

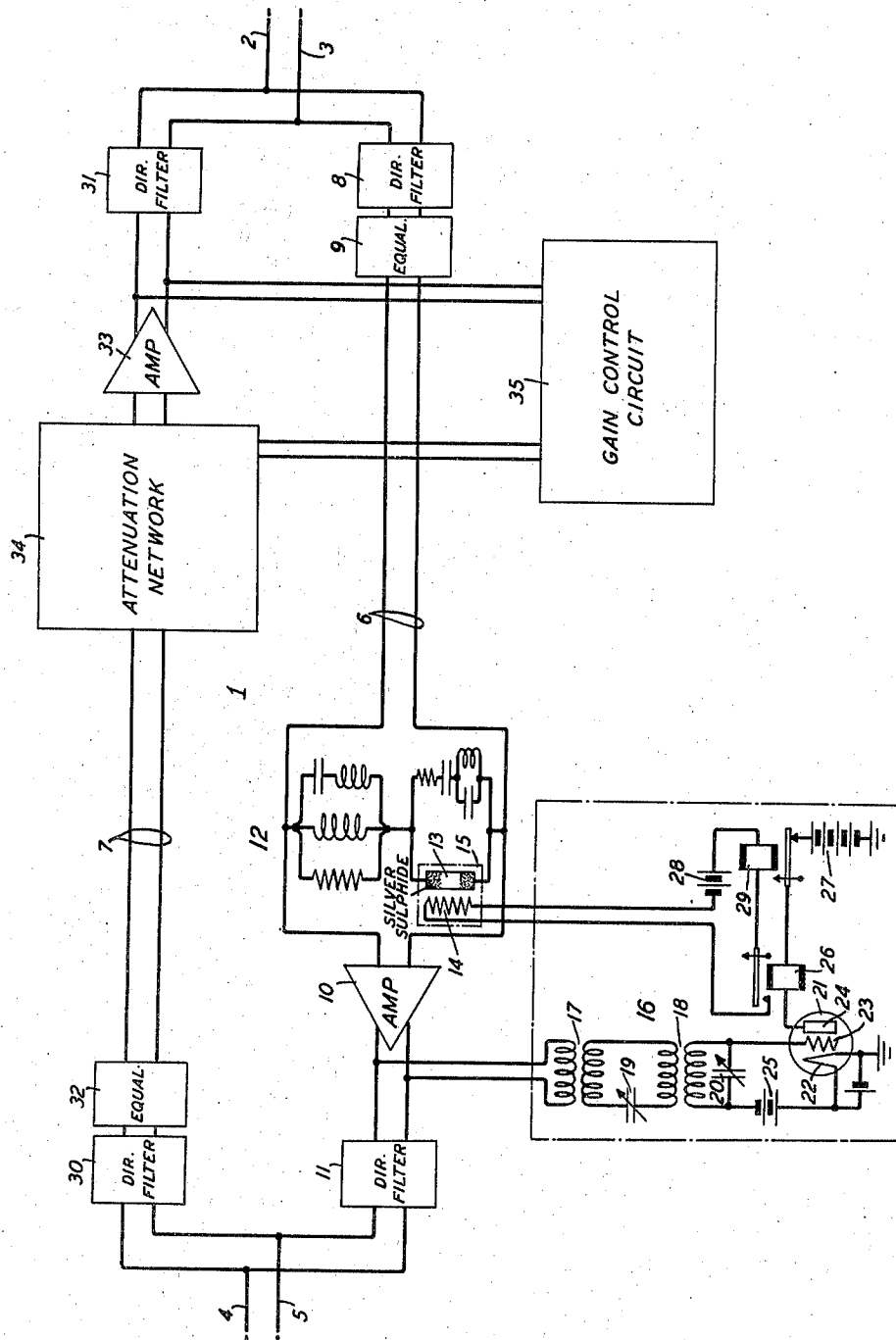
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GAIN CONTROL CIRCUITS

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GAIN CONTROL CIRCUITS

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This invention relates to gain control circuits for transmission lines and particularly to gain control circuits governed by pilot currents.

One object of the invention is to provide gain control circuits having a resistance element with a high temperature coefficient of resistance for governing the attenuation of a transmission line that shall control the temperature of the resistance element in an improved manner to hold the transmission line attenuation constant.

Another object of the invention is to provide gain control circuits having a resistance element with a high temperature coefficient of resistance for governing the attenuation of a transmission line that shall control the temperature of the resistance element by a gas-filled space discharge device according to the level of a pilot current on the transmission line to hold the transmission line attenuation constant.

A further object of the invention is to provide gain control circuits having an element of silver sulphide in a transmission line attenuation network for governing the line attenuation that shall control the temperature of the silver sulphide element by an intermittently operated gas-filled space discharge device according to the level of a pilot current on the transmission line to hold the transmission line attenuation constant.

The attenuation of a long transmission line varies with changes in the weather and changes in temperature. Changes in the attenuation of a transmission line prevents good quality of signal transmission and accordingly means must be provided to hold the line attenuation substantially constant. The attenuation of a transmission line may be conveniently controlled either by varying an attenuation network in the line or by controlling an amplifier repeater in the line.

The invention has been illustrated by means of a carrier current system having one range of carrier currents for transmitting signals in one direction and another range of carrier currents for transmitting signals in an opposite direction. A pilot current is provided for the signals transmitted in each direction. According to the invention the energy level of each pilot current is employed to control an attenuation network in the transmission line.

In the gain control circuits employed to describe the invention an attenuation network is connected across the transmission path in one direction at a repeater station. A similar network is connected across the path in the opposite direction at the repeater station. One ele-

ment of the network is preferably composed of silver sulphide but may be composed of other suitable materials such as zinc-oxide or barium. The element of silver sulphide is placed in an oven or heat chamber with a heater coil. The heater coil is controlled according to the energy level of the pilot current on the transmission line to maintain the attenuation of the transmission line in one direction substantially constant. The attenuation network is connected across the path ahead of an amplifying repeater. A filter which selects the pilot current for transmission in one direction is connected to the path beyond the amplifying repeater. The filter which selects the pilot current is connected to the input circuit of a gas-filled space discharge device which operates as a marginal device. The space discharge device is biased in order to prevent operation thereof until the energy level of the pilot current is raised above a predetermined level. A fast-operating slow-releasing relay is included in the plate circuit of the space discharge device. This relay controls an energizing circuit for the heater coil associated with the element of silver sulphide in the attenuation network. Thus, whenever the space discharge device is triggered off the energizing circuit for the heater coil is closed to heat the element of silver sulphide and reduce the resistance thereof. A second relay which is slow to operate and fast to release is included in the energizing circuit for the heater coil. The second relay serves to open the plate circuit for the gas-filled space discharge device and deenergize it so that its grid can again obtain control.

If the energy level of the pilot current is above a predetermined level, the gas-filled space discharge device is triggered off to effect operation of the relay in the plate circuit of the device. The relay in the plate circuit of the device completes the energizing circuit for the heater coil associated with the element of silver sulphide. The resistance of the silver sulphide element is reduced to increase the attenuation on the transmission path in one direction. A predetermined interval after the operation of the gas-filled space discharge device, the slow-to-operate relay is energized to break the plate circuit of the gas-filled space discharge device. At this time no further operation of the space discharge device will take place if the energy level of the pilot current has been reduced below the predetermined level. However, if the energy value of the pilot current is still above the predetermined value, then the trigger device will again be operated to again heat the element of silver sulphide. This

operation will continue to take place intermittently until the energy level of the signal on the transmission line is lowered below the predetermined value.

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

Referring to the drawing, a repeater station 1 is shown on a transmission line comprising output east conductors 2 and 3 and output west conductors 4 and 5. The repeater station 1 comprises an east-to-west channel 6 and a west-to-east channel 7. The two channels 6 and 7 are similar in construction and operation, and accordingly a detail description will be given only of the east-to-west channel 6. The transmission system employed to describe the invention is assumed to be a carrier current telephone system having one range of carrier currents for transmission of signals in one direction and another range of carrier currents for transmission in an opposite direction. A pilot current is included in the range of the currents for transmission from east to west for controlling the attenuation of the line in the east-to-west direction, and a similar pilot current is included in the range of the currents employed for transmission from west to east to control the attenuation of the line in the west-to-east direction.

30 The repeater channel 6 comprises a directional filter 8, which selects the range of carrier currents employed for transmission from east-to-west direction. An equalizing network 9, an amplifying repeater 10, and a second directional filter 11 which selects the range of carrier current, is employed in transmitting signals from the east to the west. Before the amplifying repeater 10, an attenuation network 12 is provided for controlling the attenuation of the transmission line from the east to the west direction. The attenuation network 12, which is connected across the channel 6, comprises suitable resistance capacity and inductance elements and also a variable resistance element 13 composed of silver sulphide. Although the resistance element 13 is shown in the form of silver sulphide, it is to be understood that other resistance elements having a high temperature coefficient of resistance may be employed, if so desired. Zinc oxide or barium may be employed, if so desired, in place of silver sulphide. A heater coil 14 is positioned adjacent the element 13 in a suitable oven or heat chamber 15. The heater coil 14 is controlled to vary the temperature of the silver sulphide element 13 and accordingly control the impedance of the attenuation network 12.

A filter 16, comprising transformers 17 and 18, and two adjustable capacity elements 19 and 20, is connected to the channel 6 beyond the amplifying repeater 10. The output circuit of the filter 16 is connected to the input circuit of a gas-filled space discharge device 21. The gas-filled space discharge device is marginal in its operation and may be filled with any suitable gas or vapor. The device 21 comprises a cathode 22, a grid 23 and an anode 24. A biasing battery 25 is provided in the input circuit of the gas-filled tube 21 for preventing operation or "triggering off" of the device until the energy level of the pilot current on the channel 6 is above a predetermined level.

The output circuit of the gas-filled space discharge device 21 includes a coil of a relay 26 which is quick to operate and slow to release, and an anode battery 27. The armature of the relay

26 controls a heating circuit for the coil 14 in the heating chamber 15. The energizing circuit controlled by the relay 26 includes a battery 28 and the coil of a relay 29 which is slow to operate and fast to release. The armature of the relay 29 is included in the output circuit of the gas-filled device 21.

If the energy level of the pilot current of the channel 6 is raised above the predetermined limit, the device 21 is operated to energize the slow releasing relay 26. The relay 26 on operation completes the energizing circuit for the heater coil 14. The heater coil 14 raises the temperature of the silver sulphide element 13 to lower the resistance thereof. The lowering of the resistance of the element 13 serves to control the attenuation network 12 so as to increase the attenuation on the transmission channel for transmitting signals from the east to the west. A predetermined time after the triggering off of the device 21, the relay 29 is operated to open the anode circuit of the device 21. A predetermined time after the operation of the relay 29, the relay 26 is released to open the energizing circuit for the heater coil 14 and relay 29.

If, at this time, the energy level of the pilot current on the channel 6 is still above the predetermined energy level, the device 21 will again be operated and the above cycle of operation will again be completed. However, if the energy level of the pilot current on the channel 6 has been reduced below the predetermined energy level, then the gas-filled space discharge device 21 will not be operated. The element of silver sulphide is allowed to slowly cool so that the attenuation on the transmission line will not be unduly reduced at any time. The heater coil 14 is intermittently operated in the above manner to insure that the attenuation on the transmission line in the east to the west direction is held substantially constant.

The transmission channel 7 comprises directional filters 30 and 31 which are similar to the directional filters 8 and 9 and select carrier currents employed for transmitting signals from the west to the east. An equalizing network 32 is provided which is similar to the equalizing network 9. The amplifying repeater 33 in the channel 7 is similar to the amplifying repeater 10 in the channel 6. An attenuation network 34 is provided in the channel 7 which is similar in construction and operation to the attenuation network 12 in the channel 6. The attenuation network 34 is controlled by gain control circuits 35 which are similar in construction and operation to the gain control circuits employed for controlling the attenuation network 12.

Modifications of the circuits and 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 transmission line carrying signal currents and a pilot current, an attenuation network comprising a resistance element connected to said line, said resistance element having a high negative temperature coefficient of resistance, a heating circuit for said resistance element, a gas-filled space discharge device having an anode and a cathode, a source of direct current connected to the anode of said device, means for igniting said device by said source when the pilot current level is raised above a predetermined value, means operative

substantially instantaneously upon ignition of said device for energizing said heating circuit, and means operating a predetermined time interval after energization of said heating circuit to extinguish said device, the igniting and extinguishing of said device continuing until the pilot current is at normal level.

2. In combination, a transmission line carrying signal currents and a pilot current, an attenuation network comprising an element of silver sulphide connected across said line, a coil for heating said element of silver sulphide, a gas-filled space discharge device, a source of direct current power for said device, means for igniting said device by said source when the level of the pilot current is raised above a predetermined value, means operative substantially instantaneously upon ignition of said device for heating said coil to decrease the resistance of said silver sulphide element, and means operative a predetermined time interval after energizing said coil to extinguish said device.

3. In combination, a transmission line carrying signal currents and a pilot current, an attenuation network comprising a resistance element having a high temperature coefficient of resistance, a gas-filled space discharge device, a direct current source of power for said device, means for operating said device from said source when the level of the pilot current is raised above a predetermined value, a coil for heating said element, means comprising a circuit controlled by said device for energizing said coil, and means operative a fixed time interval after the completion of said heating circuit for opening the output circuit of said device.

4. In combination, a transmission line carrying signal currents and a pilot current, a filter connected to said line for selecting the pilot current, a gas-filled space discharge device having the input circuit thereof connected to said filter, said device being ignited when the pilot current is raised above a predetermined level, an attenuation network connected across said line and comprising an element of silver sulphide, a coil for heating said element of silver sulphide, means comprising a slow releasing relay operated upon ignition of said device for energizing said heating coil, and means operative a predetermined interval after energizing said coil for extinguishing said device.

5. In combination, a transmission line carrying signal currents and a pilot current, an amplifier repeater on said line, a filter selecting said pilot current and connected to said line beyond the amplifier therein, a gas-filled space discharge device having the input circuit thereof connected to said filter, an attenuation network connected to said line before the amplifier therein, a resistance element having a high negative temperature coefficient of resistance included in said network, a coil for heating said resistance element, a quick operating and slow releasing relay controlled by said device for completing a circuit to heat said coil, and a slow operating and quick releasing relay in the circuit for heating said coil to open the plate circuit of said device.

6. In combination, a transmission line carrying signal currents and a pilot current, an amplifier repeater on said line, a filter connected to said line beyond said amplifier and selecting said pilot current, a gas-filled space discharge device having the input circuit thereof connected to said filter, said device being ignited when the pilot current is raised above a predetermined level, an attenuation network connected to said line before said amplifier and comprising an element of silver sulphide, a heating coil for said element, means comprising a slow releasing relay operated upon ignition of said device for energizing said heating coil, and means comprising a slow operating relay in the energizing circuit of said coil for extinguishing said device.

7. In combination, a transmission line carrying signal currents and a pilot current, an amplifier on said line, a filter connected to said line beyond said amplifier for selecting said pilot current, a gas-filled space discharge device having the input circuits thereof connected to said filter, said device being ignited when the pilot current is raised above a predetermined level, an attenuation network connected to said line before the amplifier therein, a silver sulphide resistance element included in said network, a heating coil for said element of silver sulphide, a quick operating and slow releasing relay controlled by said device for completing a circuit to heat said coil, and a slow operating and quick releasing relay in the circuit of said coil to open the plate circuit of said device.

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