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CONTROL CIRCUITS

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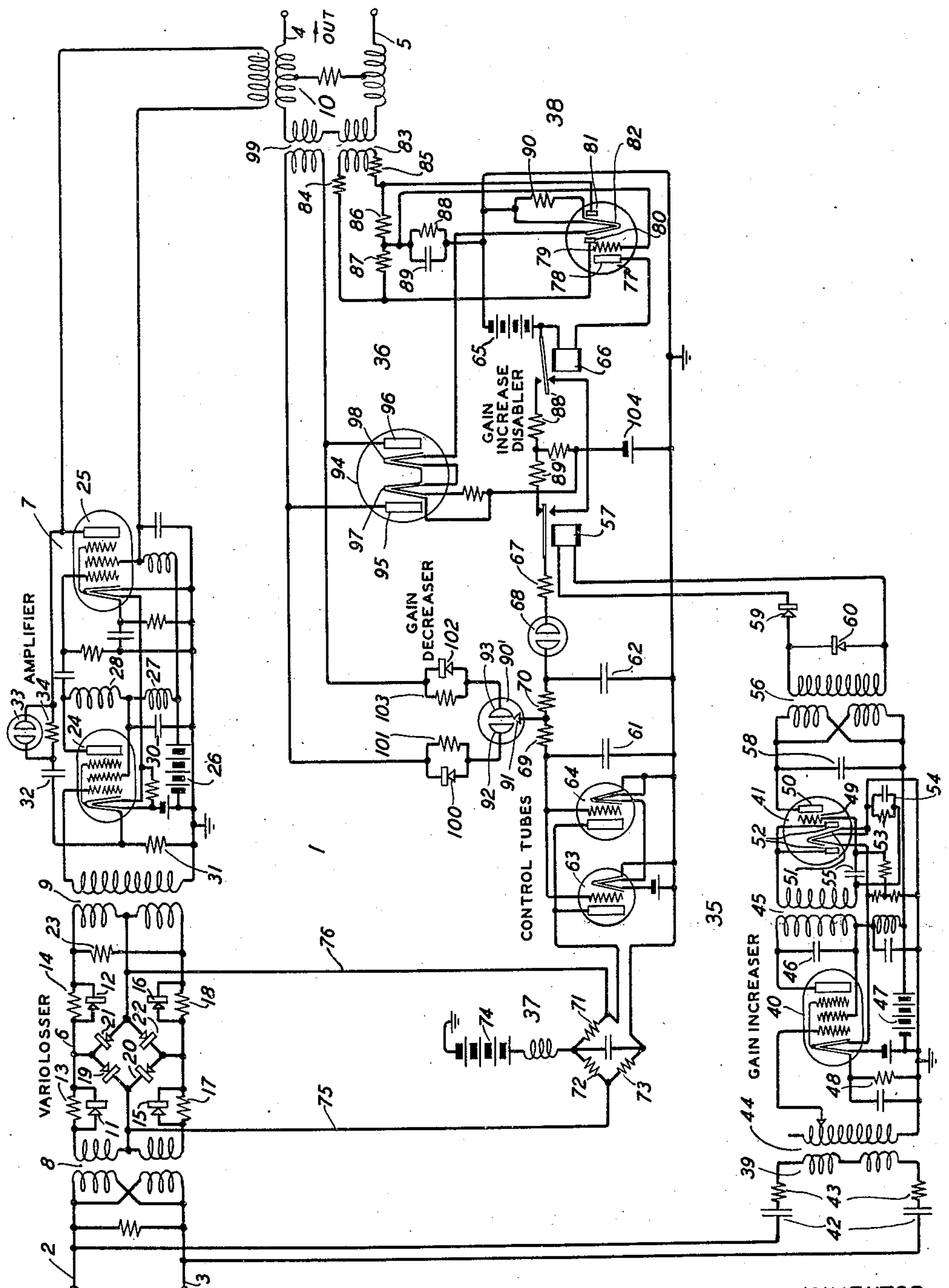

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CONTROL CIRCUITS

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This invention relates to signal systems and particularly to gain control circuits for controlling the volume on signal systems.

One object of the invention is to provide gain control circuits for a signal line that shall have a forward acting gain increaser circuit for effecting a fast increase in gain and a backward acting gain increase disabler circuit for disabling the fast gain increaser circuit when the signals are above a predetermined level and for establishing a slow gain increaser circuit.

Another object of the invention is to provide a signal system having a variolosser and a negative feedback amplifier in the signal line, a forward acting gain increaser circuit and a backward acting gain decreaser circuit for governing the variolosser to control the signals on the signal line and a gain increase disabler circuit for disabling the gain increaser circuit that shall control the feedback circuit of the amplifier to prevent transient disturbances when strong signals are suddenly applied to the system.

A further object of the invention is to provide a signal system having a variolosser in the signal line, a gain increaser circuit and a gain increase disabler circuit for disabling the gain increaser circuit that shall control the variolosser by a gain decreaser circuit under control of both positive and negative halves of the signal waves.

On long signal circuits and particularly on circuits having a radio link, trouble is often experienced at a receiving station by reason of the so-called fading produced during the transmission. It is desirable in signal circuits of the above-indicated character to correct for the fading and to hold the received signals at substantially constant volume. Furthermore, in a radio system having a radio transmitter connected to a telephone system it is desirable to have the telephone currents supplied to the radio transmitter at constant volume in order to prevent overloading the apparatus in the radio transmitter. In a radio transmitter, it is simpler to effect amplification and override the noise level encountered in a radio system when constant volume signals are supplied to the transmitter.

In a telephone system, voice currents controlled by different types of talkers are transmitted. In one extreme case may be the very loud talker and in the other extreme case may be the very weak talker. The volume range including a very loud talker and a very weak talker may be such as to cause overloading of the apparatus in a radio transmitter when the adjustments are such as to cause the weak talker to be properly transmitted. In order to prevent overloading the apparatus in the radio transmitter, the signal currents produced by the weak talker and the loud talker are controlled by voice-operated circuits so that constant volume is supplied to the radio transmitter.

In the circuits employed to describe the invention, a variolosser and a negative feedback amplifier are included in a signal line. The variolosser in the form of a varistor comprises copper oxide elements disposed in series and in shunt to the signal line for controlling the gain. The variolosser is controlled by a forward acting gain increaser circuit, a backward acting gain decreaser circuit and a relatively slow backward acting gain increaser circuit. The amplifier is of the negative feedback type and is provided with a resistance element shunted by a cold cathode tube in the negative feedback circuit for increasing the feedback substantially instantaneously when strong inputs are suddenly applied to prevent any undesirable overloading characteristics.

The gain increaser circuit which is connected to the signal line before the varistor is of the syllabic type. The signal impulses received from the signal line pass through broadly tuned frequency selective networks and are then amplified. The amplified signal impulses then pass through another frequency selective network which selects frequencies of the order of 1000 cycles. These signal currents are then applied to a diode-triode tube. The signals detected by the diode results in low frequency impulses which are amplified by the triode and supplied to a syllabic frequency filter. The output from the low frequency syllabic filter has copper oxide elements connected in series and shunt thereto in order to insure that control by the gain increaser circuit is only effected on the rising portion of the syllabic impulses. The syllabic impulses govern a gain increaser relay which completes a circuit for charging a relatively large condenser and a relatively small condenser. The two control condensers govern the bias on two control tubes forming one arm of a Wheatstone bridge. The output vertices from the bridge are connected to a network of varistors in the signal line.

A backward acting gain increase disabler circuit is provided which not only disables the fast gain increaser circuit when the signals from the transmission line have reached a predetermined level but also establishes a slow gain increaser circuit when the gain increaser relay is in the released position.

A backward acting gain decreaser circuit is provided for governing the varistor according to both halves of the signal waves. The gain decreaser circuit charges the control condensers in an opposite direction to the charging effected by the gain increaser circuits. The control condensers govern the control tubes in the Wheatstone bridge circuit to control the varistor in the signal line. A cold cathode tube having two cathodes and one anode is included in the gain decreaser circuit. Copper oxide elements shunted by resistance elements are connected to the cold cathodes in order to provide a low resistance path in the direction of the wanted current flow. A full-wave rectifier controlled by the signal wave supplied to the gain decreaser circuit is connected to the anode of the cold cathode tube to insure that control current passes through the cold cathode tube in one direction only. Inasmuch as the gain decreaser circuit is operated by the full signal waves, it can decrease gain somewhat faster without introducing any more new products in the transmission path due to unbalances in the varistor. Also since it is full wave control, low frequency transient disturbances accompanying gain decrease action do not cause such wide variations of rate of gain decrease depending on the polarity of input to the gain decreaser. Moreover, full-wave operation of the gain decreaser circuit reduces the spread of output volumes by minimizing the effect of the dissymmetry of speech waves from some carbon transmitters and permits faster gain decrease when required.

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 gain control arrangement 1 is shown connected to a signal line having input conductors 2 and 3 and output conductors 4 and 5. A variolosser 6 and a negative feedback amplifier 7 are connected in the signal line for controlling the variable volume received signals to supply constant volume output signals to the output conductors 4 and 5. The input conductors 2 and 3 are connected to the variolosser by means of a transformer 8 and the variolosser is connected to the amplifier 7 by a transformer 9. The negative feedback amplifier 7 is connected to the output conductors 4 and 5 by means of a hybrid coil 10.

The variolosser comprises two copper oxide elements 11 and 12 in series with one side of the signal line and respectively shunted by resistance elements 13 and 14. Two copper oxide elements 15 and 16 are connected in series with the other side of the line and are shunted respectively by resistance elements 17 and 18. Four copper oxide elements 19, 20, 21 and 22 are provided for establishing shunt circuits across the signal line to lower the gain. A resistance element 23 is shunted across the primary winding of the transformer 9 to lower the impedance across the transformer. Direct current circuits are completed through the copper oxide elements in series and in shunt with the signal line for varying the gain effected in a manner to be hereinafter described.

The amplifier 7 comprises two pentode tubes 24 and 25. The input circuit of the tube 24 is connected to the secondary winding of the transformer 9. A battery 26 is provided for supplying anode potential to the tubes 24 and 25. The circuit from the battery 26 to the plate of tube 24 includes two retard coils 27 and 28. The retard coil 27 with a condenser 30 serve as a plate filter and retard coil 28 is employed to couple the tube 24 with the tube 25. A resistance 31 in the cathode circuit is provided for supplying bias to the control grid of the tube 24. A negative feedback circuit is provided from the anode of the tube 25 to the cathode of the tube 24 which comprises a condenser 32 and a resistance element 34 shunted by a cold cathode tube 33. The cold cathode tube 33 breaks down instantaneously when the signals reach a predetermined level to instantaneously increase the feedback. This decrease of the gain of the amplifier takes place instantaneously and prevents transient disturbances in the amplifier output. In brief, this feedback arrangement provides a peak-chopping action and prevents the signals from causing grid current flow in the amplifier tube 25.

A gain increaser circuit 35 and a gain decreaser circuit 36 are provided for governing a bridge circuit 37 to govern the gain by the variolosser 6 so as to maintain substantially constant volume on the output conductors 4 and 5. A gain increaser disabler circuit 38 is provided for disabling the gain increaser circuit 35 when the signals are raised to a predetermined level and for establishing a slow gain increaser circuit.

The gain increaser circuit 35 comprises a filter 39, a pentode amplifier tube 40, and a diode-triode tube 41. The filter 39 which comprises two condensers 42, two resistance elements 43 and the primary of a transformer 44 is connected to the input conductors 2 and 3 ahead of the variolosser 6. The filter 39 is connected to the input circuit of the amplifier tube by the transformer 44. The output circuit of the amplifier 40 is connected by a transformer 45 to the diodes of the diode-triode 41. A condenser 46 shunted across the primary winding of the transformer 45 provides a broadly tuned frequency selective network with a peak at approximately 1000 cycles. A battery 47 is provided for supplying anode potential to the tube 40 and a resistance element 48 in the cathode circuit is provided for supplying grid bias to the tube 40.

The diode-triode 41 comprises a control grid 49, an anode 50, a cathode 51 and auxiliary anodes 52. The circuit through the diode of the diode-triode 41 may be traced from one terminal of the secondary winding of the transformer 45, through the auxiliary anodes 52, cathode 51, resistance 53 shunted by condenser 54 to the other terminal of the secondary winding of the transformer 45. Variations in the potential drop across the resistance 53 shunted by the condenser 54 are impressed on the control grid 49 through a condenser 55. A transformer 56 connects the output from the triode of the diode-triode 41 to the operating coil of a gain increaser relay 57. A filter comprising a condenser 58 and the primary winding of the transformer 56 is provided in the output of the triode of the diode-triode to select impulses of syllabic frequency. Preferably the filter is tuned to approximately 5 cycles. A copper oxide element 59 is connected in series with the secondary winding of the transformer 56 and a copper oxide element 60 is connected in shunt to the secondary winding of the transformer 56 in order to restrict operation of the gain increaser circuit 35 to initial rising portions of the signal waves.

The gain increaser relay 57 when operated completes a circuit for charging control condensers 61 and 62 in a direction to decrease the negative bias on the grids of two control tubes 63 and 64. The charging circuit completed by the gain increaser relay 57 when operated may be traced from a battery 65 through the armature of a gain increase disabler relay 66, front contact of the relay 66, front contact of the relay 57, armature of the relay 57, resistance element 67, cold cathode tube 68 and condenser 62 shunted by the resistance elements 69 and 70 and condenser 61 to the other terminal of the battery 65. The control condenser 61 is relatively small compared to the size of the control condenser 62. The condenser 61 may be of the order of three-tenths of a microfarad whereas the condenser 62 may be four microfarads.

The plate circuits of control tubes 63 and 64 form one arm of the Wheatstone bridge circuit 37. The other arms of the bridge circuit comprise resistance elements 71, 72 and 73. A grounded battery 74 is connected across two vertices of the bridge 37 and two conductors 75 and 76 connected to the other bridge vertices are joined to the variolosser 6 for controlling the operation thereof.

Assuming that voice signals on the signal line are of insufficient strength to operate the gain decreaser circuit 36 or the gain increase disabler circuit 38, then the gain increaser circuit 35 will be operated to effect operation of the gain increaser relay 57 according to the syllabic frequency of the voice currents. Operation of the gain increaser relay 57 completes a circuit for impressing a positive charge on the control condensers 61 and 62. The positive charge on the control condensers 61 and 62 changes the bias on the grids of the control tubes 63 and 64 to decrease the resistance of the control tubes in the bridge circuit 37. This operation of the bridge circuit impresses a positive potential on the conductor 75 and a negative potential on the conductor 76 to lower the resistance value of the series arms of the variolosser 6 in the signal circuit.

One circuit completed through the variolosser 6 from the bridge 37 may be traced from one terminal of the bridge through conductor 75, one secondary winding of transformer 8, copper oxide elements 11 and 12, respectively, shunted by the resistance elements 13 and 14, primary winding of the transformer 9 and conductor 76 to the other terminal of the bridge 37. A second circuit is completed from the bridge 37 through the conductor 75 the other secondary winding of the transformer 8, copper oxide elements 15 and 16, respectively, shunted by the resistance elements 17 and 18, second primary winding of the transformer 9 and the conductor 76 to the other terminal of the bridge 37. The circuits above traced include the series copper oxide elements 11, 12, 15 and 16 which have their resistance values reduced to increase the gain on the transmission line. The shunt copper oxide elements 19, 20, 21 and 22 are so poled as to oppose any current flow through them by the above-described operation of the bridge 37.

The gain increase disabler circuit 38 comprises a double diode-triode 77 having an anode 78, a control grid 79, auxiliary anodes 80 and 81 and a cathode 82. The diode is connected to the hybrid coil 10 in the signal circuit by means of a transformer 83. The secondary winding of the transformer 83 completes a circuit through resistance elements 86 and 87.

The double diode respectively completes circuits through the resistance elements 86 and 87. The circuit through one-half of the double diode may be traced from the auxiliary anode 80 through the resistance element 87, resistance element 88 shunted by condenser 89 and a resistance element 90 to the cathode 82. In like manner, a similar circuit is completed from the auxiliary anode 81 through the resistance element 86. The potential drop across the resistance element 90 serves to impress a bias on the control grid 79 when no signals are on the signal circuit. The resistance element 88 shunted by the condenser 89 serves to impress a bias on the control grid 79 according to the signals on the signal line. The output circuit for the triode of the double diode-triode 77 may be traced from the grounded battery 65 through the coil of the relay 66, anode 78, cathode 82 and resistance element 90 to the battery 65.

When there is no signal input on the signal line plate current flows through the triode of the double diode-triode 77 sufficiently strong to operate the relay 66. When signals are received, the negative bias impressed on the control grid 79 may be sufficient to release the gain increase disabler relay 66. The sensitivity of the gain increase disabler circuit and also the sensitivity or point of release of the gain increase disabler relay 66 is ordinarily set four to eight decibels greater than that of the gain decreaser circuit 36 to be described later. In other words, the gain increase disabler circuit 38 is operated when the signals on the signal circuit have reached a predetermined strength and prior to the operation of the gain decreaser circuit 36.

Upon release of the gain increase disabler relay 66 the connection of the battery 65 through the front contact of the relay 66 through the front contact of the gain increaser relay 57 is broken. No gain increase can take place when the gain increaser relay 57 is operated and the gain increase disabler relay 66 is in released position. A slow gain increaser circuit is completed from the battery 65 when the gain increase disabler relay 66 is in released position at the same time that the gain decreaser relay 57 is in released position.

The slow gain increaser circuit is completed when the two relays 57 and 66 are in released position and may be traced from the grounded battery 65 through the armature of the relay 66, back contact of the relay 66, resistance elements 88′ and 89′, back contact and armature of the relay 57, resistance element 67, cold cathode tube 68, condenser 62 shunted by resistance elements 69 and 70 and condenser 61 and ground return to the battery 65. By reason of the resistance elements 88′ and 89′ included in this circuit, it is apparent that the gain increase will be effected slowly. The gain increase disabler relay 66 has a hang-over time of about two-tenths of a second so that it is held in released position nearly continuously by connected speech syllables. A slow gain increase is effected during talk spurts except when the gain increaser relay 57 is operated and upon operation of the gain decreaser circuit 36 on occasional strong peaks. The gain increaser relay has been made to stop the slow gain increase operation in order to tend to equalize the output volumes at low input volumes as compared with high input volumes. At low input volumes the gain increaser relay 57 is not operated as frequently or for as long a period as at high input volumes. Thus, the slow gain increaser action operates more of the time on low input volumes when the output speech volume is near the proper value.

The gain decreaser circuit 36 comprises a three-element cold cathode tube 90' having an anode 91 and two cathodes 92 and 93 and a full-wave rectifier tube 94 having anodes 95 and 96 and cathodes 97 and 98. The cold cathode tube 90 and the rectifier tube 94 are both connected to the secondary winding of a transformer 99 which in turn is connected to the hybrid coil 10. The cold cathode tube 90' is ignited by circuits completed through the cold cathodes 92 and 93 by each half-wave signal when of sufficient strength. The ignition circuit for the cold cathode tube 90' may be traced from the cathode 92 through copper oxide element 100 shunted by resistance element 101, secondary winding over the transformer 99, and copper oxide element 102 shunted by resistance element 103 to the cold cathode 93. The copper oxide elements 100 and 102 are poled in a direction to provide a low resistance in the direction of the wanted current flow and thus speed up gain decrease action when a large gain decrease is required.

The operating circuit for the tube 90' which is completed through the anode 91 of the cold cathode tube 90' may be traced from the anode 91, through resistance elements 69 and 70 and condensers 61 and 62 in parallel to ground, grounded battery 104, cathode 97 or 98 and anode 95 or 96 of the rectifier 94 according to which polarity of the signal wave is impressed on the circuit. The two anodes 95 and 96 of the rectifier 94 are connected to opposite terminals of the secondary winding of the transformer 99. The rectifier 94 is a full-wave rectifier and insures that current flow through the cold cathode tube 90' can take place only in one direction. Consequently, the condensers 61 and 62 cannot be charged in a direction to effect an increase in gain in place of a decrease in gain. The copper oxide elements 100 and 102 are also poled in a direction to help insure that the operating circuit of cold cathode tube 90' can only have current flow therethrough in one direction.

Assuming the operation of the gain decreaser circuit 36 is as above described, then a negative charge will be impressed on the control condensers 61 and 62. The control condensers 61 and 62 are of different sizes and operate in the same manner as the control condensers disclosed in the patent to A. M. Curtis, 2,143,056, June 10, 1939. The negative charge on the condensers 61 and 62 places a bias on the control grids of the control tubes 63 and 64 to increase the resistance value of the control tubes in the bridge circuit 37. The bridge circuit is then operated to place a positive potential on the conductor 76 and a negative potential on the conductor 75. When the bridge circuit 37 is so operated direct current circuits are completed through the variolosser 6 to increase the resistance values of the copper oxide elements 11, 12, 15 and 16 and to decrease the resistance values of the shunted copper oxide elements 19, 20, 21, and 22. One circuit through the variolosser may be traced from the conductor 76, through the copper oxide element 21 and the copper oxide element 19 to the conductor 75. A similar circuit may be traced from the conductor 76, through the copper oxide elements 22 and 20 to the conductor 75. The series copper oxide elements 11, 12, 15 and 16 are positioned to oppose any current flow through them at this time. Thus, the resistance values of the shunted copper oxide elements are reduced and no reduction takes place in the values of the series copper oxide elements so that the variolosser is operated in a manner to decrease the gain on the signal line.

In the gain control circuits above described, one forward acting gain increaser circuit 35 which is relatively fast in operation controls the variolosser to effect a quick gain increase. The gain increaser circuit 35 is disabled by the gain increase disabler circuit 38 when the signals on the signal circuit have been raised to a predetermined level. The gain increase disabler circuit 38 also establishes a slow gain increaser circuit which operates when the gain increase relay is in released position. The gain decreaser circuit 36 which is less sensitive than the gain increase disabler circuit is operated by each half signal wave when the signal waves are above a predetermined level. In the case of very strong inputs being suddenly applied to the gain control circuit, it is not desirable to have the gain decreaser to take care of such strong inputs by reason of the fact that there is a delay in the operation of the gain decreaser circuit with the possibility of a few cycles overloading the amplifier tube. In order to take care of strong input signals suddenly applied to the control circuit, the negative feedback circuit for the amplifier 7 is provided with a cold cathode tube 33 which increases the feedback current instantaneously when strong input signals are suddenly applied to the gain control circuit.

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

What is claimed is:

1. In gain adjusting circuits, a variolosser for controlling the gain on a signal circuit, means comprising a forward acting fast gain increasing circuit for governing said variolosser under control of syllabic impulses to raise the gain on the signal circuit at a relatively fast rate, a backward acting gain increase disabler circuit for preventing control of said variolosser by the fast gain increaser circuit when the signals on the signal circuit beyond the variolosser are above a predetermined value, and means controlled by the gain increase disabler circuit for controlling said variolosser to effect a relatively slow gain increase on the signal line.

2. In gain control circuits, a gain adjusting device for controlling the gain on a signal circuit, means comprising a forward acting fast gain increaser circuit for governing said device to raise the gain on the signal circuit at a relatively fast rate, means controlled by signals on the signal circuit beyond said device for controlling said device to effect a relatively slow gain increase and means comprising a backward acting gain increase disabler circuit for preventing control of said device by the fast gain increaser circuit when the signals on the signal circuit beyond said device are above a predetermined level.

3. In gain control circuits, a gain adjusting device for controlling the gain on a signal circuit, means comprising a forward acting fast gain increaser circuit for governing said device to raise the gain on the signal circuit, a backward acting gain increase disabler circuit for preventing control of said device by the fast gain increaser circuit when the signals on the signal circuit beyond the device are above a predetermined value, and means for controlling said device to effect a slow gain increase when the gain increase disabler circuit is in operation and the fast gain increaser circuit is not operated.

4. In gain control circuits, a gain adjusting device for controlling the gain on a signal circuit, means comprising a forward acting fast gain increasing circuit for governing said device to raise relatively fast the gain on the signal circuit, means comprising a backward acting gain decreaser circuit for controlling said device to decrease the gain on the signal circuit when the signals on the circuit beyond said device are above a predetermined value, a backward acting gain increase disabler circuit having a greater sensitivity than the gain decreaser circuit for preventing control of said device by the fast gain increaser circuit and means for controlling said device to effect a slow gain increase when the gain increase disabler circuit is in operation and the fast gain increaser circuit is not operated.

5. In gain control circuits, a gain adjusting device for controlling the gain on a signal circuit, means comprising a forward acting fast gain increasing circuit for governing said device under control of syllabic impulses to raise the gain on the signal circuit, means for insuring control of said device only on the rising portion of a syllabic impulse, means comprising a backward acting gain decreaser circuit for controlling said device to decrease the gain on the signal circuit when the signals on the circuit beyond said device are above a predetermined value, a backward acting gain increase disabler circuit having a greater sensitivity than the gain decreaser circuit for preventing control of said device by the fast gain increaser circuit and means for controlling said device to effect a slow gain increase when the gain increase disabler circuit is in operation and the fast gain increaser circuit is not operated.

6. In gain control circuits, a gain adjusting device for controlling the gain on a signal line, gain increaser means for controlling said device to raise the gain of the signals on the signal circuit, gain increase disabler means for disabling said gain increaser means when the signals on the signal circuit are above a predetermined value and means comprising a backward acting gain decreaser circuit operated by each half of the signal waves when the signals are above a predetermined level for governing said device to decrease the gain on the signal circuit.

7. In gain control circuits, a gain adjusting device for controlling the gain on a signal line, gain increaser means for controlling said device to raise the gain of the signals on the signal circuit, gain increase disabler means for disabling said gain increaser means when the signals on the signal line are above a predetermined value, means comprising a backward acting gain decreaser circuit having a three-element cold cathode tube ignited across two electrodes by each half signal wave when above a predetermined value for completing an operating circuit through the third electrode of the tube to control the device and reduce the gain and means comprising a full wave rectifier in the operating circuit of said tube for preventing reverse current flow therethrough.

8. In gain control circuits, a gain adjusting device for controlling the gain on a signal circuit, gain increaser means for controlling said device to raise the gain of the signals on the signal circuit, gain increase disabler means for disabling said gain increaser means when the signals on the signal circuit are above a predetermined value, means comprising a backward acting gain decreaser circuit having a three-element cold cathode tube therein operated by each half of the signal waves when the signals are above a predetermined level for governing said device to decrease the gain on the signal circuit and means comprising a full wave rectifier in the operating circuit of said tube to prevent reverse current flow through the tube operating circuit.

9. In gain control circuits, a gain adjusting device for controlling the gain on a signal circuit, means comprising a forward acting gain increaser circuit for governing said device to increase the gain on the signal circuit, means comprising a backward acting gain increase disabler circuit for disabling said gain increaser circuit when the signals on the line beyond said device are raised to a predetermined level, means comprising a backward acting gain decreaser circuit for governing said device to decrease the gain on the signal circuit, a three-element cold cathode tube in said decreaser circuit having two cold cathodes and an anode, said tube being ignited across said cathodes by each half wave impressed on the gain decreaser circuit when the signals are above a predetermined value, and full wave rectifier means in circuit with the anode of said tube and having the signal waves in the gain decreaser circuit impressed thereon for insuring operation of said tube in a direction to control said device and reduce the gain.

10. In gain control circuits, a gain adjusting device for controlling the gain on a signal circuit, gain increaser means for controlling said device to raise the gain of the signals on the signal circuit, gain increase disabler means for disabling said gain increaser means when the signals on the signal line are above a predetermined value, means comprising a backward acting gain decreaser circuit for governing said device to decrease the gain on the signal circuit, a cold cathode tube in said decreaser circuit having two cathodes and an anode, said cathodes having each half wave of signal current on the decreaser circuit impressed thereon to ignite the tube across the cathodes, rectifier elements shunted by resistance elements connected to each of said cathodes in the ignition circuit with the rectifier elements poled to assist in igniting the tube and to oppose reverse current flow through the tube anode and full wave rectifier means in series with the tube anode circuit and having signal waves on the decreaser circuit impressed thereon for insuring completion of the anode circuit through said tube in a direction to control said device and reduce the gain.

11. In combination a transmission line having a varistor followed by a negative feedback amplifier, a resistance element shunted by a gas-filled tube connected in series in the negative feedback circuit, said tube igniting when relatively strong input signals are suddenly applied to the amplifier to prevent the peak load on the amplifier from overloading it, means comprising a gain increaser circuit connected to the transmission line ahead of said varistor for governing the varistor to increase the gain, means comprising a gain decreaser circuit connected to the transmission line beyond said amplifier for governing said varistor to decrease the gain on the transmission line when the signals rise above a predetermined level and means comprising a gain increase disabler circuit connected to the transmission line beyond said amplifier for disabling said gain increaser circuit, said gain increase dis-

abler circuit having a higher sensitivity than said gain decreaser circuit.

12. In combination, a transmission line having a gain control device therein, a negative feedback amplifier connected in said line beyond said device, said amplifier having fast acting means in the feedback circuit thereof for limiting the signal peaks, means comprising a gain increaser circuit connected to the transmission line ahead of said device for governing said device to increase the gain on the transmission line, means comprising a gain decreaser circuit connected to the transmission line beyond said amplifier for governing said device to decrease the gain on the transmission line, said gain decreaser circuit being too slow acting to prevent overload of said amplifier by said signal peaks, and means comprising a gain increase disabler circuit connected to the transmission line beyond said amplifier for disabling said gain increaser circuit when the signals on the line beyond said amplifier reach a predetermined strength.

13. In combination, a transmission line having a gain control device therein, a negative feedback amplifier connected in said line beyond said device, a resistance element shunted by a gas-filled tube connected in series in the feedback circuit, said tube igniting when relatively strong input signals are suddenly applied to the amplifier to increase the feedback instantaneously and prevent the peak loads on the amplifier from overloading it, a forward acting gain increaser circuit for governing said device to increase the gain on the transmission line, means comprising a gain decreaser circuit connected to the transmission line beyond said amplifier and having a time delay for governing said device to decrease the gain on the transmission line and means comprising a backward acting gain increase disabler circuit for disabling said gain increaser circuit when the signals on the line beyond said amplifier go above a predetermined value.

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