 and ground returning to the other terminal of the condenser 24. It is thus apparent the resistance elements 102 and 105 are connected across the condenser 24 for effecting a discharge of the condenser. The discharge action on the condenser reduces the negative biasing potential on the grids of the gain control devices 5 and 6 in the transmitting channel to increase the gain which is effected. At the same time the potential impressed on the grids of the space discharge devices 32 and 33 comprising the gain control device in the receiving channel is reduced to reduce the gain effected in the receiving channel. It may be noted that the resistance element 43 connected across the gain control device in the receiving channel serves to limit the control of the gain in the receiving channel, so that a certain gain in the transmitting channel is not accompanied by an equal equivalent loss in the receiving channel.

When the space current for the space discharge devices 15 and 16 comprising the gain control device 6 is raised to a predetermined point, the relay 27 is operated to exclude the resistance element 102 from the discharge circuit of the condenser 24. The relay 27 is provided in order to effect a more uniform gain of energy in the transmitting channel. If the relay 27 were not provided, the gain in the transmitting channel would be very rapid at the beginning of the discharge of the condenser 24 and then become relatively slow. The excluding of the resistance element 102 from the discharge circuit

for the control condenser 24 serves to increase the rate at which the discharge of the condenser takes place and the gain of energy upon the transmitting channel.

When the gain in the transmitting channel is raised so that the peaks of speech beyond the gain control devices 5 and 6 are above the lower limiting value, then the gas-filled tube 66 in the gain increase disabler circuit is operated or triggered off. The operation of the gas-filled tube 66 effects the operation of the relay 67. The relay 67 moves the armature 79 from engagement with the contact member 80 into engagement with the contact member 81. This breaks the discharge circuit for the condenser 24 and prevents further increase in the gain on the transmitting channel. When the armature 79 of the relay 67 engages the contact member 81, the condenser 88 effectively shunts a portion of the impedance in the input circuit of the amplifier 65 to increase the sensitivity of the gain increase disabler circuit. When the gas-filled tube 66 and the gain increase disabler circuit cease to operate by reason of the peaks of speech beyond the gain control device in the transmitting channel falling below the lower limiting value, the relay 67 is held operated for a limited period by reason of the hangover action produced by the condenser 82*a* and the resistance element 83.

If the peaks of speech on the transmitting channel beyond the gain control devices 5 and 6 and the amplifier 8 rise above the upper limiting value, then the negative potential impressed on the grids of the detector tubes 86 and 87 in the gain decreaser circuit is overcome to permit current flow through the detector tubes and charging of the control condenser 24. The charge on the condenser 24 serves to impress negative biasing potential on the gain control devices 5 and 6 in the transmitting channel and the gain control device 31 in the receiving channel. The operation of the control condenser in governing the gain on the transmitting and receiving channels is the same as the control disclosed in the above mentioned patent to John L. Hogg and Stephen Doba, Jr.

In case the receiving channel is in operation and the transmitting channel is idle, it is desirable to have the charge held on the condenser 24 and to permit no change in the setting of the gain control devices in the transmitting channel. The echo suppressor circuits 107 serves to effect energization of the winding 94 of the relay 77 whenever the receiving channel is in use. Thus the armature 108 of the relay 77 is moved from engagement with the contact member 109 into engagement with the contact member 110 whenever the receiving channel is in use. Such movement of the armature 108 serves first to break the circuit of the biasing batteries 76 and 75 for controlling the potential impressed on the grid of the gas-filled tube 66 in the gain increase disabler circuit 47. The gas-filled tube 66 is operated to effect operation of the relay 67. The relay 67 opens the discharge circuit for the control condenser 24 and prevents any discharge of the condenser 24. The engagement of the armature 108 of the relay 77 with the contact member 110 serves to short-circuit one-half the secondary winding of the transformer 90 connected to the detector tubes 86 and 87 in the gain decreaser circuit 48. This serves to prevent any operation of the detector tubes 86 and 87 and accordingly to prevent any increase in the charge on the condenser 24 when the receiving channel is in use.

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 a signal system, a transmission line, a gain control device connected to the line for controlling the volume of the transmitted signals, means comprising a gas-filled space discharge device having an anode and a cathode and which suddenly becomes operative when the energy level on the line before said gain control device exceeds the peaks of the weakest talkers, control means quickly operated by said gas-filled space discharge device for increasing the gain by the gain control device, and means in the anode circuit of gas-filled device for effecting a predetermined hangover in the operation of said control means by said gas-filled device.

2. In a signal system, a transmission line, a gain control device connected to the line for controlling the volume of the transmitted signals, gain increasing means comprising a gas-filled space discharge device controlled according to the volume on the line before the gain control device and a relay controlled by said gas-filled space discharge device for increasing the gain by the gain control device, a condenser and a resistance element connected across the output circuit of said gas-filled device for effecting a hangover in the operation of said relay, gain preventing means comprising a gas-filled space discharge device controlled according to the volume on the line beyond the gain control device and a relay controlled by said last mentioned gas-filled device for preventing increase in the gain above a predetermined level by the gain control device and a condenser and a resistance element connected to the output circuit of the gas-filled device in the gain preventing means for effecting a hangover in the operation of the last mentioned relay.

3. In a signal system, a transmission line, a gain control device connected to the line for controlling the volume of the transmitted signals, means comprising a marginal device controlled according to the energy level on the line before the gain device, control means quickly operated by said marginal means for controlling the gain device when the energy level on the line exceeds the peaks of the weakest talkers to increase the gain effected thereby, and means comprising a condenser and a resistance element in circuit with said marginal device to produce a hangover in the operation effected thereby.

4. In a signal system, a transmission line, a gain control device connected to the line for controlling the volume of the transmitted signals, gain increasing means comprising a gas-filled space discharge device controlled according to the energy level on the line before the gain device and a relay controlled by the gas-filled device for controlling the gain device to increase the gain effected thereby, a condenser and a resistance element in series across the output circuit of said gas-filled device for effecting a hangover in the operation of said relay, gain preventing means comprising a gas-filled space discharge device controlled according to the energy volume on the line beyond the gain device and a relay for preventing increase in the gain by the gain device above a predetermined level and a condenser and a resistance element in series across the output circuit of the gas-filled device in the gain pre-

venting means for effecting a hangover in the operation of the relay in the gain preventing means.

5. In a signal system, a transmission line, a gain control device connected to the line for controlling the volume of signals transmitted over the line, gain increasing means comprising a gas-filled space discharge device controlled according to the volume on the line before the gain control device and a relay quickly operated by said gas-filled space discharge device when the energy level on the line exceeds the peaks of the weakest talkers for increasing the gain by the gain control device, a condenser and a resistance element connected across the output circuit of said gas-filled device for effecting a hangover in the operation of said relay, gain preventing means comprising a gas-filled space discharge device controlled according to the volume on the line beyond the gain control device and a relay for preventing increase in the gain above a predetermined level by the gain control device, a condenser and a resistance element connected across the output circuit of said last mentioned gas-filled device for effecting a hangover in the operation of the last mentioned relay, and means controlled according to the volume on the line beyond the gain control device for controlling the gain control device to lower the gain effected thereby.

6. In a signal system, a transmission line, a vacuum tube gain control device connected to the line for controlling the volume of the transmitted signals, means for impressing a negative potential on the grid of said gain control device according to the energy volume on the line beyond the gain control device, gain increasing means comprising a gas-filled space discharge device controlled according to the energy volume on the line before the gain control device and a relay quickly operated by the gas-filled tube for increasing the gain by said gain control device if the energy level on the line before the gain device exceeds the peaks of the weakest talkers and the energy level on the line beyond the gain device is below a predetermined level, and means comprising a condenser and a resistance in the output circuit of said gas-filled tube for effecting a hangover in the operation of said relay by the gas-filled tube.

7. In a signal system, a transmission line, a vacuum tube gain control device connected in series with the line for controlling the volume of the transmitted signals, means comprising a condenser for impressing a negative potential on the grid of the gain device to limit the gain, a resistance element, gain increasing means controlled according to the energy volume on the line before said gain device for completing a circuit through said resistance element to discharge said condenser to increase the gain of the gain device, and means controlled according to the space current of the gain device for varying the value of said resistance element in circuit with the condenser to control the rate of gain by the gain device.

8. In a transmission system, transmitting and receiving channels, a gain control device connected to said transmitting channel, control means for governing said gain control device to increase the energy volume of signals on the line to a predetermined level, gain preventing means operated from the transmitting channel when the energy is above a predetermined level for preventing increase in the energy of the signals by said control means, gain decreasing means for controlling the gain control device to lower the gain effected thereby, and means automatically operated when the receiving channel is in use for operating said gain preventing means and for preventing operation of the gain decreasing means.

9. In a transmission system, transmitting and receiving channels, a variable gain control device connected to said transmitting channel, gain increasing means for governing the gain control device to effect increase in the gain thereby, gain preventing means operated when the energy beyond the device is above a predetermined level for preventing operation of said gain increasing means to increase the gain, gain decreasing means for controlling the gain control device to lower the gain, and means controlled from the receiving channel when the receiving channel is in use for disabling the gain decreasing means and for operating the gain preventing means.

10. In a transmission system, transmitting and receiving channels, a three-element vacuum tube variable gain control device connected to said transmission channel, a condenser for controlling the grid potential on the gain control device to govern the gain effected thereby according to the charge on the condenser, gain increasing means for controlling the charge on said condenser to increase the gain by the gain control device, gain preventing means for preventing control of said condenser by the gain increasing means to increase the gain above a predetermined amount, gain decreasing means for controlling said condenser to lower the gain effected by the gain control device and means automatically operated when the receiving channel is in use for preventing operation of the gain decreasing means and for operating the gain preventing means.

11. In a transmission system, transmitting and receiving channels, two three-element vacuum tubes connected in series with said transmitting channel for controlling the gain therein, two three-element vacuum tubes connected across the receiving channel for controlling the gain therein, a condenser for controlling the grid potential on the gain control tubes connected to the transmitting and receiving channels, gain control means governed by the energy volume on the transmitting channel for controlling the charge on said condenser to increase the gain on the transmitting channel and decrease the gain on the receiving channel, gain preventing means governed by the energy volume on the transmitting channel for preventing control of said condenser by the gain control means, gain decreasing means operated when the energy peaks on the transmitting channel are above a predetermined level for controlling said condenser to lower the gain on the transmitting channel and increase the gain on the receiving channel, and means automatically operated when the receiving channel is in use for preventing operation of said gain decreasing means and for operating the gain preventing means.

12. In a signal system, a transmission line, a gain control device connected to the line for controlling the energy volume of the transmitted signals, control means governed according to the energy volume on said line for controlling said gain control device to increase the gain on the line, and means automatically governed by the operation of the gain control device for controlling the rate of gain effected by the gain control device under control of the control means.

13. In a signal system, a transmission line, a vacuum tube gain control device connected ef-

fectively in series with the line for controlling the energy volume of the transmitted signals, control means governed according to the energy volume on said line for controlling said gain control device to increase the energy gain on the line, and means automatically operated according to the space current of said gain control device for governing the rate of gain effected by the gain control device under control of the control means.

14. In a signal system, a transmission line, a gain control device connected to the line for controlling the volume of the transmitted signals, gain increasing means governed according to the energy level on the line before said gain control device for increasing the gain by the gain control device, and means automatically governed by the operation of said gain control device for controlling the rate of gain effected by the gain control device under control of the gain increasing means.

15. In a signal system, a transmission line, a three-element vacuum tube variable gain control device connected effectively in series with the line for controlling the volume of the transmitted signals, means for impressing potential on the grid of said gain control device according to the energy volume on the line beyond the gain device to limit the gain, gain increasing means comprising a gas-filled space discharge device and a relay controlled according to the energy volume on the line before the gain device for lowering the potential impressed on the grid of the gain device to increase the gain, and means controlled according to the space current of said gain device for governing the rate of gain effected by the gain device under control of the gain increasing means.

16. In a signal system, a transmission line, a three-element vacuum tube gain control device connected to the line for controlling the volume of the transmitted signals, means for impressing a potential on the grid of said gain control device according to the energy volume on the line beyond the gain control device to limit the gain, gain increasing means comprising a gas-filled space discharge device controlled according to the energy volume on the line before the gain control device and a relay controlled by the gas-filled tube for increasing the gain by said gain control device if the energy level on the line before the gain device exceeds the peaks of the weakest talkers and the energy level on the line beyond the gain device is below a predetermined level, means in the output circuit of said gas-filled tube for effecting a hangover in the operation of said relay by the gas-filled tube, and means for controlling the rate of gain by the gain control device under control of the gain increasing means.

17. In a transmission system, transmitting and receiving channels, a gain control device connected in series with the transmitting channel, a gain control device connected across the receiving channel, control means for jointly controlling said gain control devices according to the energy volume on the transmitting channel, and means for limiting the gain in the receiving channel by the gain control device connected thereto to effect changes in gain by different amounts by the two gain control devices under control of said control means when a strong talker is on the transmitting channel.

18. In a transmission system, transmitting and receiving channels, a three-element vacuum tube gain control device connected in series with the transmitting channel, a three-element vacuum tube gain control device connected across the receiving channel, a resistance element shunted across the gain control device connected across the receiving channel for limiting the gain by said device to effect operation of the two gain control devices by different amounts, and means for simultaneously controlling the grid potentials of said devices in accordance with the energy volume present at a point on one of said channels.

19. In a signal system, a transmission line, a gain control device connected to the line for controlling the volume of the signals, a condenser, means for controlling said device according to the charge on the condenser, control means governed according to the energy volume of said line for controlling the charge on said condenser to increase the gain on the line, and means for automatically varying the rate of charge on said condenser according to the operation of said device.

STEPHEN DOBA, JR.