

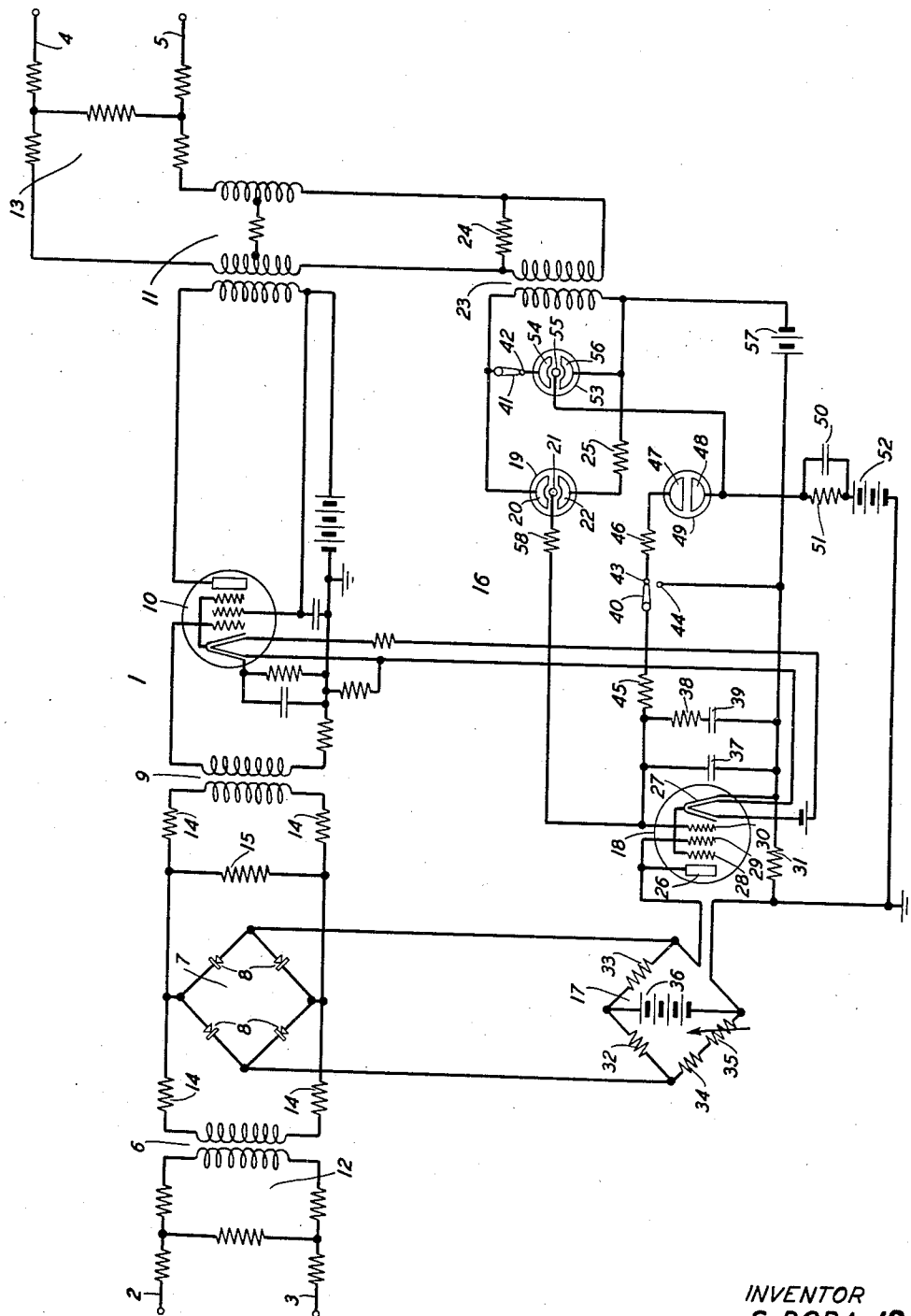
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VOLUME LIMITER CIRCUIT

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VOLUME LIMITER CIRCUIT

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This invention relates to signal transmission systems and particularly to volume limiter circuits for signal transmission systems.

One object of the invention is to provide a new and improved volume limiter circuit.

Another object of the invention is to provide an improved volume limiter circuit that shall be controlled by a marginal acting cold cathode tube to limit the volume of signals on a transmission line.

Another object of the invention is to provide a signal transmission line with a varistor in the form of a bridge governed according to the charge on a control condenser that shall have the control condenser charged under control of a gas-filled tube when the energy of the signals on the line goes above a predetermined level and that shall control the discharge of the control condenser in an improved manner.

A further object of the invention is to provide a volume limiter circuit of the above-indicated character that shall have condensers of different size to govern the limiting action and that shall govern the discharge of the control condenser by an opposing delay condenser shunted by a resistance element and charged according to the energy level of the signals on the transmission line.

In the transmission of signals, for example, voice currents, it is desirable to limit the amplitude of the signals in order to protect apparatus on the line. The transmission line which is to be protected against high amplitude currents may be subjected to prolonged signals above a predetermined level or may be subjected to powerful transient currents and clicks of high amplitude. When a signal is subject to short, high amplitude currents it is desirable to have the limiting action of short duration while still taking care of high amplitude currents of prolonged duration. Furthermore, it is desirable in speech currents to govern the limiting action in a manner to prevent too rapid a change in loss on the transmission line between syllables of speech.

In a volume limiter circuit constructed in accordance with the invention a varistor in the form of a bridge is placed in the transmission line for limiting the level of the signals. The varistor is formed of elements having a non-linear resistance characteristic, for example, copper-oxide elements. Two vertices of the bridge are connected across the transmission line and the other two vertices of the bridge are connected to control circuits which vary the current

flow through the copper-oxide elements and, accordingly, the impedance of the bridge. The current flow through the copper-oxide bridge is controlled according to the charge on two control condensers of different sizes. The smaller condenser controls the bridge when small peaks of signals above a predetermined level are on the line and the larger condenser serves to control the bridge in the case of prolonged energy periods above a predetermined level. The charge on the two control condensers is controlled by a gas-filled tube, preferably in the form of a cold cathode tube, according to the energy level of the currents on the transmission line. The cold cathode tube has an ignition circuit and an operating circuit. The ignition circuit is controlled from the transmission line so that the cold cathode tube is broken down whenever the signals or the currents on the transmission line go above a predetermined level. The two control condensers are connected in the operating circuit of the tube in order to be charged whenever the signals go above a predetermined level.

In the case of a small energy peak on the transmission line above the predetermined level, the smaller control condenser will quickly govern the bridge to protect the apparatus on the transmission line. Upon cessation of the abnormal peak, the smaller condenser discharges into the larger condenser and the loss on the transmission line is returned to normal value. In case of a prolonged period of high energy level on the transmission line, the larger condenser will be charged to control the action of the varistor in the form of a copper-oxide bridge.

In the transmission of ringing currents prior to the transmission of speech currents it has been found the hundred cycle ringing current is usually preceded and terminated by very powerful transient currents which would cause some types of limiters to introduce so much loss into the circuit that the ringing operation would be completely lost. The smaller control condenser is quick enough in operation to take care of the powerful transient currents preceding the ringing currents and to insure satisfactory transmission of the ringing currents.

In the transmission of speech currents it is very often desirable to prevent too rapid a change in loss on the transmission line between syllables of speech. In order to prevent too rapid a change in loss on the transmission line between syllables of speech, provision has been made to effect discharge of the control condensers through a circuit which has a timing action. The dis-

charge circuit for the control condensers includes a cold cathode tube, a delay condenser shunted by resistance element, and a source of current. The source of current is of a value sufficient to ignite the cold cathode tube in the discharge circuit. The delay condenser is charged simultaneously with the charging of the control condensers and in a direction to oppose any discharge from the control condensers. The delay condenser opposes discharge of the control condensers and discharge of the control condensers cannot take place until the charge on the delay condenser has been reduced. It may be noted that the discharge circuit above mentioned does not interfere with the operation of the smaller control condenser in discharging into the larger condenser in the case of high peaks of signal currents which are not too close together.

The single figure in the accompanying drawing is a diagrammatic view of a volume limiter circuit constructed in accordance with the invention.

Referring to the drawing a signal transmission line 1 is provided with input conductors 2 and 3 and output conductors 4 and 5. The input conductors 2 and 3 are connected by transformer 6 to a varistor 7 in the form of a copper-oxide bridge having two vertices connected across the transmission line. The bridge comprises copper-oxide elements 8. A transformer 9 beyond the varistor 7 is connected to the input circuit of an amplifier 10 in the form of a pentode space discharge device. The output circuit of the amplifier is connected by a hybrid coil 11 to the output conductors 4 and 5. Impedance pad 12 comprising resistance elements is inserted in the line ahead of the transformer 6 and an impedance pad 13 is inserted in the line beyond the hybrid coil 11. Resistance elements 14 are inserted in the transmission line on each side of the varistor 7 and a resistance element 15 is connected across the transmission line beyond the varistor 7.

Control circuits 16 are provided for governing the varistor 7 to limit the energy level of the signals on the transmission line. The control circuits 16 comprise a bridge 17, an amplifier 18 in the form of a pentode space discharge device and a cold cathode gas-filled tube 19. The cold cathode tube 19 comprises three electrodes 20, 21 and 22. Electrodes 20 and 22 of the cold cathode tube 19 are connected by transformer 23 to the hybrid coil 11 in the transmission line. A resistance element 24 is connected across primary winding of the transformer 23 and a resistance element 25 is connected in series with the secondary winding of the transformer 23 and the tube electrodes 20 and 22. The pentode tube 18 comprises an anode 26, cathode 27, screen grid 29, a suppressor grid 28 and a control grid 30. The output circuit of the pentode tube 18 with a resistance element 31 forms one arm of the bridge 17. Two resistance elements 32 and 33 form two other arms of the bridge 17 and two resistance elements 34 and 35 form the fourth arm of the bridge 17. A suitable source of current 36 is connected across two vertices of the bridge 17 and the other two vertices are connected to the free vertices of the varistor 7. Under normal operating conditions with no energy peaks on the signal line above a predetermined level the bridge 17 is balanced so that no current is supplied from the bridge 17 to the varistor 7. Upon change in the output circuit of the pentode tube 18 the bridge 17 is unbalanced to supply current to the varistor 7. When current is supplied to the varistor 7 from

the bridge 17 the impedance of the varistor 7 is lowered to produce a shunting action on the transmission line.

A condenser 37 shunted by a resistance element 38 and a relatively large condenser 39 is provided in the input circuit of the amplifier 18 to control the operation thereof in accordance with the signals on the transmission line. The condenser 37 is charged when a short peak of signal energy appears on the transmission line for controlling the amplifier 18 to effect a limiting action for a short period of time. The condenser 37 which is relatively small compared with condenser 39 is then discharged into the condenser 39. If the energy level on the transmission line continues for a prolonged period or if a large number of small peaks above the predetermined level are on the transmission line, then the condenser 39 is charged for holding the energy level on the transmission line below the predetermined level for an extended period of time.

Two switch arms 40 and 41 are provided for controlling the discharge of the condensers 37 and 39. The switch arm 41 is adapted to engage a contact member 42 and the switch arm 40 is adapted to engage a contact member 43 or a contact member 44. When the switch arms 40 and 41 are in the position shown in the drawing and in engagement with contact members 43 and 42 the discharge of the condensers 37 and 39 is controlled to prevent a too sudden change in limiting action between symbols of speech. With the switch arm 40 in engagement with contact member 43 a discharge circuit for the condensers 37 and 39 may be traced from ground through resistance element 31, condenser 37, shunted by condenser 39 and resistance 38, resistance 45, switch arm 40, contact member 43, resistance member 46, electrodes 47 and 48 of a cold cathode tube 49, delay condenser 50 shunted by a resistance element 51 and battery 52 to ground. The delay condenser 50 is charged under control of a cold cathode tube 53 to oppose discharge of the condensers 37 and 39.

The cold cathode tube 53 comprises three electrodes 54, 55 and 56. The cold cathode tube 53 is connected in parallel with the cold cathode tube 19 to the transformer 23 when the switch arm 41 is in engagement with the contact member 42. The ignition circuit for the tube 53 may be traced from the electrode 54 through contact member 42, switch arm 41 and secondary winding of the transformer 23 to the electrode 56. The operating circuit for the cold cathode tube 53 may be traced from one terminal of a relatively small battery 57 through the secondary winding of the transformer 23, switch arm 41, contact member 42, electrode 54, electrode 55, delay condenser 50 shunted by resistance element 51, battery 52 and resistance element 31 to the other terminal of the battery 57. In the circuit under consideration the battery 57 may be of the order of 24 volts and the battery 52 may be of the order of 70 volts.

The ignition circuit for the cold cathode tube 19 may be traced from the electrode 20 through the secondary winding of the transformer 23 and the resistance element 25 to the electrode 22. The operating circuit of the cold cathode tube 19 may be traced from one terminal of the condenser 37 through the resistance element 58, electrode 21, electrode 20, secondary of the transformer 23 and battery 57 to the other terminal of the condenser 37. When peaks of the energy on the transmission line go above a predeter-

mined limit the cold cathode tube 19 is broken down and the condenser 37 is charged from the battery 57. The condenser 37 governs the amplifier 18 to unbalance the bridge 17 and effect current flow from the battery 36 through the varistor 7. The varistor 7 in turn limits the energy on the transmission line. If the peak of energy above a predetermined limit on the transmission line is of short duration the condenser 37 will be discharged into the condenser 39. If a number of peaks go above the predetermined limit or if the energy on the transmission line is above the predetermined limit for an extended period of time then the condenser 39 is charged for governing the operation of the amplifier tube 18. The condenser 37 is relatively fast in operation and in the case of ringing current will take care of the high peaks of energy caused at the beginning of ringing operation. The condenser 37 is discharged into the larger condenser 39 sufficiently rapidly to prevent interference with the ringing operation.

During the transmission of speech it is desired not to effect too rapid a change in the line impedance between syllables when the syllables are above the predetermined limit. The delay condenser 50 is charged at the same time the condensers 37 and 39 are charged. The battery 52 is of a potential just sufficient to break down the cold cathode tube 49. Thus any charge on the delay condenser 50 due to the breakdown of cold cathode tube 53 will oppose battery 52 and thus prevent discharge of the condensers 37 and 39 through cold cathode tube 49. The condensers 39 and 37 cannot be discharged until the charge on the delay condenser 50 has discharged through the resistance element 51.

In case it is not desired to effect slow discharge of the control condensers 37 and 39 through the delay condenser 50 then the switch arm 41 is moved to disengage the contact member 42 and the switch arm 40 is moved to engage the contact member 44. The control circuits thus constructed will effect discharge of the condensers 37 and 39 solely through the resistance element 45. Under these conditions the cold cathode tubes 53 and 49 and the delay condenser 50 will not be utilized.

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

What is claimed is:

1. In combination, a signal transmission line, a control condenser, means for controlling the loss on said line according to the charge on said condenser, a cold cathode tube, a discharge circuit for the control condenser comprising a delay condenser shunted by a resistance element and said cold cathode tube means for separately and simultaneously charging said condensers when the energy level on the line is above a predetermined point, said delay condenser being charged in a direction to oppose the discharge of the control condenser and means comprising a source of potential in the charging circuit of said delay condenser for igniting said tube to complete the control condenser discharge circuit when the charge on the delay condenser is reduced.
2. In combination, a signal transmission line, a control condenser, means for controlling the loss on said line according to the charge on said condenser, a circuit comprising a delay condenser shunted by a resistance element for governing the discharge of the control condenser, and

means comprising two cold cathode tubes operated when the energy level on said line is above a predetermined point for respectively charging the control condenser to limit the volume on said line and charging said delay condenser to oppose the discharge of the control condenser.

3. In combination, a signal transmission line having a loss device thereon, a control condenser, means for controlling the operation of said loss device according to the charge on said condenser, a discharge circuit for the control condenser comprising a delay condenser and a cold cathode tube, means for separately and simultaneously charging said condensers when the energy level on the line is above a predetermined point, said delay condenser being charged in a direction to oppose the discharge of the control condenser, a resistance element in shunt to said delay condenser for controlling the time delay of discharge of the control condenser and means for igniting said cold cathode tube when the charge is reduced on the delay condenser to effect discharge of the control condenser.

4. In combination, a transmission line, a varistor for limiting the signal level on the transmission line, means comprising a control condenser for governing said varistor, means comprising a cold cathode tube for charging said condenser when the energy value on said line goes above a predetermined point, a discharge circuit for said control condenser comprising a delay condenser shunted by a resistance element, and means comprising a second cold cathode tube which becomes operative upon operation of said first-mentioned tube for charging said delay condenser in a direction to oppose the discharge of said control condenser.

5. In a volume limiter, a transmission line having a copper-oxide varistor thereon, means comprising two control condensers for controlling the operation of said varistor and the loss on said line according to the charge on the condensers, means comprising a gas-filled tube for charging said condensers when the energy level of the signals on said line goes above a predetermined value, a discharge circuit for said condensers comprising a delay condenser shunted by a resistance element, and means comprising a gas-filled tube for charging said delay condenser upon charging of said control condensers in a direction to oppose the discharge of the control condensers, said resistance element in shunt to said delay condenser provides a delay in the discharge of the delay condenser to delay the discharge of the control condensers.

6. In combination, a signal transmission line, a control condenser, means for effecting a loss on said line according to the charge on said condenser, means comprising a cold cathode tube for charging said condenser when the energy level of the signals on said line is above a predetermined level, a second cold cathode tube, a delay condenser shunted by a resistance element, means for operating said second-mentioned cold cathode tube simultaneously with said first-mentioned cold cathode tube, means for charging said delay condenser upon operation of said second-mentioned cold cathode tube, means comprising a third cold cathode tube for completing a circuit to discharge the control condenser, and means for igniting said third-mentioned cold cathode tube when the charge is reduced on the delay condenser to effect discharge of the control condenser.

7. In combination, a signal transmission line,

a control condenser, means for effecting a loss on said line according to the charge on said condenser, means comprising a circuit with a cold cathode tube therein for charging said condenser

5 when the energy level of the signals on said line is above a predetermined level, a delay condenser shunted by a resistance element, a second cold cathode tube operated simultaneously with said

10 first-mentioned cold cathode tube, means for charging said delay condenser in a circuit separated from the control condenser charging circuit according to the operation of said second cold cathode tube and means controlled by the discharge of a delay condenser through the resistance element for discharging the control condenser.

8. In combination, a signal transmission line, a bridge comprising copper-oxide elements connected across said line for limiting the volume of

20 the signals, means comprising two control condensers of different size for controlling said bridge, the smaller condenser being quick acting to limit short peaks of energy and the larger condenser being connected in shunt to the smaller condenser to prevent prolonged energy volume on the line above a predetermined value, means

25 comprising a cold cathode tube operating as a marginal device for charging said condensers when the energy level on the transmission line goes above the predetermined level a delay condenser shunted by a resistance element, a second cold cathode tube operated simultaneously with said first-mentioned cold cathode tube, means

30 operated by said second-mentioned tube for charging said delay condenser, and means operated by the discharge of the delay condenser for discharging said control condenser.

9. In combination, a transmission line, means

comprising a control condenser for controlling a characteristic of said line, a discharge circuit for said condenser comprising a gas-filled tube, a delay condenser shunted by a resistance element and a source of current sufficient to ignite said

5 tube, a cold cathode tube having an operating circuit in series with a source of current for charging the control condenser and an ignition circuit controlled from the line and a second cold cathode tube having an ignition circuit connected

10 in parallel to the ignition circuit of said first-mentioned cold cathode tube and an operating circuit in series with said two sources for charging said delay condenser to oppose the discharge of the control condenser, said cold cathode tubes

15 being ignited to charge said condensers when the energy level on the line is above a predetermined value and said resistance element in shunt to the delay condenser controlling the discharge of the control condenser.

10. In combination, a space discharge device, means comprising a control condenser for controlling said device according to the charge on the condenser, a discharge circuit for the control condenser comprising a delay condenser shunted

25 by a resistance element, two cold cathode tubes, means for igniting said two tubes when the energy level on the line is above a predetermined value, circuit connections for charging the control condenser under control of one of said tubes

30 when ignited and circuit connections for charging the delay condenser under control of the other tube when ignited, said delay condenser being charged in a direction to oppose discharge of the control condenser and said resistance element controlling the time of discharge of the control condenser.

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