United States Patent

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[33] **Canada**
[31] **021268**

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[54] **THIN FILM HYBRID CIRCUIT RESISTOR TRIMMER**
1 Claim, 3 Drawing Figs.

[52] **U.S. Cl.** **219/68**
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[50] **Field of Search** ..... 29/610, 611, 620, 593; 219/383, 384, 68, 69 C, 69, 69 P, 69 M, 70

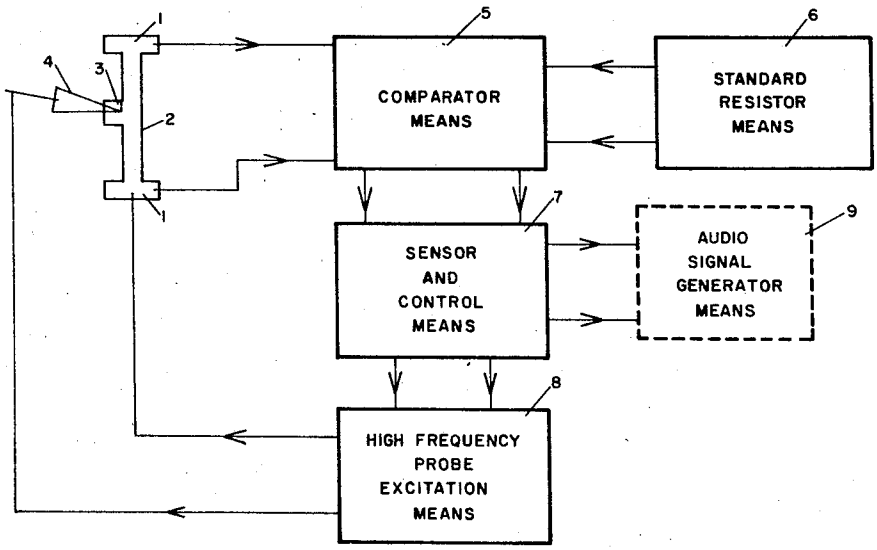
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ABSTRACT: Process for trimming thin film resistors comprising applying a probe to the surface of the resistor and moving the probe along said surface, said probe being excited by a high frequency power source. Apparatus for carrying out the process includes the high frequency excitation source.



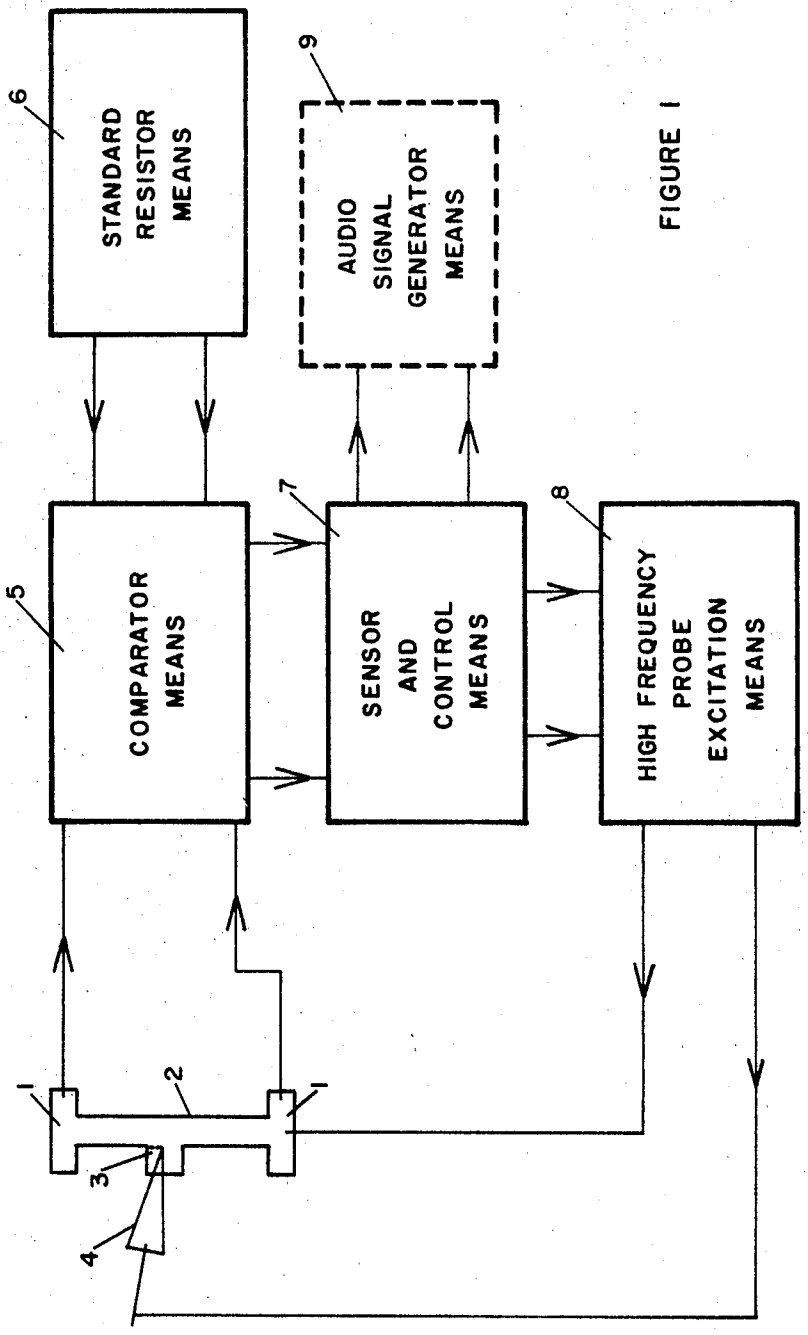
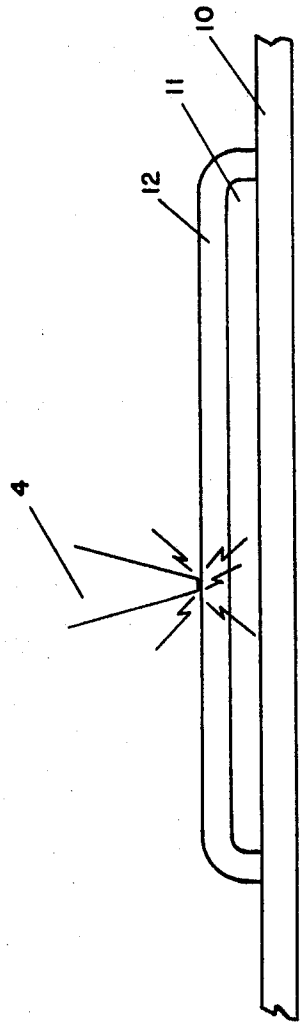


FIGURE 1

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FIGURE 2



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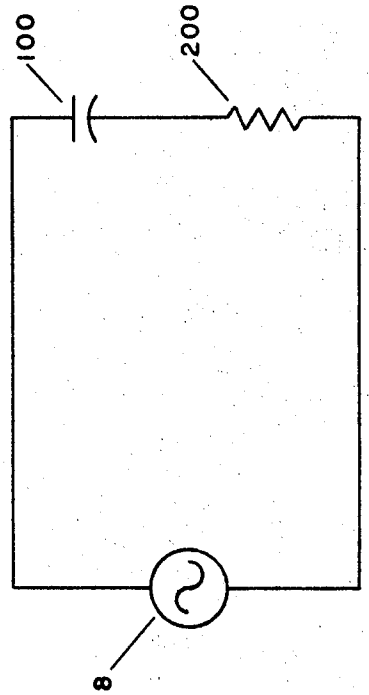


FIGURE 3

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THIN FILM HYBRID CIRCUIT RESISTOR TRIMMER

This invention relates to a process for trimming deposited thin film resistors which form a part of hybrid microelectronic networks, and to apparatus for carrying out the process. More specifically, this invention relates to a process, incorporating a high frequency electric field, for trimming deposited resistor films, and to apparatus for carrying out the process.

As is well known in the art, there is presently no process available by means of which it is possible to deposit a thin film resistor of a specific resistance value to a great degree of precision with ease and repeatability. As a result, a thin film resistor, having a lesser resistance value than is required, is initially deposited, and the resistor is then trimmed, changing its length/width ratio, until it achieves a value within specified tolerance limits of the desired value. However, the trimming step presents its own problems, and a problem which is especially acute in the art today is the problem of trimming a deposited NiCr film resistor to a high degree of precision.

It is, therefore, an object of the invention to provide a process for trimming thin film resistors to a high degree of precision.

It is a further object of the invention to provide apparatus for carrying out the above process.

It is a special object of the invention to provide a process for trimming deposited NiCr film resistors to a high degree of precision.

It is still further object of the invention to provide apparatus for carrying out the second above-mentioned process.

It is noted that although the process and apparatus are especially applicable to NiCr deposited film resistors, the invention is not restricted thereto as the process and apparatus may be used to trim resistors of other deposited materials such as tantalum, etc.

In accordance with the invention, a process for trimming deposited thin film resistors comprises applying a probe, excited by a power source, to the top surface of said resistor and moving said probe along said surface to thereby remove substantially that portion of the resistor contacted by said probe, whereby the length/width ratio of the film is altered; comparing the value of resistance of said resistor to a desired value of resistance; sensing the difference in resistance between the value of said resistor and said desired value; providing a control signal to turn off said power source when said difference falls within a specified limit, thereby removing the excitation from said probe; characterized in that said power source is a high frequency power source.

Apparatus for carrying out the above process comprises comparator means having two input means and an output means; standard resistance means having a value of resistance corresponding to said desired value of resistance; sense and control means having input and output means; probe means; probe excitation means having input and output terminals; said comparator means having one input means adapted to be connected across said resistor and the other input means adapted to be connected across said standard resistance means, and having its output means adapted to be connected to the input means of said sense and control means; the output means of said sense and control means being adapted to be connected to the input terminals of said probe exciting means; whereby, when a substantially null signal is detected by said sensing means, a turnoff signal is applied to said probe exciting means; one of the output terminals of said probe excitation means being adapted to be connected to said probe means, the other output terminal being adapted to be connected to said resistor; said probe means being adapted to make contact with and to be moved along the top surface of said resistor; whereby when said probe means is excited by said probe excitation means, the portion of the resistor substantially in contact with the probe means will be removed; characterized in that said probe excitation means comprises a high frequency power source.

For better understanding of the invention, attention is directed to the following description together with the accompanying drawings in which:

FIG. 1 illustrates a preferred embodiment of the apparatus in accordance with the invention;

FIG. 2 is a side view of the element 2 in figure 1; and

FIG. 3 is the equivalent electrical circuit of the element illustrated in figure 2.

Referring now to figure 1, the resistor to be trimmed 2 is attached to gold lands 1 as is well known in the art. A trimming area 3 is usually deposited integral with the resistor for ease in trimming the resistor. Probe means 4 advantageously comprises a micromanipulator (not shown) for three dimensional movement of the probe through a joy stick and an excitation signal is supplied to the probe from the high frequency probe excitation means 8. The resistor 2 is connected to the comparator means 5 whose other input is connected to a standard resistor means 6. The comparator means may be a bridge and the standard resistor means may comprise a precision resistor standard decade box. The comparator means measures the difference between the standard resistor and the resistor to be trimmed and provides an output signal proportional to the difference in resistance to the sensor and control means 7. The sensor means is advantageously a null sensor and the high frequency probe excitation means 8 is controlled by the control means which turns the excitation means off when the sensor senses a null, i.e. when the difference between the resistance of the resistor to be trimmed and the standard resistor is within a specified tolerance level.

In a preferred embodiment of the invention, an audio signal generator 9 (shown in dotted lines) is connected to a second output of the sensor and control means. When a null is sensed, the control means provides a signal to turn the audio signal generator on to thereby provide an audible indication to the operator of the fact that the resistor has attained the desired value.

A possible explanation of how the film under the strip is removed may be had by referring to FIG. 2. In FIG. 2, 10 is a substrate on which a thin film 11 is deposited. When the film 11 is a NiCr film, it must be stabilized by heat treatment after it is formed, and during the heat treatment, a layer of chromium oxide 12 is formed over the film. When the probe 4 is applied to the film, as shown in FIGS. 1 and 2, and an excitation signal is applied to the probe, the high frequency electric field at the tip of the probe 4 breaks down the oxide layer and a continuous electrical discharge forms to bridge the gap. The heat generated by the discharge is sufficient to melt the film in close proximity to the tip of the probe.

The probe, oxide layer and underlying film form a capacitor so that an equivalent circuit of the generator, probe and film resistor is as shown in FIG. 3 where 100 represents capacitance and 200 represents the resistance of the film between the gold land and the generator lead. One of the criteria for the selection of the frequency of operation of excitation means 8 is that the capacitive reactance of the capacitor at that frequency should be low. As the capacitance of the capacitor is of low value, a high frequency is required to attain this end.

In further considering the selection for an excitation frequency, it must also be taken into account that the comparator means normally comprises a bridge which is sensitive at a given frequency. To prevent interference of the bridge by the excitation signal, the excitation frequency should be of the order of 100 times as great as the bridge frequency.

A system has been constructed in accordance with the invention in which an excitation frequency of 23 kHz. was used. Higher frequencies, for example in the range of 100 kHz., would provide better performance if the practical problem of being able to easily and inexpensively provide an excitation source to operate at this frequency range could be overcome. As a general rule, and keeping in mind the above considerations and the present state of the art, the excitation frequency should be in excess of 20 kHz.

While a system contemplating an HF source has source has been described, it will be immediately apparent to one skilled in the art that a low frequency source, and in fact, even a DC source could be used. However, for the reasons stated above, the results at LF and DC will not be as satisfactory as those produced at HF.

Although only one embodiment has been described, this was for the purpose of illustrating, but not limiting the invention. Various modifications, which may come readily to the mind of one skilled in the art, are considered to be within the scope of the invention as defined in the appended claims.

We claim:

1. Apparatus for trimming a thin film resistor to a desired value of resistance comprising; comparator means having two input means and an output means; standard resistance means having a value of resistance corresponding to said desired value of resistance; sense and control means having input and output means; probe means; probe excitation means having input and output terminals; said comparator means having one input means adapted to be connected across said resistor and

the other input means adapted to be connected across said standard resistance means, and having its output means adapted to be connected to the input means of said sense and control means; the output means of said sense and control means being adapted to be connected to the input terminals of said probe exciting means; whereby, when a substantially null signal is detected by said sensing means, a turnoff signal is applied to said probe exciting means; one of the output terminals of said probe excitation means being adapted to be connected to said probe means, the other output terminal being adapted to be connected to said resistor; said probe means being adapted to make contact with and to be moved along the top surface of said resistor; whereby when said probe means is excited by said probe excitation means, the portion of the resistor substantially in contact with the probe means will be removed; characterized in that said probe excitation means comprises a high frequency sinusoidal power source and wherein the frequency of said power source is in excess of 20 kHz.