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TRANSMISSION SYSTEM

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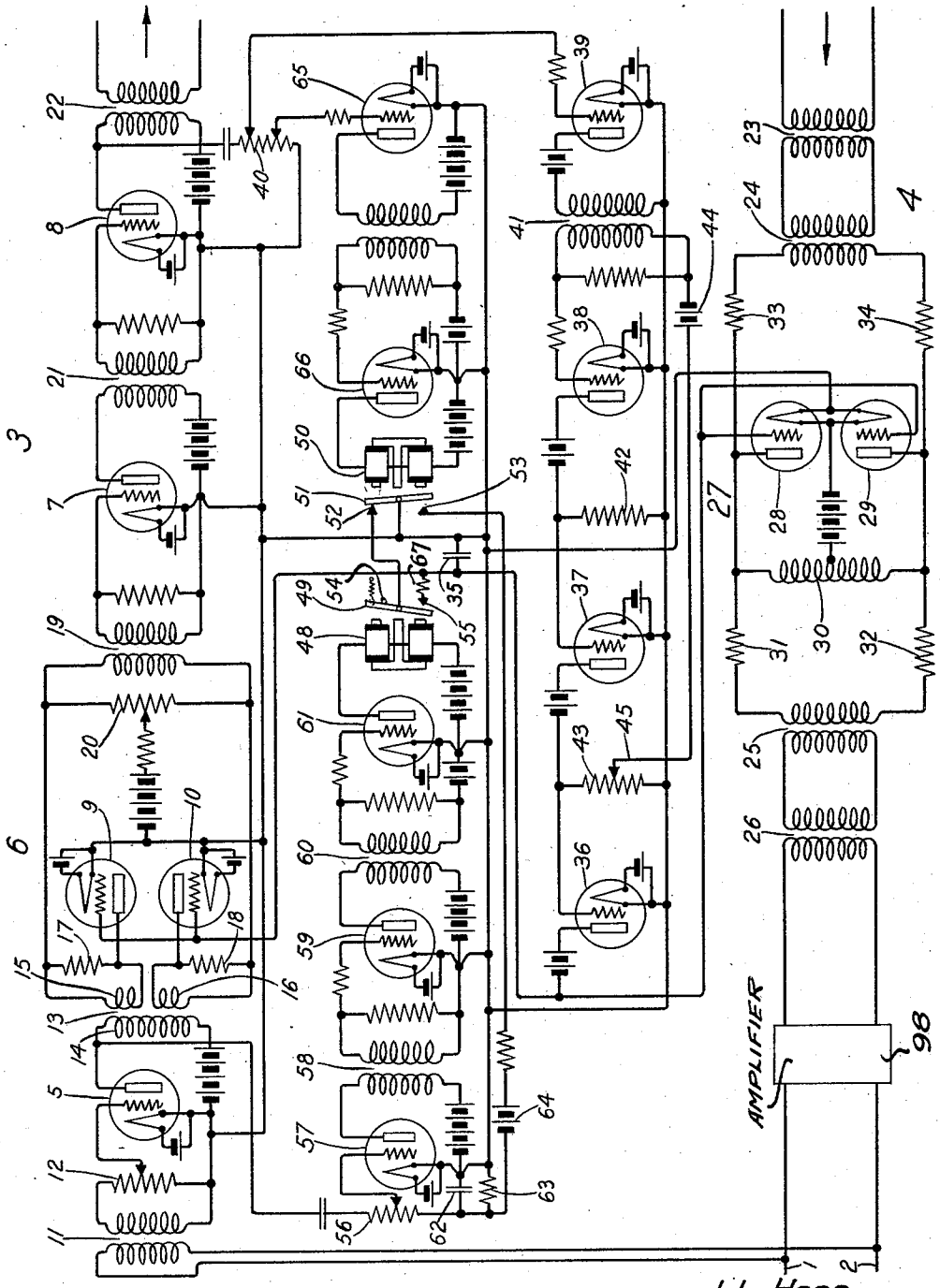

INVENTORS: J. L. HOGG
S. DOBA

BY Wayne B Wells.

ATTORNEY

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JOHN L. HOGG, OF EAST ORANGE, NEW JERSEY, AND STEPHEN DOBA, OF BROOKLYN, NEW YORK, ASSIGNORS TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

TRANSMISSION SYSTEM

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This invention relates to signal transmission systems and particularly to volume control circuits for governing the energy level at desired points in signal transmission systems.

One object of the invention is to provide a signal transmission system with a vacuum tube loss device that shall be controlled in an improved manner according to the charge on a condenser to maintain the volume of energy at a desired point on the system within a predetermined range.

Another object of the invention is to provide a signal transmission system with transmitting and receiving channels each having a vacuum tube loss device connected thereto under the control of a capacity element that shall effect a decreased loss in one channel when an increased loss is effective in the other channel and that shall control the charging and discharging of the capacity element in an improved manner.

A further object of the invention is to provide a four-wire transmission system with a vacuum tube loss device connected in series with one channel and a vacuum tube loss device connected across the other channel that shall have a capacity element for controlling the potential on the grids of the loss devices to govern the energy volume on the system in an improved manner.

In signal transmission systems there are many cases where it is very desirable to hold the voltages of the signal or speech currents within a predetermined range. In the transatlantic radio system, it is necessary to hold the voltages on the system in front of the radio transmitter within a limit which will not overload the transmitter. In transmitting broadcasting programs over wires it is necessary to control the volume which passes over the transmission lines.

According to the present invention vacuum tube loss devices are employed to maintain the energy volume at a desired point in a transmission system within predetermined limits. The potential on the grids of the vacuum tube loss devices is governed according to the charge on a condenser and the charge on the condenser is automatically controlled in accordance with the loss desired in the system.

The invention has been illustrated by means of a four-wire transmission system having vacuum tube loss devices in the transmitting and receiving channels. In the transmitting channel two three-element thermionic tubes are connected in push-pull relationship for controlling the impedance of such channel. The anode-cathode circuits of such tubes are connected in series with the channel so that the potential on the grids of the tubes may be controlled to vary the impedance effected in the channel by the tubes. The potential impressed on the grids of the tubes is controlled in accordance with the peaks of speech current beyond the impedance means comprising the two thermionic tubes in push-pull relationship.

The vacuum tube loss device in the receiving channel comprises two three-element thermionic tubes in push-pull relationship having their anode-cathode circuits connected across the receiving channel. A condenser is provided for controlling not only the potential impressed on the grids of the impedance tubes in the transmitting channel, but also the potential impressed on the grids of the impedance tubes in the receiving channel. The charge on the condenser is controlled in accordance with the peaks of the speech current beyond the impedance tubes in the transmitting channel. By connecting the impedance tubes in series with the transmitting channel and across the receiving channel, it will be noted that any increased loss caused in the transmitting channel by a charge on said condenser will be accompanied by a corresponding decreased loss in the receiving channel. It is necessary to vary the impedance means in the receiving channel in an opposite manner to the impedance means in the transmitting channel in order to maintain the four-wire circuit balanced and prevent any singing conditions.

Means are provided for preventing charging of the condenser until the peaks of speech current beyond the impedance tubes in the transmitting channel are above an upper limiting value. When the upper limiting value

of the peaks of speech in the transmitting channel beyond the impedance tubes is reached, the condenser which controls the impedance tubes in the transmitting and receiving channels is charged in accordance with the energy volume in the transmitting channel beyond the impedance tubes. Means are further provided for either discharging the condenser or preventing further charging of it when the peaks of speech on the transmitting channel beyond the impedance tubes therein fall below a lower limiting value. If the peaks of speech current on the transmitting channel beyond the impedance tubes are below the lower limiting value and the peaks of speech of the transmitting channel before the impedance tubes are above the peaks of speech current for a weak talker, the condenser is discharged. If the peaks of speech current beyond the impedance tubes in the transmitting channel fall below the lower limiting value and the peaks of speech current on the transmitting channel before the impedance tubes fall below the peaks of current for a weak talker, then further charging of the condenser is prevented and the charge thereon is held for a limited period. Thus, when conversation ceases for a short period the setting of the impedance means on the line is held for a short period.

In some respects the volume control circuits operate similar to the circuits disclosed in the application of R. C. Mathes Serial No. 372,951, filed June 22, 1929, which became Patent 1,810,025, June 16, 1931. The control for the impedance means is obtained from the transmitting channel beyond the impedance means and the energy level in the transmitting channel is held between an upper and a lower limiting value. By holding the energy volume between an upper and a lower limiting value it is possible to operate the system without continuous hunting action when a substantially constant energy level is maintained on the transmitting channel before the impedance means therein.

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

Referring to the drawing a two wire system comprising conductors 1 and 2 is connected to a four-wire system comprising a transmitting channel 3 and a receiving channel 4. The transmitting channel comprises a three element thermionic amplifier tube 5, a vacuum tube loss device 6 and two thermionic amplifier tubes 7 and 8. The vacuum tube loss device 6 comprises two three-element thermionic tubes 9 and 10 which are connected in push-pull relationship. A transformer 11 which is connected to the two wire circuit comprising conductors 1 and 2 is connected to the input circuit of the amplifier tube 5 by means of a potentiometer 12.

The impedance tubes 9 and 10 are connected to the amplifier tube 5 by means of a transformer 13 having a primary winding 14 in the output circuit of the amplifier tube 5 and two secondary windings 15 and 16. Resistance elements 17 and 18 are connected across the secondary windings 15 and 16 of the transformer 13. The resistance elements 17 and 18 have an impedance which is relatively low as compared with the impedance of the tubes 9 and 10. The output circuits of the impedance tubes 9 and 10 are connected by a transformer 19 to the input circuit of the amplifier tube 7. A resistance element 20 having a low value as compared with the impedance of the tubes 9 and 10 and of the order of the sum of the impedances of the resistance 17 and 18 is connected across the primary of the transformer 19. The amplifier tube 7 is connected to the amplifier tube 8 by means of a transformer 21 and the output circuit of the amplifier 8 is connected to a transformer 22.

In the receiving channel 4 are inserted two transformers 23 and 24. The transformers 23 and 24 serve as step-up transformers. Between the transformer 24 and transformers 25 and 26 is inserted a vacuum tube loss device 27 comprising two three-element thermionic tubes 28 and 29. The two tubes 28 and 29 are connected in push-pull relationship with their anode-cathode circuits across the receiving channel. The plates of the tubes 28 and 29 are directly connected to the channel conductors and the filaments of such tubes are connected to the channel conductors by means of an inductance 30. Between the primary winding of transformer 25 and the inductance 30 are inserted resistance elements 31 and 32 and between the secondary winding of transformer 24 in the impedance tubes 28 and 29 are inserted resistance elements 33 and 34. The impedance of the resistance elements 31 to 34, inclusive, is relatively high as compared to the impedance of the thermionic tubes 28 and 29. The transformers 25 and 26 are step-down transformers and have a ratio of transformation similar to the ratio of transformation of the transformers 23 and 24. The transformer 26 is connected to the conductors 1 and 2 of the two-wire circuit by means of amplifier 98.

A condenser 35 is provided for controlling the charge on the grids of the tubes 9 and 10 connected to the transmitting channel and the tubes 28 and 29 connected to the receiving channel. A negative potential impressed on the grids of the tubes 9 and 10 will increase the loss in the transmitting channel, whereas a negative potential impressed on the grids of the tubes 28 and 29 will decrease the loss in the receiving channel. The condenser 35 is charged from the output circuit of the amplifier tube 8 in the transmitting channel by a circuit comprising thermionic tubes 36, 37,

38 and 39. The input circuit of the amplifier tube 39 is connected to a potentiometer 40 in the output circuit of the amplifier tube 8. The output circuit of the tube 39 is connected to the rectifier tube 38 by a transformer 41. The output circuit of the rectifier tube 38 is connected to the amplifier tube 37 by a potentiometer 42. The output circuit of the amplifier tube 37 is connected to the amplifier tube 36 by a potentiometer 43 and the output circuit of the amplifier tube 36 is directly connected to the condenser 35.

When the peaks of speech current in the output circuit of the amplifier tube 8 are below an upper limiting value, the grid of the rectifier tube 38 is maintained strongly negative by means of battery 44. This insures substantially zero potential between the grid and filament of the amplifier tube 37. However, there is a substantial current flow through the amplifier tube 37 and the potentiometer 43. The potential drop across a portion of the potentiometer 43 adds to the negative potential impressed on the grid of the amplifier tube 38. The connection of the potentiometer 43 to the grid of the amplifier tube 38 is effected by means of a conductor 45. The potential drop across the potentiometer 43 also maintains the grid of the amplifier tube 36 strongly negative so that no current flows in the output circuit of the amplifier tube 36 for charging the condenser 35.

If the peaks of speech current in the output circuit of the amplifier tube 8 are raised above the upper limiting value, the negative potential on the grid of the amplifier tube 38 is reduced to impress potential on the grid of the amplifier tube 38. It may be noted that the potentiometer 42 is relatively large and a small current flow therethrough will produce a substantial change in the output of the amplifier tube 37 and the current flow through the potentiometer 43. Thus, a large and very abrupt change is effected in the potential applied between the grid and filament of the amplifier tube 36.

The charging current from the output of the amplifier tube 36 for the condenser 35 will last only during the time that the energy in the output circuit of the amplifier tube 8 is above the upper limiting value. The instant such voice wave peaks fall below the upper limiting value, the charging of the condenser 35 stops. The charge on the condenser, however, is retained and when another peak of the voice waves beyond the amplifier 8 rises above the upper limiting value another increment of charge is impressed on the condenser 35. The charge is retained on the condenser 35 when the peaks of voice waves beyond the amplifier 8 fall below the upper limiting value because when this decrease in energy beyond the amplifier 8 occurs, the potential across the potentiometer 42 falls to zero, while the potential across the potentiometer 43 increases to impress a high negative potential on the grid of the tube 36. The impressing of a high negative potential on the grid of the amplifier tube 36 causes the impedance in the charging circuit of the condenser 35 to be raised to a very high value. The above mentioned circuits can be adjusted so that the discharge of the condenser 35 is very slow and little change in the charge will be observed after a period of five minutes.

The discharge of the condenser 35 is effected by means of a control relay 48 having an armature 49 and an auxiliary relay 50 having an armature 51. The relay 48 is controlled from the output of the amplifier tube 5 in the transmitting channel 3 before the impedance tubes 9 and 10. The auxiliary relay 50 is controlled by the potentiometer 40 in the output of the amplifier tube 8 in the transmitting channel. In the released position, the armature 51 of the relay 50 is biased to engage the contact member 52. When the relay 50 is operated the armature 51 is moved into engagement with the contact member 53. The armature 49 of the relay 48 is biased to engage the stop member 54 when the relay is in released position. The armature 49 is held in engagement with the contact member 55 when the relay 48 is operated.

A potentiometer 56 in the output circuit of the amplifier tube 5 is connected to the input circuit of an amplifier tube 57. The output circuit of the amplifier tube 57 is connected by a transformer 58 to the input circuit of an amplifier tube 59. The output circuit of the amplifier tube 59 is connected by a transformer 60 to the input circuit of a detector tube 61. The output circuit of the detector tube 61 is connected to the control relay 48.

When the peaks of the voice currents in the output circuit of the amplifier tube 5 are above the peaks of a very weak talker, the amplifier tubes 57 and 59 and the detector tube 61 supply current for operating the control relay 48. A condenser 62 having a resistance element 63 connected across it is connected in the input circuit of the amplifier tube 57. The condenser 62 is charged from a battery 64 when the auxiliary relay 50 is operated to impress a high negative potential on the grid of the amplifier tube 57 which blocks the tube 57 to insure the release of the control relay 48.

The auxiliary relay 50 is operated from the potentiometer 40 in the transmitting channel by means of an amplifier tube 65, and a detector tube 66. The auxiliary relay 50 is operated when the peaks of voice current in the output circuit of the amplifier tube 8 are above a lower limiting value. If the auxiliary relay 50 is in released position while the control relay 48 is in an operative position,

it will be noted condenser 35 is discharged through a resistance element 67.

Assuming the control relay 48 and the auxiliary relay 50 to be in the positions shown on the drawing and conversation to take place over the four-wire system, the relay 48 would be operated as soon as the peaks of the voice currents in the output circuit of the amplifier tube 5 rises above the peaks of voice current for a weak talker. It may be noted that the high negative potential impressed upon the grid of the rectifier tube 38 insures against any charging of the condenser 35 until the peaks of the voice currents in the output circuit of the amplifier tube 8 rise above the upper limiting value. When the peaks of the voice currents in the output circuit of the amplifier tube 8 rise above the lower limiting value, the auxiliary relay 50 is operated. When the auxiliary relay 50 is operated, the condenser 62 associated with the amplifier tube 57 is charged to block the tube 57 and release the relay 48.

The system will remain in this position if the peaks of the voice currents in the output circuit of the amplifier tube 8 remain between the upper and lower limiting values. If the peaks of the voice currents in the output circuit of the amplifier tube 8 rise above the upper limiting value, the amplifier tubes 36, 37, 38 and 39 impress a charge on the condenser 35. The charge on the condenser 35, as before set forth impresses negative potential on the grids of the two impedance tubes 9 and 10 in the transmitting channel and the grids of two impedance tubes 28 and 29 in the receiving channel. The placing of negative potential on the grids 9 and 10 in the transmitting channel adds to the loss in the transmitting channel whereas the negative potential impressed upon the grids of the tubes 28 and 29 in the receiving channel reduces the loss in the receiving chanel.

Whenever the peaks of the voice frequency currents in the output circuit of the amplifier tube 8 fall below the upper limiting value, charging of the condenser 35 ceases. However, no substantial discharge of the condenser 35 takes place immediately unless the peaks of the voice frequency currents in the output circuit of the amplifier 8 fall below the lower limiting value. If the peaks of the voice frequency currents in the output circuits of the amplifier tube 5 in the transmitting channel are above the peaks of voice frequency currents for a weak talker to operate the control relay 48 and the peaks of speech in the output circuit of the amplifier tube 8 fall below the lower limiting value, then the auxiliary relay 50 is in released position when the control relay is in an operative position. The condenser 35 is then discharged through the resistance element 67 to decrease the impedance in the transmitting channel and increase the impedance in the receiving channel.

If conversation ceases for a brief period of time, the charge on the condenser 62 impresses a strong negative potential on the grid of the amplifier tube 57 which controls the control relay 48. The slow discharge of this condenser 62 prevents any immediate operation of the control relay 48. This insures if conversation is immediately resumed that the setting of the volume control circuits will remain unchanged.

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 transmission system, transmitting and receiving channels, a vacuum tube loss device connected in series with one of said channels, another vacuum tube loss device connected across the other channel, and means to control the grid potentials of said devices in accordance with the volume of energy present at a point on one of said channels.

2. In a transmission system, transmitting and receiving channels, a vacuum tube loss device having its anode-cathode circuit connected in series with the transmitting channel, a vacuum tube loss device having its anode-cathode circuit connected across the receiving channel, and means to control the grid potentials of said devices in accordance with the volume of energy present at a point on one of said channels.

3. In a transmitting system, transmitting and receiving channels, a vacuum tube loss device having its anode-cathode circuit connected in series with the transmitting channel, a vacuum tube loss device having its anode-cathode circuit connected across the receiving channel, a condenser for controlling the potential on the grids of said devices and means for charging said condenser according to the energy volume on the transmitting channel beyond the device therein.

4. In a transmitting system, transmitting and receiving channels, a vacuum tube loss device having its anode-cathode circuit connected in series with the transmitting channel, a vacuum tube loss device having its anode-cathode circuit connected across the receiving channel, a condenser for controlling the potential on the grids of said devices, and means for charging said condenser according to the energy volume on the transmitting channel beyond the device therein and for preventing charging of the condenser until the energy volume in the transmitting channel beyond the device therein is above an upper limiting value.

5. In a transmitting system, transmitting and receiving channels, a vacuum tube loss device having its anode-cathode circuit connected in series with said transmitting channel, a vacuum tube loss device having its

anode-cathode circuit connected across the receiving channel, and means comprising a condenser for varying the potential on the grids of said devices according to the energy volume on one of said channels beyond the loss device therein to cause an increased loss in one channel and a corresponding decreased loss in the other channel or vice versa irrespective of the frequency of the currents transmitted.

6. In a transmission system, transmitting and receiving channels, a vacuum tube loss device having its anode-cathode circuit connected in series with one of said channels, a vacuum tube loss device having its anode-cathode circuit connected across the other channel, means comprising a condenser for varying the potential on the grids of said devices according to the energy volume on one of said channels adjacent the loss device therein to cause an increased loss in one channel and a corresponding decreased loss in the other channel or vice versa irrespective of the frequency of the currents transmitted, and means for charging said condenser when the energy volume beyond the device in one channel is above an upper limiting value and for preventing charging of the condenser when the energy volume beyond the device in said last mentioned channel is below the upper limiting value.

7. A transmission system comprising a signal line, a vacuum tube loss device connected directly in series with said line, a condenser, means for varying the charge on said condenser according to the volume of energy present in said line adjacent to said device, and means for varying the potential on the grid of said device according to the charge on the condenser.

8. In a transmitting control system, a signal line, a vacuum tube loss device connected directly in series with said line for controlling the energy volume transmitted over the line, means comprising a condenser for varying said loss device according to the charge on the condenser, and means for charging said condenser according to the energy volume on the line beyond said loss device and for preventing charging of the condenser until the energy volume on the line beyond the loss device is above an upper limiting value.

9. A transmission control system comprising a signal line, a vacuum tube loss device having the anode-cathode circuit thereof connected directly in series with said line, means comprising a condenser for varying the potential on the grid of said device in accordance with the volume of energy present in said line beyond and adjacent to said device, and means for preventing charging of said condenser until a predetermined energy volume is present in said line and for insuring the discharging of said condenser when the energy volume at a point on said line falls below another predetermined level.

10. In a volume control system, a signal line, a vacuum tube loss device having the anode-cathode circuit thereof connected in series with said line, a condenser for varying the potential on the grid of said device to control the loss caused by the device, means for charging said condenser in accordance with the energy volume on the line beyond the device and means comprising two relays respectively controlled by the volume of energy in the line on opposite sides of said device for governing the discharging of said condenser when the device inserts a greater loss in the line than is desired.

11. In a transmission system comprising a signal line, a vacuum tube loss device having the anode-cathode circuit thereof connected in series with the line for effecting a variable loss on the line, means comprising a condenser for varying the potential on the grid of said loss device to control the loss caused thereby, means for charging the condenser when the energy volume on the line beyond the device is above an upper limiting value, and means for preventing discharge of the condenser until the energy volume beyond the device is below another and lower limiting value.

12. In a transmission system comprising a signal line, a three-element vacuum tube loss device having the anode-cathode circuit thereof connected directly in series with said line, means comprising a condenser for varying the potential on the grid of said loss device to control the loss caused by the device, means for charging the condenser when the volume of energy on the line beyond the device is above an upper limiting value to increase the loss caused by the device, and means for preventing discharge of the condenser until the volume of energy on the line beyond the device is below a lower limiting value and the peaks of signal current before the loss device are above the peaks of a very weak talker.

13. In a transmission system comprising a signal line, a three-element vacuum tube loss device connected in series with said line, means comprising a condenser for varying the potential on the grid of said loss device to control the loss caused thereby, means for charging the condenser when the volume of energy on the line beyond the device is above an upper limiting value to increase the loss caused by the device and for preventing charging of the condenser when the volume of energy on the line beyond the device is below the upper limiting value and means for discharging the condenser when the volume of energy beyond the device is below a lower limiting value and the peaks of energy volume before the device are above a minimum value.

14. In a volume control system, a signal line, a vacuum tube loss device in series with said line, a condenser for varying the potential on the grid of said device to control the loss caused by the device, means for charging said condenser in accordance with the energy volume on the line beyond the device when the volume of energy beyond the device is above an upper limiting value, a control relay, means for operating said control relay when the volume of energy on the line before the device rises above a minimum value, an auxiliary relay, means for operating said auxiliary relay when the volume of energy on the line beyond the device is above the lower limiting value, means for releasing the control relay when the auxiliary relay is operated, and means for discharging said condenser when the control relay is in operative position and the auxiliary relay is in released position.

15. In a volume control system, transmitting and receiving channels, a vacuum tube loss device having the anode-cathode circuit thereof in series with said transmitting channel, a vacuum tube loss device having the anode-cathode circuit thereof connected across said receiving channel, a condenser for varying the potential on the grids of said devices to control the losses caused by the devices, means for charging said condenser in accordance with the energy volume on the transmitting channel beyond the device therein when the volume of energy beyond the device in the transmitting channel is above an upper limiting value, a control relay, means for operating said control relay when the volume of energy on the transmitting channel before the device therein rises above a minimum value, an auxiliary relay, means for operating said auxiliary relay when the volume of energy on the transmitting channel beyond the device therein is above the lower limiting value, means for releasing the control relay when the auxiliary relay is operated, and means for discharging said condenser when the control relay is in operative position and the auxiliary relay is in released position.

16. In a transmission system, a signal line, a vacuum tube loss device connected to said line for varying the loss therein, means comprising a condenser for varying the potential on the grid of said device, means for varying the charge on said condenser in accordance with the energy volume on the line beyond said device and means for preventing variation of the charge on the condenser when the peaks of signal current before the loss device are below a predetermined level.

17. In a transmission system, a signal line, variable impedance means connected to said line for controlling the energy volume transmitted over the line, means comprising a condenser for varying said impedance means according to the volume of energy present at a point in said system and means for preventing variation of the charge on the condenser when the peaks of signal current before the loss device are below a predetermined level.

18. In a transmission system, a signal line, a vacuum tube loss device connected to said line for controlling the energy volume transmitted over the line, means comprising a condenser for varying the potential on the grid of said device according to the volume of energy present at a point in said system and means for preventing variation of said loss device to change the charge on the condenser when the volume before the loss device is below a predetermined level.

19. In a transmission system, a signal line, a loss device connected to said line, means for controlling the loss device according to the energy volume on the line beyond the loss device, and means for preventing control of said loss device by the first mentioned means when the peaks of the energy volume on the line before the loss device are below a predetermined level.

20. A transmission line, a loss device connected to said line, means for controlling said loss device according to the energy volume on the line beyond the loss device, and means governed by the peaks of energy volume on said line before the loss device for preventing operation of said first mentioned means under predetermined energy volume conditions on the line before the loss device.

In witness whereof, we hereunto subscribe our names this 11th and 17th days of April, 1930.

JOHN L. HOGG.
STEPHEN DOBA.