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A. M. CURTIS

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SIGNAL TRANSMISSION LINE

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FIG. 1

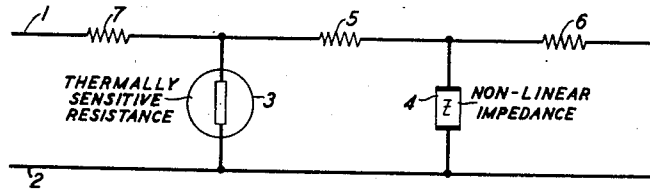


FIG. 2

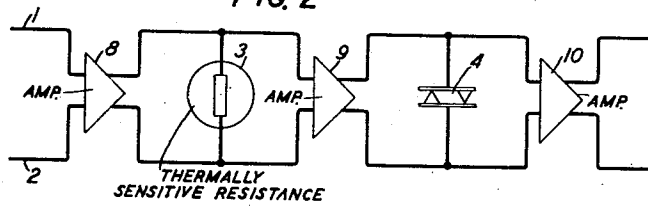


FIG. 3

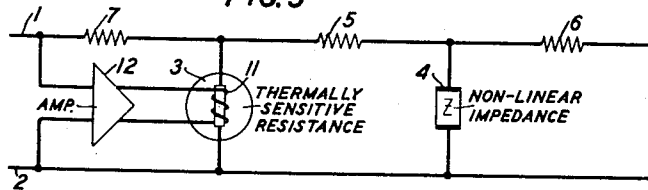
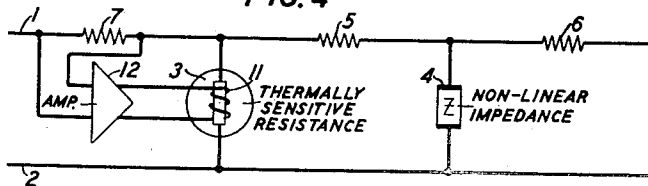


FIG. 4



INVENTOR
A.M. CURTIS
BY
Wayne B Wells
ATTORNEY

UNITED STATES PATENT OFFICE

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SIGNAL TRANSMISSION LINE

Austen M. Curtis, South Orange, N. J., assigner
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

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10 Claims. (Cl. 178—44)

This invention relates to signal transmission lines and particularly to volume limiters for signal transmission lines.

One object of the invention is to provide a signal circuit with a volume limiter having quick-acting and slow-acting varistors to limit the signal volume without introducing objectional distortion of the signals.

Another object of the invention is to provide a signal circuit with an improved volume limiter comprising a quick-acting varistor connected across the signal circuit to effect instantaneous limiting of high signal peaks and a relatively slow-acting varistor connected across the signal circuit to assume control of the signal peak limiting operation after a time delay.

A further object of the invention is to provide a signal circuit with a volume limiter comprising a quick-acting varistor connected across the signal circuit to effect instantaneous chopping of high signal peaks and a varistor having a resistance element with a high negative temperature coefficient of resistance which is connected across the signal circuit and which is controlled by the signals to assume control of the signal peak limiting operation a time interval after the operation of the quick-acting varistor.

Telephone circuits are at times subjected to strong syllabic peaks which may overload apparatus on or connected to the circuits. In circuits subjected to high energy peaks it is desirable to provide signal peak limiters which operate substantially instantaneously to insure against overloading apparatus connected to the circuit.

A varistor composed of silicon carbide crystals with a binder material or copper oxide may be connected across a signal circuit to instantaneously limit the peaks of strong signals. The varistor may also be in the form of a gas-filled space discharge device. However, instantaneous limiters of the above-mentioned type have the tendency to generate harmonics which make the quality of the strong syllables raspy and unpleasant.

According to the present invention two resistance elements are connected across the signal circuit for limiting the peaks of strong syllables. One of the resistance elements is instantaneous in operation to limit the peaks of strong syllables. The resistance element having an instantaneous operation in limiting the signal peaks may be silicon carbide crystals with a binder material, copper oxide or a gas-filled space discharge device. The other resistance element connected across the signal circuit is slow-acting in limiting the peaks of strong signals. The slow-acting limiter

is preferably thermally controlled according to the signal peaks and may be any suitable material having a high negative temperature coefficient of resistance. The slow-acting limiter resistance may be silver sulphide or boron and may be heated directly or indirectly by the signals. The quick-acting resistance is connected across the signal circuit ahead of the slow-acting resistance. Series resistance means are connected in the signal circuit between the connections of the two resistance elements to the circuit, before the slow-acting resistance element and beyond the quick-acting resistance element.

In a volume limiter circuit constructed in accordance with the invention the quick-acting resistance element first limits the peak of strong syllables and very soon thereafter the slow-acting resistance element takes control of the limiting operation away from the quick-acting resistance element. The transfer of the limiting operation control from the instantaneous peak limiter to the slow-acting thermal limiter reduces the period during which objectional harmonics are produced to a small fraction of a second.

When a signal having a strong energy peak appears on the signal circuit, an over-strong and rapidly building up wave front is applied to the two varistors. This strong wave front finds the impedance of the thermal varistor very high but the amplitude of the wave front at the output is instantaneously reduced by the quick-acting varistor. However, a large part of the input voltage is still applied to the thermal varistor which heats and reduces its impedance. This removes excess voltage from the instantaneous varistor which then ceases to limit and distort the signal wave. The transition period in the above operation may last from .05 to .5 second. After the over-strong current has returned to normal, the thermal varistor cools relatively slowly, reducing the loss through the volume limiter to its normal amount.

In the accompanying drawing Fig. 1 is a diagrammatic view of a circuit constructed in accordance with the invention;

Figs. 2, 3 and 4 are diagrammatic views of modifications of the circuit shown in Fig. 1 of the drawing.

Referring to Fig. 1 of the drawing a signal circuit which may be a telephone line is shown comprising conductors 1 and 2. Two varistors 3 and 4 are connected across the conductors 1 and 2 for limiting the peaks of the transmitted signals. The varistor 4 is quick-acting and in

the circuit shown in Fig. 1 is assumed to be composed of silicon carbide crystals combined with a binder material. A varistor composed of silicon carbide crystals with a binder material operates instantaneously in limiting the peaks of strong syllables.

The varistor 3 shown in Fig. 1 of the drawing is composed of silver sulphide which is heated directly by the signals on the signal circuit. Silver sulphide, which has a high negative temperature coefficient of resistance, does not heat instantly and does not operate to limit the peaks of the signals on the circuit comprising the conductors 1 and 2 until a period of time after the operation of the instantaneously acting varistor 4. A series resistance or impedance 5 is connected in the circuit between the connections of the varistors 3 and 4, an impedance or resistance 6 is connected in the circuit beyond the varistor 4 and an impedance or resistance 7 is connected in the circuit before the varistor 3. The impedance or resistance 7 may represent the telephone circuit or an amplifier of any definite output impedance which is high in relation to the resistance of the thermal varistor 3 when heated. The resistance 6 may represent the input circuit of an amplifier or similar circuit high in impedance relative to the resistance of the instantaneous-acting varistor 4 when subjected to a voltage to be limited. The resistance 5 serves to insure that the operation of the instantaneous varistor 4 does not reduce the current through the thermal varistor sufficiently to interfere with its operation. The resistance 5 may, if so desired, be in the form of an amplifier.

When the conductors 1 and 2 are subjected to a signal having a high energy peak, the quick-acting varistor 4 operates substantially instantaneously to chop the high peak. A limited period after the operation of the quick-acting varistor, the slow-acting thermal varistor 3 is heated sufficiently to take away the peak limiting operation from the quick-acting varistor. The transfer of the limiting operation from the quick-acting varistor to the slow-acting varistor is effected sufficiently quick to prevent any objectionable distortion of the signal.

Referring to Fig. 2 of the drawing, a modification of the circuit shown in Fig. 1 is illustrated wherein like parts will be indicated by similar reference characters. The signal circuit comprising conductors 1 and 2 has a thermal varistor 3 connected across it similar to the thermal varistor shown in Fig. 1. The quick-acting thermal varistor 4 is composed of a pair of copper oxide elements poled oppositely in place of silicon carbide crystals with a binder material as shown in Fig. 1 of the drawing. The impedance elements 7, 5 and 6 shown in Fig. 1 of the drawing are replaced by amplifiers 8, 9 and 10 in Fig. 2 of the drawing. The circuit shown in Fig. 2 of the drawing operates in the same manner as the circuit shown in Fig. 1 of the drawing.

The modified circuit shown in Fig. 3 of the drawing is the same as the circuit shown in Fig. 1 except that the thermal varistor 3 is heated by heater coil 11 in place of being heated directly by the signals on the signal circuit. The heater coil 11 is connected to the output circuit of an amplifier 12. The input circuit of the amplifier 12 is connected across the conductors 1 and 2 before the resistance element 7.

The circuit shown in Fig. 4 of the drawing is the same as the circuit shown in Fig. 3 of the drawing except that the input circuit of the am-

plifier 12 is connected across the resistance 7 in place of being connected across the conductors 1 and 2. The circuit shown in Figs. 3 and 4 operates in the same manner as the circuit shown in Fig. 1 of the drawing.

Modifications in the circuits 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, two peak limiter impedance elements on said line for limiting the peaks of the signals, each of said limiter impedance elements being operated by waves of the same amplitude, one of said impedance elements being relatively quick-acting and the other impedance element being relatively slow-acting.

2. In combination, a signal transmission line, impedance means effectively connected in series with said line, a relatively quick-acting variable impedance element connected across said line after said series impedance means for quickly limiting the peaks of the signals, a relatively slow-acting variable impedance element connected across said line before said series impedance means for limiting the signal peaks after a time delay.

3. In combination, a signal transmission line, resistance means effectively connected in series with said line, a relatively quick-acting resistance means connected across said line beyond said series resistance means, a heat controlled resistance means connected across said line before said series resistance, and means for heating said heat controlled resistance means according to the energy level of the signals, said heat controlled resistance means operating after a time delay to limit the signal peaks.

4. In combination, a signal transmission line, a peak limiter impedance element connected across said line, said element being relatively fast in operation to limit high signal peaks, and a second signal peak limiter impedance element connected across said line before said first-mentioned impedance element, said second impedance element being slow in operation to take effect in limiting high signal peaks a period of time after the operation of said first-mentioned impedance element.

5. A peak signal limiter for a signal transmission line comprising a quick-acting peak limiter resistance element connected across said line, a relatively slow-acting peak limiter resistance element connected across said line before said quick-acting peak limiter resistance element, and resistance means connected in series with said line beyond said quick-acting peak limiter, between said quick-acting and slow-acting resistance elements and before said slow-acting peak limiter resistance element.

6. A peak signal limiter for a signal transmission line comprising a quick-acting peak limiter resistance means connected across said line to limit the peaks of strong energy signals, and a second peak limiter resistance means connected across said line before said quick-acting peak limiter resistance means, said second peak limiter resistance means comprising a resistance element having a high negative temperature coefficient of resistance and heated by the signals on the line.

7. A signal peak limiter for a signal transmission line comprising a quick-acting peak limiter

resistance means connected across said line to limit the peaks of strong energy signals, a second peak limiter resistance means connected across the line before said quick-acting peak
 5 limiter resistance means, said second resistance means comprising a resistance element having a high negative temperature coefficient of resistance, and resistance means connected in series with said line between said quick-acting and said
 10 slow-acting resistance means.

8. A signal peak limiter for a signal transmission line comprising a quick-acting resistance means connected across said line to limit the peaks of strong energy signals, a second peak
 15 limiter resistance means connected across the line before said quick-acting peak limiter resistance means, said second resistance means comprising a resistance element having a high negative temperature coefficient of resistance, resist-
 20 ance means connected in series with said line before said second resistance means, between said quick-acting resistance means and the second resistance means and beyond the quick-acting resistance means, and means for heating said
 25 second resistance means according to the energy level of the signal on the line ahead of the resistance means before the resistance having a high negative temperature coefficient of resistance.

9. A signal peak limiter for a signal transmission line comprising a quick-acting peak limiter resistance means connected across said line to limit the peaks of strong energy signals, said
 5 quick-acting peak limiter resistance means comprising silicon carbide crystals and a binder material, and a second peak limiter resistance means connected across said line before said quick-acting peak limiter means, said second peak limiter
 10 resistance means comprising a resistance element having a high negative temperature coefficient of resistance and heated under control of the signals on the line.

10. A signal peak limiter for a signal transmission line comprising a quick-acting peak limiter
 15 resistance means connected across said line to limit the peaks of strong energy signals, said quick-acting peak limiter resistance means comprising copper oxide elements, and a second peak limiter resistance means connected across said
 20 line before said quick-acting peak limiter means, said second peak limiter resistance means comprising a resistance element having a high temperature coefficient of resistance and heated under
 25 control of the signal on the line.

AUSTEN M. CURTIS.