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TRANSMISSION CIRCUIT

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FIG. 1

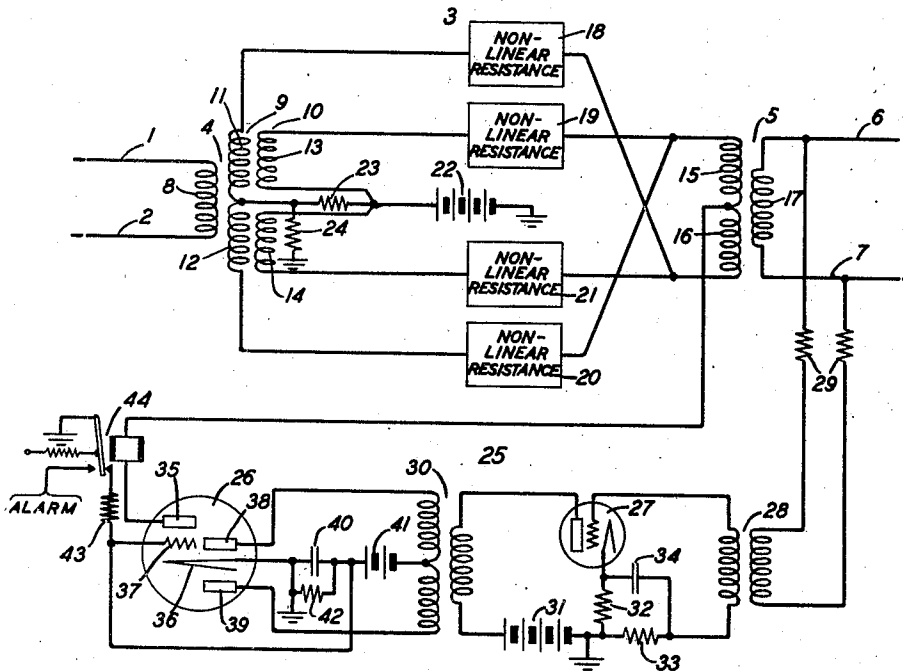
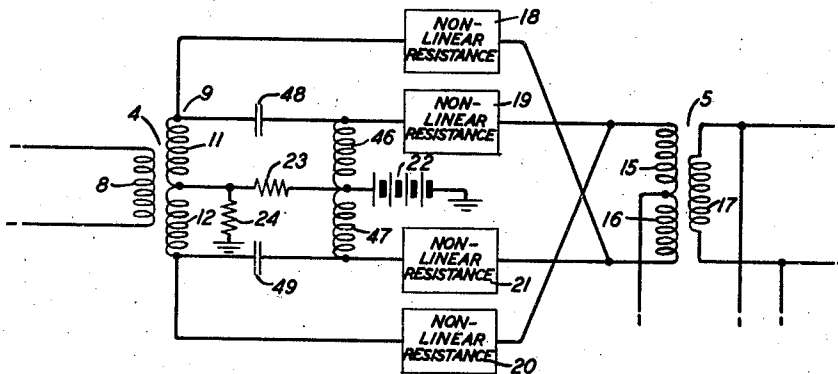


FIG. 2



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TRANSMISSION CIRCUIT

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14 Claims. (Cl. 178—44)

This invention relates to signal transmission circuits and particularly to control circuits for limiting the energy volume of the signals on transmission circuits.

One object of the invention is to provide a transmission circuit having an impedance pad composed of elements having non-linear resistance characteristics and connected across and in series with the circuit that shall control the impedance elements in an improved manner to limit the energy volume of the signals on the transmission circuit.

Another object of the invention is to provide a signal transmission circuit with an impedance network that shall be controlled by a feed-back circuit to limit the energy volume of the signals so that in case small peaks of signal go above a limit the signals will be compressed and in case of high signal peaks the signals will be subjected to volume reduction.

A further object of the invention is to provide a transmission circuit with an attenuation network having substantially constant input and output impedances and a low minimum loss and a feed-back circuit that shall control the attenuation network to limit the energy volume of the signals.

In many types of circuits it is very desirable to insure that the peaks of signal waves do not go above a predetermined energy level. In radio circuits, for example, trouble is often encountered by reason of over-modulation of broadcast transmitters. In case of over-modulation by a broadcast transmitter interference is often effected with broadcast stations operating in adjacent frequency bands.

According to the present invention the speech input circuit of a radio transmitter is provided with an energy volume limiter for insuring against over-modulation. The signals in the speech input circuit are so controlled that compression takes place in case of short peaks of signal waves above an upper limit and volume reduction takes place in case of high signal peaks.

A lattice network or pad having substantially constant input and output impedances and a low minimum loss is inserted in the speech input circuit of a radio transmitter. The impedance elements of the network are preferably composed of the material disclosed in the patent to K. B. McEachron No. 1,822,742, dated September 8, 1931. The impedance elements composed of silicon carbide crystals and a binder mixed with conducting material are connected in series and across the speech input circuit. The series and

cross-connected elements have their resistance value varied inversely with respect to each other by controlling the direct current flow through them. Networks of this type are shown in the patent to Andrew C. Norwine, No. 2,021,920, November 26, 1935.

A feed-back circuit which is connected to the speech input circuit at a point beyond the network or pad controls the impedance elements connected across and in series with the speech input circuit. The feed-back circuit comprises a diode-triode space discharge device having the plate circuit of the triode connected in circuit with the impedance elements of the lattice network. The diode of the space discharge device is connected to the speech input circuit by means of an amplifier-space discharge device. A condenser and a bias for the diode are connected in circuit with the diode. The condenser when charged impresses a negative bias on the grid of the triode and thus serves to control the current flow through the impedance elements of the lattice network in the speech input circuit. A bias is placed on the diode in order to prevent any control of the lattice network in the speech input circuit until the energy volume of the signals on the speech input circuit are raised above a predetermined level. Preferably two resistance elements are shunted across the control condenser in order to effect discharge of the condenser at two different rates. A relay having the energizing coil thereof in the plate circuit of the triode serves to open the shunt circuit of one of the resistance elements across the control condenser when the plate circuit of the triode is reduced below a predetermined limit.

When both the resistance elements are in shunt to the control condenser a discharge of the control condenser may be effected in five-tenths of a second. Thus, when only small peaks of the signals go above the predetermined upper limit, the condenser will be discharged in five-tenths of a second so that compression only of the signal waves on the speech input circuit is effected by means of the lattice network. If high peaks of the signal waves go beyond the predetermined upper limit, the space current flow through the triode is reduced to such a point that the relay in circuit therewith is released to open the shunt circuit of one of the resistance elements across the control condenser. In this case the condenser has a discharge rate of five seconds and accordingly volume reduction of the signals on the speech input circuit is effected. The charging time constant of the control condenser is pref-

erably of the order of five-hundredths of a second.

In the accompanying drawing,

Fig. 1 is a diagrammatic view of a volume limiter circuit constructed in accordance with the invention; and

Fig. 2 is a diagrammatic view of a modification of the lattice network shown in Fig. 1 of the drawing.

Referring to Fig. 1 of the drawing a speech input circuit for a radio transmitter is shown having input conductors 1 and 2 connected to a lattice network 3 by means of a transformer 4. The lattice network 3 is connected by a transformer 5 to output conductors 6 and 7. The transformer 4 comprises primary winding 8 and two equal secondary windings 9 and 10. The secondary winding 9 is divided into sections 11 and 12 and the secondary winding 10 is divided into sections 13 and 14. The transformer 5 comprises a primary winding divided into sections 15 and 16 and a secondary winding 17.

The lattice network 3 comprises four elements 18, 19, 20 and 21 which are composed of silicon carbide crystals and a binder mixed with conducting material. These elements have non-linear resistance characteristics. The impedance elements 19 and 21 are effectively connected in series with the speech input circuit and the impedance elements 18 and 20 are effectively connected across the speech input circuit. A battery 22 which is connected to the junction point of the sections 13 and 14 of the secondary winding 10 supplies potential for effecting a direct current flow through the impedance elements 18 to 21 inclusive to vary the resistance values of the elements. A resistance 23 of the order of 20,000 ohms is connected between the junction point of the sections 11 and 12 of the secondary winding 9 and the junction point of the sections 13 and 14 of the secondary winding 10. The terminal of the resistance 23 adjacent to the secondary winding 9 is grounded through a 5,000 ohm resistance 24. In the connection as above described if the battery 22 produces 220 volts, the drop across the resistance 23 will be of the order of 170 volts and the drop across the resistance 24 will be of the order of 50 volts.

A feed-back circuit 25 is provided for controlling the direct current flow through the impedance elements 18 to 21 inclusive according to the energy volume of the signals on the speech input circuit. The feed-back circuit comprises a diode-triode space discharge device 26 and an amplifier space discharge device 27. The input circuit of the amplifier device 27 is connected to the output conductors 6 and 7 of the speech input circuit by means of transformer 28 and two resistance elements 29. The output circuit of the amplifier 27 is connected by transformer 30 to the diode of the space discharge device 26. A battery 31 is provided for supplying plate potential to the amplifier 27 and resistance elements 32 and 33 and condenser 34 are provided for impressing a bias on the grid of the amplifier 27.

The triode of the space discharge device 26 comprises an anode 35, a cathode 36 and a grid 37. The diode comprises two anodes 38 and 39. A control condenser 40 and a battery 41 are connected in circuit with the diode of the space discharge device 26. The battery 41 serves to impress a bias on the diode so that no current can flow therethrough until this bias is overcome. In the circuit under consideration the bias is of the order of 22½ volts. The control condenser is charged by the current flow through the diode

when the bias produced by the battery 41 is overcome. The condenser 40 when charged serves to impress a negative bias on the grid 37 of the triode for controlling the operation of the triode.

The condenser 40 is normally shunted by two resistance elements 42 and 43. The shunt circuit of the resistance element 43 across the control condenser 40 is controlled by a relay 44 having the energizing coil thereof in the plate circuit of the triode of the space discharge device 26. The relay 44 is a high speed relay with a mechanical bias. In the operated position the relay 44 connects the resistance 43 across the control condenser 40 and in the release position the shunt circuit of the resistance 43 is broken and an alarm not shown is operated. In the circuit under consideration a discharge of the condenser 40 may be effected in the order of five tenths of a second when the condenser is shunted by both the resistance elements 42 and 43. When the control condenser 40 is shunted only by the resistance element 42 a discharge of the condenser will take place in about five seconds. The charging rate of the condenser 40 in the circuit under consideration is of the order of about five hundredths of a second.

Assume that the signals on the speech input circuit are below the predetermined upper limit and that no charge is impressed on the control condenser 40. At this time a circuit is completed from the grounded battery 22 through the impedance elements 19 and 21 in parallel, coil of the relay 44 and plate circuit of the triode to ground. The impedance elements 19 and 21 connected in series with the speech input circuit will have a maximum direct current flow therethrough so that their resistance values will be reduced to a minimum. The voltage drop across each of the impedance elements 19 and 21 will be of the order of 170 volts and the voltage drop across the triode will be of the order of about 50 volts. The current flow through the impedance elements 18 and 20, which are connected across the speech input circuit, depends upon the relation of the voltage drop across the resistance 23 and the voltage drop across the impedance elements 19 and 21. The voltage drop across the impedance elements 19 and 21 is in opposition to the voltage drop across the resistance element 23 in the circuits of the impedance elements 18 and 20. In the situation under consideration there will be no current flow through the impedance elements 18 and 20 because the voltage drop across the impedance elements 19 and 21 is equal and opposite to the voltage drop across the resistance element 23. In the circuit under consideration the plate current flow through the triode is of the order of about five milliamperes and the loss through the lattice network 3 is less than four decibels.

If the peaks of the signal waves go above the predetermined upper limit for short periods the bias on the diode of the device 26 will be overcome and a charge is placed on the control condenser 40. The circuits of the diode may be traced from the cathode 36 through the condenser 40, battery 41 and the two sections of the secondary winding of the transformer 30 in parallel to the anodes 38 and 39. The charge impressed on the condenser 40 places a negative bias on the grid 37 of the triode. This lowers the space current flow through the triode and accordingly lowers the voltage drop across the impedance elements 19 and 21 which are effectively connected in series with the speech input

circuit. A reduction in the voltage drop across the impedance elements 19 and 20 serves to effect current flow through the impedance elements 18 and 20 which are connected across the speech input circuit. Inasmuch as the resistance values of the impedance elements 18 to 21 varies in accordance with the direct current flow through them, the resistance values of the impedance elements 19 and 21 are increased and the resistance values of the impedance elements 18 and 20 are reduced. Accordingly, the loss of the lattice network 3 in the line is increased to limit the signal volume. At this time it is assumed that the resistance elements 42 and 43 are both connected in shunt to the control condenser 40. Accordingly, the condenser will be discharged in five tenths of a second and only compression of the signals on the speech input circuit will be effected.

Assume that high peaks of the signal waves go above the predetermined upper limit so that a relatively large charge is impressed on the condenser 40. Under these conditions a negative bias will be impressed on the grid 37 of the triode to reduce the space current flow through the triode sufficiently to release the relay 44.

Upon release of the relay 44 the shunt circuit for the resistance element 43 across the control condenser 40 is opened. Under these conditions the condenser 40 can only be discharged in five seconds and accordingly volume reduction of the signals on the speech input circuit will take place. The voltage drop across the series impedance elements 19 and 21 in the circuit under consideration will vary from 85 volts to 170 volts. For minimum loss of the network in the speech input circuit the drop across the impedance elements 19 and 21 will be 170 volts and for maximum loss the voltage drop across the impedance elements 19 and 21 will be 85 volts. The voltage drop across the impedance elements 18 and 20 varies from zero for minimum loss of the network to 85 volts for maximum loss for the network.

In the above manner the charge on the control condenser 40 in circuit with the diode is varied according to the energy value of the signals on the speech input circuit. The control condenser 40, in turn, varies the space current flow through the triode of the device 26 for varying the direct current flow through the impedance elements 18 to 21 inclusive. The impedance of the elements 18 to 21 varies in accordance with the direct current flow through them. The resistance values of the elements 19 to 21 vary inversely with respect to the resistance values of the impedance elements 18 and 20 when controlled by the feed-back circuit.

Referring to Fig. 2 of the drawing a modification of the lattice network 3 shown in Fig. 1 is illustrated. Similar parts in the circuit shown in Fig. 2 of the drawing will be indicated by like reference characters. In the circuit shown in Fig. 2 of the drawing the secondary winding 10 of the transformer 4 is dispensed with. An inductance coil with two windings 46 and 47 which are not in inductive relation with the transformer 4 connect the battery 22 to the impedance elements 19 and 21. The circuit from the secondary winding 9 through the impedance elements 21 is effected by means of condensers 48 and 49. The condensers 48 and 49 block any direct current flow directly between the impedance elements 18 and 19 and 20 and 21. The impedance network shown in Fig. 2 of the drawing operates in the same manner as the imped-

ance network shown in Fig. 1 and a detailed description of the operation thereof is deemed unnecessary.

Modifications in the circuits and in the arrangements and location of parts may be 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 circuit, an attenuation network provided with impedance elements having non-linear resistance characteristics connected in series with and across said signal circuit, a diode-triode having the plate circuit of the triode connected in series with said elements, control means comprising a control circuit governed by the energy volume of the signal on the signal circuit when small signal peaks go above a predetermined limit for controlling said diode and means comprising a condenser controlled by said diode for governing said triode to vary the resistance values of said series and cross-connected impedance elements inversely to limit the energy volume on the signal circuit.

2. In combination, a signal circuit, an attenuation network provided with elements of silicon carbide crystals with a binder material connected in series with and across the signal circuit, a diode-triode having the plate circuit of the triode connected in series with said impedance elements and control means comprising a condenser governed by said diode according to the energy volume on the signal circuit when small signal peaks go above a predetermined limit for controlling said triode to vary the resistance values of said series and cross-connected impedance elements inversely to limit the energy volume on the signal circuit.

3. In combination, a signal circuit, an attenuation network provided with elements of silicon carbide crystals with a binder material, said elements being connected in series with and across the signal circuit, means comprising a space discharge device having the plate circuit thereof connected in series with said elements for varying the resistance values of said series and cross-connected elements inversely, means comprising a condenser for controlling said device according to the energy volume of the signals when the signal peaks go above a predetermined upper limit and means for effecting volume compression and volume reduction of the signals according to the height of the signal peaks and the charge on said condenser.

4. In combination, a signal circuit, an attenuation network having impedance elements connected in series with and across said signal circuit, said elements having non-linear resistance characteristics and varying in resistance according to the direct current flow therethrough, a control circuit connected to the signal circuit, a diode-triode having the diode thereof governed by said control circuit according to the energy of the signal on said signal circuit when small signal peaks go above a predetermined limit, and means comprising a condenser controlled by said diode for controlling said triode to vary the resistance values of said cross-connected and series impedance elements inversely to limit the energy volume on the signal circuit.

5. In a radio transmitter, a speech input circuit, a lattice network having elements composed of silicon carbide crystals and a binder material arranged in series with and across said input circuit, means comprising a diode-triode for con-

trolling said network to vary the resistance values of the cross-connected and series elements inversely, a condenser for controlling the triode according to the condenser charge and means
5 for charging said condenser by said diode according to the energy volume of the signals when the signal peaks go above a predetermined limit to limit the energy volume of the signals.

6. In a radio transmitter, a speech input circuit, a lattice network having non-linear resistance elements arranged in series with and across said input circuit, a feed-back circuit connected to said input circuit beyond said network, a diode-triode space discharge device having the
10 diode connected to said feed-back circuit and the output circuit of the triode connected to said network, means for impressing a negative bias on said diode and for impressing a negative bias on the grid of the triode when the potential on the diode from feed-back circuit overcomes the bias on the diode, and means for controlling said non-linear resistance elements by said triode to limit the volume on the speech input circuit beyond the network.

7. In combination, a signal circuit, variable impedance means in said circuit, and control means governed by the signals on the signal circuit for controlling said impedance means to effect compression of the signals in case only
20 small peaks go above an upper limit and for controlling said impedance means to effect reduction in volume of the signals in case of high energy peaks above the upper limit.

8. In combination, a signal circuit, a variable impedance means in said circuit, and control means comprising a feed-back circuit connected to the signal circuit beyond the impedance means for controlling said impedance means to compress the signals in case of small peaks and for
30 controlling said impedance to effect volume reduction in case of high peaks.

9. In combination, a signal circuit, a variable impedance in said circuit, a condenser, means for controlling said impedance according to the charge on said condenser, means for impressing
40 a charge on said condenser according to the energy of the signals on the signal circuit, and means for discharging said condenser at two different rates according to the heights of the energy peaks of the signals on the signal circuit.

10. In combination, a signal circuit, a variable impedance in said circuit, a condenser, control means for controlling said impedance according to the charge on said condenser, means for impressing a charge on said condenser according to the energy of the signals on the signal circuit, means for preventing charging of said condenser until the signals have reached a predetermined upper energy level, and means for discharging
50 said condenser at two different rates to effect compression of the signals in case only small signal peaks go above the upper limit and to effect volume reduction of the signal in case high peaks go above the upper limit.

11. In combination, a signal circuit, a variable impedance in said circuit, a diode-triode space

discharge device, means for controlling said impedance according to the space current flow through the triode of said device, a condenser for impressing a variable bias on the grid of the triode to control the resistance value of said impedance, means comprising a feed-back circuit
5 connected to said diode to charge said condenser according to the signals on said signal circuit, a bias on the diode to prevent charging of the condenser until the signal peaks are above a predetermined level, and means for discharging said condenser at two different rates according to the heights of the energy peaks of the signals on the signal circuit.

12. In combination, a signal circuit, a variable impedance pad in said circuit, means comprising a space discharge device for controlling said pad to limit the energy volume of the signals on the signal circuit, a condenser for impressing a variable bias on said device to control the impedance
20 value of said pad, means for impressing a charge on said condenser according to the energy of the signals on said signal circuit, and means for discharging said condenser at one rate to effect compression of the signals in case small peaks of signals go above an upper limit and means for discharging said condenser at another rate to effect volume reduction in case of signals with high peaks.

13. In combination, a signal circuit having a variable impedance therein, a diode-triode space discharge device, means for controlling said impedance according to the operation of the triode, a condenser in circuit with said diode to control the bias on the grid of said triode, a bias on said diode, a feed-back circuit connected to the diode for charging said condenser when the signal peaks are high enough to overcome the diode bias, two resistance elements connected in shunt to said condenser for discharging said condenser rather rapidly when the signal peaks are relatively low, and means controlled by the triode of said device for opening the shunt circuit of one of said resistance elements across the condenser when the signal peaks are relatively high to effect
40 a slow discharge of said condenser.

14. In combination, a signal circuit having a variable impedance therein, a diode-triode space discharge device, means for controlling said impedance according to the operation of the triode, means comprising a condenser in circuit with the diode for impressing a bias on the grid of the triode, a bias on said diode, a feed-back circuit connected to the diode for charging said condenser when the signal peaks on the signal line are high enough to overcome the diode bias, two resistance elements respectively connected in shunt to said condenser for discharging the condenser at one rate when the signal peaks are relatively low, and means comprising a relay controlled by the triode for opening the shunt circuit of one of said resistance elements when the signal peaks are relatively high to effect a slow discharge of said condenser.

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