

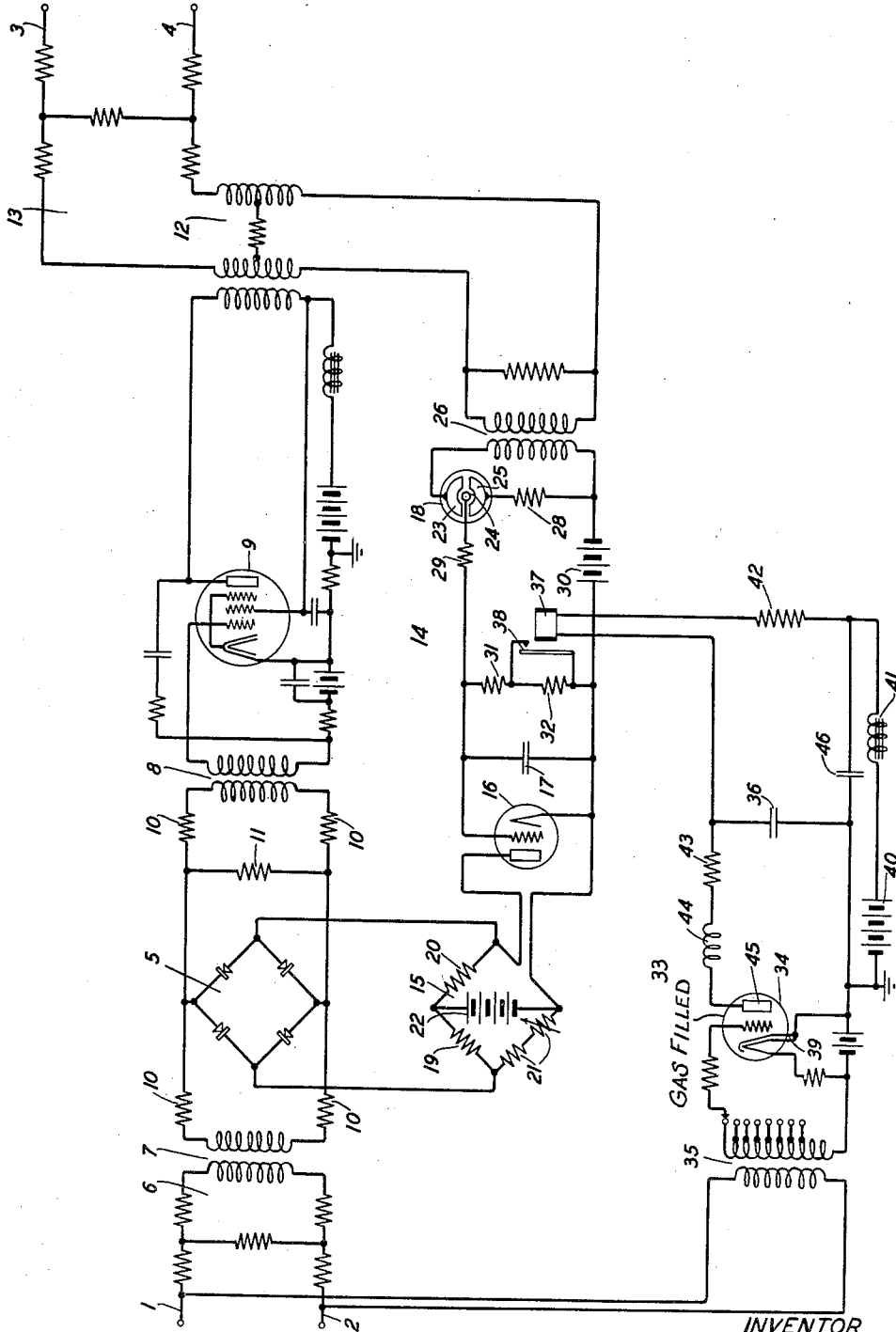
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## VOLUME LIMITER CIRCUIT

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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 signal transmission system with a volume limiter circuit that shall introduce a loss in the signal path for a limited period of time when the signal goes above a predetermined limit and that shall introduce a loss in the signal path for a relatively short period of time when very high signal peaks occur.

Another object of the invention is to provide a volume limiter circuit on a signal transmission line having a variolossor therein that shall charge a control condenser to effect a loss on the line by said variolossor when the signal peaks go above a predetermined level and that shall discharge said control condenser at one rate for small signal peaks and at a much faster rate for high signal peaks.

A further object of the invention is to provide a signal transmission line with a volume limiter circuit having a control condenser charged when the signal energy goes above a predetermined level for governing a variolossor in the transmission line and a resistance shunted across the control condenser to effect discharge thereof at a normal rate that shall short-circuit a portion of said resistance to effect a relatively quick discharge of said control condenser in case extremely high signal peaks occur on the transmission line.

In signal transmission lines, for example, a telephone line, it is desirable in many cases to provide volume limiter circuits to prevent overload of apparatus on the line by high energy signals. In many volume limiter circuits the reduction in the volume of signals when initiated by very high energy signals on the line persists for a period of time to interfere with following low volume signals. High energy impulses on a transmission line may be caused by the ringing operation or by switchboard clicks. In the ringing operation preceding a telephone conversation it has been found that brief transients may occur at the start of a ringing operation. The amplitude of the transients greatly exceeds the normal amplitude of the ringing current and when passed through a volume limiter may cause it to introduce sufficient loss in the ringing path to prevent calling the distant station. Clicks caused by the operation of various switching means may also cause sufficient loss in a transmission line to interfere with following low volume signals.

According to the present invention, a volume limiter is provided with a peak operated detector-relay circuit that shall effect a quick reduction in the loss on a transmission line which is caused by very high energy peaks. During the

ringing operation on a telephone line, the transients at the start of the ringing operation cause the insertion of a large loss on the line to protect the apparatus thereon and then, after the cessation of the abnormally strong transients, the peak operated detector-relay circuit quickly operates to reduce the loss on the line.

In the volume limiter circuit employed to describe the invention, a varistor in the form of a copper-oxide bridge is connected across the transmission line. The copper-oxide bridge is controlled by a backward acting control circuit connected to the transmission line. A marginal acting cold cathode tube is broken down when the energy peaks on the transmission line go above a predetermined limit. The cold cathode tube, when ignited, charges a control condenser. The control condenser, when charged, operates a space discharge device to effect current flow through the copper-oxide bridge and, accordingly, increase loss on the transmission line. The control condenser is shunted by a resistance element in order to effect discharge of the condenser in a predetermined time interval. The discharge of the condenser by the resistance element is relatively slow and, in the case of brief extremely high energy peaks on the transmission line, interference with following low volume signals may take place. Accordingly, a peak operated detector-relay circuit is provided to effect a faster discharge of the control condenser whenever extremely high energy peaks occur on the transmission line.

The peak operated detector-relay circuit is connected to the transmission line before the variolossor therein and comprises a marginal acting gas-filled tube which governs a control relay. The marginal acting gas-filled tube is set to be operated only in the case of extremely high energy peaks and will not operate in the case of normal voice currents. This tube may operate on the very highest peaks of the strongest talkers. An auxiliary condenser is connected across the output circuit of the gas-filled tube and upon ignition of the gas-filled tube the condenser is discharged through the tube. A charging circuit is provided for the auxiliary condenser which includes the operating coil of the control relay. The control relay, when operated, short-circuits a portion of the resistance in shunt to the control condenser in order to obtain a quick discharge of the control condenser. The control relay is operated shortly after the breakdown of the gas-filled tube and its release is delayed by the current supplied for charging the auxiliary condenser. Capacity and resistance elements may be provided for controlling the charging time of the auxiliary condenser.

The gas-filled tube in the peak operating de-

tector-relay circuit is set so as to be operated only in case of exceptionally high energy peaks on the transmission line. The control relay is operated by the transients at the beginning of a ringing operation but it is very seldom operated by voice currents. After the transients in the case of a ringing operation have passed, the volume limiter having the discharge resistance for the control condenser momentarily reduced to a small fraction of its usual value by operation of the relay 37, recovers in about .2 or .3 of a second to return the amplitude of the ringing currents to normal. The net result of this operation would be that the effective ringing time would be shortened by .1 to .15 of a second. This is a small part of the duration of the ringing operation which usually lasts at least one second. Normally, the loss inserted in the transmission line by the volume limiter is returned to normal in about six or seven seconds. This normal return is effected by the resistance in shunt to the control condenser. When the peak operated detector-relay circuit is in operation, the loss on the transmission line after a very high signal peak is effective in about .2 to .3 of a second.

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 having input conductors 1 and 2 and output conductors 3 and 4 is provided with a variollosser in the form of a copper-oxide bridge 5. Two vertices of the bridge 5 are connected across the transmission line and the other two vertices are controlled to limit the volume of the signals on the transmission line. An impedance pad 6 may precede the variollosser 5 and is connected thereto by means of a transformer 7. A transformer 8 connects the variollosser to the input circuit of a suitable amplifier 9. Resistance elements 10 are connected in the transmission line on each side of the bridge 5 and a resistance element 11 is connected in shunt to the bridge. The amplifier 9 is shown in the form of a pentode space discharge device of the feedback type. The output circuit of the amplifier 9 is connected to a suitable hybrid coil 12. An impedance pad 13 may be connected in the transmission line beyond the hybrid coil 12.

A control circuit 14 connected to the hybrid coil 12 is provided for controlling the copper-oxide bridge 5. The control circuit 14 comprises a Wheatstone bridge 15, an amplifier 16 in the form of a space discharge device, a control condenser 17 and a cold cathode gas-filled tube 18. The Wheatstone bridge 15 has three arms in the form of resistance elements 19, 20 and 21. The fourth arm of the bridge 15 is formed by the plate circuit of the amplifier 16. Two vertices of the bridge 15 are connected to the copper-oxide bridge 5 and the other two vertices are connected to a suitable source 22.

The cold cathode tube 18 comprises three electrodes 23, 24 and 25. The electrodes 23 and 25 are connected to the secondary winding of a transformer 26 which is connected to the hybrid coil 12. When peaks of energy above a predetermined limit occur on the transmission line, the gas-filled tube 18 becomes conducting across the electrodes 23 and 25. The ignition circuit for the cold cathode tube 18 includes the secondary winding of transformer 26, resistance element 28 and the electrodes 23 and 25. Upon

break down of the cold cathode tube 18, an operating circuit is completed for charging the control condenser 17. The circuit for charging the condenser 17 may be traced from one terminal of the condenser 17 through a resistance 29, electrodes 24 and 23, secondary winding of the transformer 26, and battery 30 to the other terminal of the control condenser 17. The control condenser 17 governs the potential between the grid and the filament of the amplifier 16 which, in turn, controls the bridge 15. The bridge governs the operation of the copper-oxide bridge 5 in the signal transmission line.

A resistance divided into sections 31 and 32 is connected across the condenser 17. The sections 31 and 32 of the resistance serve to effect a relatively slow discharge of the condenser 17 after it has been charged by operation of the cold cathode tube 18.

A peak operating detector-relay circuit 33 is provided for short-circuiting the resistance section 32 to effect a relatively quick discharge of the control condenser 17 shortly after exceptionally high energy peaks have occurred on the transmission line. The peak operating detector-relay circuit comprises a gas-filled space discharge device 34 which is connected to the input conductors 1 and 2 of the transmission line by means of transformer 35. An auxiliary condenser 36 is connected in shunt to the plate circuit of the tube 34 to be discharged upon ignition of the tube. A control relay 37 having an armature 38 is controlled by the gas-filled tube 34 and the auxiliary condenser 36 for short-circuiting the resistance section 32 upon operation of the relay. The plate circuit for the gas-filled tube 34 may be traced from the grounded cathode 39 through battery 40, inductance 41, resistance 42, operating coil of the relay 37, resistance 43, and inductance 44 to the plate 45 of the tube 34.

The charging circuit for the auxiliary condenser 36 may be traced from one terminal of the battery 40 through the inductance 41, resistance 42, operating coil of the relay 37 and condenser 36 to the other terminal of the battery 40. A condenser 46 cooperates with the resistance 42, the inductance 41 and the relay 37 for controlling the rate at which the condenser 36 is charged.

If the energy on the signal transmission line goes above a predetermined limit, the cold cathode tube 18 is broken down for charging the control condenser 17. The control condenser 17, when charged, operates the tube 16 to unbalance the Wheatstone bridge 15. The unbalancing of the bridge 15 effects current flow through the copper-oxide bridge 5. The impedance of the copper-oxide bridge 5 in shunt to the transmission line is lowered to limit the volume of the signals on the transmission line. Upon denenergization of the tube 18, the charge on the condenser 17 is discharged through the resistance sections 31 and 32 at a relatively slow rate. The discharge of the condenser 17 slowly restores the balance of the bridge 15 to restore the copper-oxide bridge 5 to its initial high impedance which removes the loss placed on the transmission line.

In case an exceptionally high energy peak occurs on the transmission line, then the gas-filled tube 34 is ignited to discharge the auxiliary condenser 36 through the current limiting elements 43 and 44 and to operate the relay 37. The discharge of condenser 36 removes plate voltage from the tube 34 and restores the tube to a non-conducting state. Operation of the re-

lay 37 effects short-circuiting of the resistance section 32 to discharge the control condenser 17 at a relatively rapid rate. The auxiliary condenser 36 is charged upon extinction of the tube 34 to provide hang-over in the operation of the relay 37. The hang-over in the operation of the relay 37 is made sufficiently long to insure a quick discharge of the control condenser 17.

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 variollosser in a signal transmission line, means comprising a control condenser for governing said variollosser according to the charge on the condenser, means for charging said condenser when the energy on the transmission line goes above a predetermined level, means for discharging said condenser at a normal rate, and means operated when very high amplitude peaks occur on said line for effecting a relatively quick discharge of said condenser.

2. In combination, a variollosser in a signal transmission line, means comprising a control condenser for governing said variollosser according to the charge on the condenser, means for charging said condenser when the energy on the transmission line beyond said variollosser goes above a predetermined level, means for effecting discharge of said condenser at a normal rate, and means for effecting a much faster discharge of said condenser when very high amplitude peaks occur on said line before said variollosser.

3. In combination, a variollosser in a signal transmission line, means comprising a control condenser for governing said variollosser according to the charge on the condenser, means for charging said condenser when the energy on the transmission line goes above a predetermined level, a resistance element in shunt to said condenser for controlling the discharge thereof, and means for short-circuiting a portion of said resistance to effect a relatively quick discharge of said condenser when very high amplitude peaks occur on said line.

4. In combination, a variollosser in a signal transmission line, means comprising a control condenser for governing said variollosser according to the charge on the condenser, a resistance element in shunt to said condenser for controlling the discharge thereof, means comprising a cold cathode tube for charging said condenser when the voltage on the transmission line goes above a predetermined level, and means comprising a relay operated when very high amplitude peaks occur on said line for short-circuiting a portion of said resistance to effect a quick discharge of the control condenser.

5. In combination, a variollosser in a signal transmission path, means comprising a control condenser for governing said variollosser according to the charge on the condenser, means for charging said condenser when the voltage on the transmission path goes above a predetermined level, a resistance in shunt to said control condenser for controlling the discharge thereof, a marginal gas-filled tube ignited when the voltage on the transmission path before said variollosser goes above a higher predetermined level, an

auxiliary condenser, means comprising a relay for short-circuiting a portion of said resistance to discharge said control condenser at a fast rate, means for discharging said auxiliary condenser and for operating said relay upon ignition of said tube, and means for charging said auxiliary condenser and for providing a hang-over in the operation of said relay upon release of said tube.

6. In combination, a variollosser in a signal transmission line, means comprising a control condenser for governing said variollosser according to the charge on the condenser, means for charging said condenser when the voltage on the transmission line beyond said variollosser goes above a predetermined level, means for effecting discharge of said condenser at a normal rate, a marginal gas-filled tube ignited when the amplitude of peaks on the transmission line before said variollosser goes above a higher predetermined level, means comprising a relay for effecting a relatively quick discharge of said control condenser, an auxiliary condenser, means for discharging said auxiliary condenser and for operating said relay upon ignition of said tube, and means for providing a hang-over in the operation of said relay and for charging said auxiliary condenser upon release of said tube.

7. In combination, a variollosser in a signal transmission line, means comprising a control condenser for governing said variollosser according to the charge on the control condenser, means comprising a marginal space discharge device for charging said condenser when the voltage on the transmission line beyond said variollosser goes above a predetermined level, means for effecting discharge of said control condenser at a normal rate, a marginal gas-filled tube ignited when the voltage on the transmission line before said variollosser goes above a higher predetermined level, an auxiliary condenser connected in shunt to said tube and discharged upon ignition of the tube, a relay for effecting a quick discharge of said control condenser upon operation of said tube and a circuit for operating said relay upon charging said auxiliary condenser.

8. In combination, a variollosser in a signal transmission line, means comprising a control condenser for governing said variollosser according to the charge on the control condenser, means comprising a marginal space discharge device for charging said condenser when the energy on the transmission line beyond said variollosser goes above a predetermined level, a resistance element connected in shunt to said control condenser to effect discharge of the condenser at a normal rate, a marginal gas-filled tube ignited when the energy on the transmission line before said variollosser goes above a second higher predetermined level, an auxiliary condenser connected in shunt to said tube and discharged upon ignition of the tube, a charging circuit for said auxiliary condenser, a relay having the energizing coil thereof connected in said condenser charging circuit and operated upon ignition of said tube, said relay upon operation thereof serving to shunt a portion of said resistance element to quickly discharge the control condenser, and means for providing a delay in the charging of the auxiliary condenser to insure a hang-over in the relay operation.

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