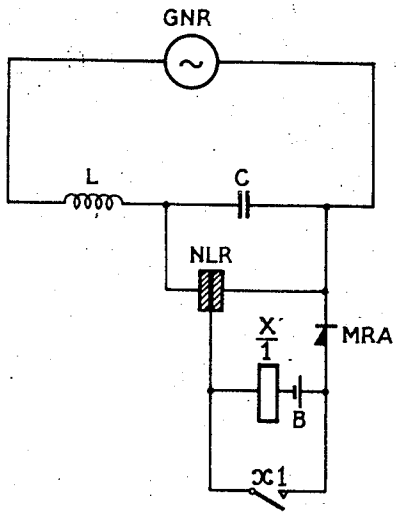
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ELECTRICAL CIRCUIT EMPLOYING NONLINEAR RESISTANCE MATERIAL

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INVENTOR
THOMAS GEORGE RICE

BY Chas. Le. Candy

ATTORNEY

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ELECTRICAL CIRCUIT EMPLOYING NON-LINEAR RESISTANCE MATERIAL

Thomas George Rice, Huyton, near Liverpool, England, assignor to Automatic Electric Laboratories Inc., Chicago, Ill., a corporation of Delaware

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The present invention concerns improvements in or relating to circuits employing non-linear resistance material and in particular to non-linear resistance material of the kind in which the resistance falls with an increase of applied voltage and is substantially independent of the direction in which the current flows. Such resistance material usually consists of a combination of silicon carbide mixed with carbon and/or tungsten or molybdenum which is agglomerated under pressure and subsequently baked. It is conveniently made up in the form of discs, rods or the like and electrodes are sprayed on the surfaces.

It is an object of the present invention to make use of the resistance properties of such non-linear resistance material so as to influence a low voltage circuit including such material by means of a higher voltage derived from a circuit not adapted to supply a substantial amount of power.

According to the invention a circuit arrangement is provided employing non-linear resistance material of the kind above referred to and is characterised in that such material provided with suitable electrodes is included in a closed low voltage circuit, a higher voltage being adapted to be applied to said material without making any circuit changes in the low voltage circuit to effect an increase of current in said circuit.

An inductive device in said low voltage circuit is adapted to enable the increase of current to be utilised or indicated.

The non-linear resistance material may consist of a single piece of material having separate electrodes for the high and the low voltage source or it may consist of a number of discs arranged back to back so that the electrodes of adjoining discs make contact, the low voltage circuit being connected across one or more of said discs and the high voltage source being connected across other discs including the discs included in the low voltage circuit. The high voltage source may be derived from a tuned circuit, for instance a condenser and inductance in series, the high voltage source being taken from across the condenser terminals or from a step-up transformer. Further it may be controlled by signals sent from a distance or the initiating voltage may be locally generated.

The invention will be better understood by referring to one example of carrying it into effect which will be described with reference to the accompanying drawing, although it will be understood that considerable modifications may be made on the lines indicated above.

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Referring to the drawing, the non-linear resistance material NLR is represented by two discs each having electrodes sprayed on both sides thereof. The two discs are placed back to back so that electrodes thereof are in electrical contact. The low voltage circuit consists of a battery B, a relay X and one of the discs of non-linear resistance material NLR. Possibly a rectifier such as MRA may be provided, but this is not essential. Under these conditions the resistance of the disc in series with the relay X and battery B is high as determined by the voltage of the battery B and the relay X will not operate. The high voltage circuit consists of a generator GNR which may be at a distant station and may be connected through valves, transformers and the like to the terminals of an inductance L and capacity C in series. The inductance L and capacity C are tuned to a certain frequency and if even a weak voltage of the frequency to which they are tuned is applied across the terminals of L and C in series, a comparatively high voltage is generated across the condenser C or the inductance L provided that the effective resistance in the circuit is sufficiently low. The terminals of the condenser C are connected across the outside electrodes of the two discs of non-linear resistance material. It is found that when current of the appropriate frequency is applied across the inductance and condenser in series the relay X operates and if desired it can lock operated through the contact $x1$. In this way a very convenient A. C. relay for responding to a particular frequency has been evolved. It will be understood that there may be a number of frequencies received over a line but that only for the frequency for which L and C are tuned will the relay operate. It has been found in one example that if the battery B has a voltage of 20 volts and the inductance and capacity are tuned to a frequency of 750 cycles, and a voltage of a sufficiently weak character and having a frequency of 750 cycles is applied across their terminals, then variations in the frequency of this voltage beyond 5 cycles either way from the frequency of 750 cycles will prevent the operation of relay X, which will however operate if the frequency is within the band width mentioned.

It is also to be noted that by means of the circuit disclosed very small powers incapable of operating a relay without the use of an amplifier of some kind can be made to operate a relay thereby indicating that the device has ampli-

fying properties. Such amplifying properties by suitable adaptations of the circuit may be used for the purpose of further amplifications or feedback circuits may be made use of as in thermionic valves, having regard of course to the different properties of such valves and the material under consideration.

What I claim as new and desire to secure by Letters Patent is:

1. In combination, a non-inductive non-linear electrical resistance device having a high resistance at low voltages and a low resistance at high voltages, a low voltage circuit connected across at least a portion of said resistance device, a high voltage circuit connected across said resistance device, and means for impressing a high voltage from said high voltage circuit across said resistance device, to cause a substantially increased current flow in said low voltage circuit and said resistance device.

2. In combination, a non-inductive electrical resistance device having a high resistance at low voltages and whose resistance decreases substantially instantaneously to a low value at high voltages, a closed circuit connected across at least a part of said resistance device and including a low voltage source of current, and means for connecting a high voltage of the proper value across said resistance device and in parallel with said closed circuit to cause a substantially increased current flow in said closed circuit and said resistance device.

3. In combination, a non-inductive electrical resistance device having a high resistance at low voltages and whose resistance decreases substantially instantaneously to a low value at high voltages regardless of the direction of current flow, a closed circuit connected across at least a part of said resistance device and including a low voltage source of direct current, and means for impressing a high voltage across said resistance device and in parallel with said closed circuit to cause a substantially increased current flow in said closed circuit and said resistance device.

4. In combination, a non-inductive electrical resistance device whose resistance decreases substantially instantaneously to a comparatively low value when subjected to a high voltage regardless of the polarity of said high voltage, a low voltage circuit connected across said resistance device and including a low voltage source of direct current, and means for impressing a high voltage of alternating polarity across said resistance device and in parallel with said low voltage circuit to cause a substantially increased current flow in said low voltage circuit.

5. In combination, an electric circuit including a non-inductive high-resistance device whose resistance decreases substantially instantaneously to a low value at high voltages regardless of the polarity of said voltages, a second circuit including a low voltage source of direct current and connected across said resistance device, means for impressing an alternating high voltage from said first named circuit across said resistance device whose resistance is thereby decreased suddenly to cause a substantially increased current flow in said second circuit, and a unidirectional current conducting device connected in series with said low voltage source.

6. In an electric circuit, two or more resistance devices whose resistance is high at low voltages but drops to a low value substantially instantaneously at high voltages regardless of the polarity of said voltages, said resistance devices

being provided with suitable electrodes and connected in series with one another through said electrodes, a closed circuit including a source of low voltage connected in parallel with a portion of said resistance devices between an outer electrode and an inner electrode, means for connecting an alternating high voltage across said portion of said resistance devices and an additional one or more of said devices, to cause a sudden decrease in the resistance of said devices and a substantially increased current flow in said closed circuit from said low voltage source.

7. In an electric circuit, a tuned network, two or more resistance units which are substantially non-conducting at low voltages but have a low resistance at high voltages regardless of the polarity of said high and low voltages, said resistance units being connected in series with one another and in parallel with one element of said tuned network, a low voltage circuit connected in parallel with a portion of said resistance units and including a low voltage source of direct current, means for causing an alternating high voltage to appear across said one element of said tuned circuit, thereby to cause a sudden decrease in the resistance of said resistance units and an increase in the current flow through said low voltage circuit, and inductive means in said low voltage circuit responsive to said increased current flow.

8. In an electric circuit, a source of alternating voltage, a reactor and a condenser connected in series and tuned to a certain frequency, a plurality of non-inductive resistors of the type in which the resistance falls suddenly from a high value to a low value with a given increase in voltage, said resistors being connected in series with one another and in parallel with said condenser in a closed circuit, a second closed circuit connected in parallel with a portion of said resistors, said second closed circuit comprising an electromagnetic device and a source of direct current connected in series, the current flow in said second closed circuit being normally inadequate to operate said electro-magnetic device, and means for impressing an alternating voltage of said certain frequency across said reactor and condenser to increase the voltage across said condenser and said resistors and reduce the resistance of said resistors suddenly, the current flow in said second circuit being increased sufficiently thereby to operate said electro-magnetic device.

9. In combination, a source of alternating electro-motive force, a tuned circuit comprising a reactor and a condenser in series, a plurality of non-inductive resistors having a high resistance at low voltages connected in parallel with said condenser in a high voltage closed circuit, a low voltage closed circuit comprising a relay and a low voltage source of direct current connected in parallel with a portion of said resistors, means for impressing on said tuned circuit from said first named source an alternating voltage of the frequency to which said circuit is tuned, a high voltage being induced thereby across said condenser and said high voltage circuit to suddenly decrease the resistance of said resistors and said low voltage circuit and cause the operation of said relay, and locking contacts closed by the operation of said relay to maintain said relay operated from said low voltage source independently of said resistors.

10. In an electric circuit, a transmission line, a source of alternating voltage of variable frequency associated with one end of said transmis-

sion line, a reactor and a condenser connected across the other end of said line and tuned so that a high voltage appears across said condenser only when a voltage of a certain frequency is impressed on said line, a plurality of non-linear resistors of the type in which the resistance decreases suddenly from a high value to a low value at high voltages and is independent of the direction of current flow, a relay and a low voltage source of direct current connected in parallel with one or more of said resistors, said one or more resistors and other resistors being also connected in parallel with said condenser, and means for impressing a voltage of said certain frequency on said line from said variable source to induce said high voltage across said condenser and said resistors and thereby reduce the resistance of said resistors and cause the operation of said relay.

THOMAS GEORGE RICE.