July 4, 1967 R. L. BADELT 3,329,921

ADJUSTABLE CENTER TAP RESISTOR

Filed Oct. 16, 1964

FIG 1

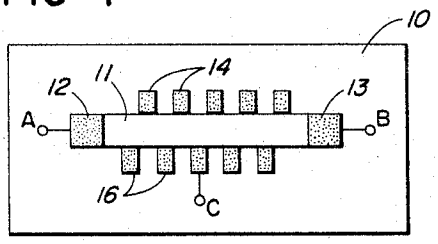
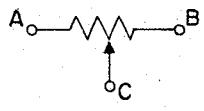


FIG 2



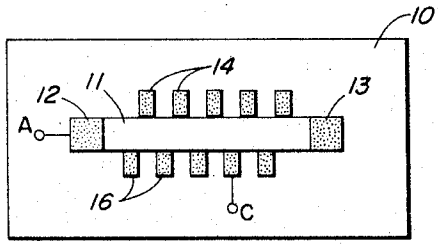


FIG 3

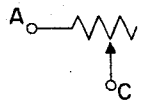


FIG 4

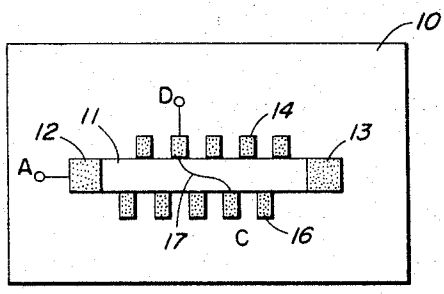


FIG 5

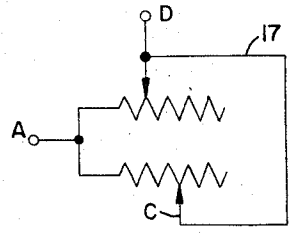


FIG 6

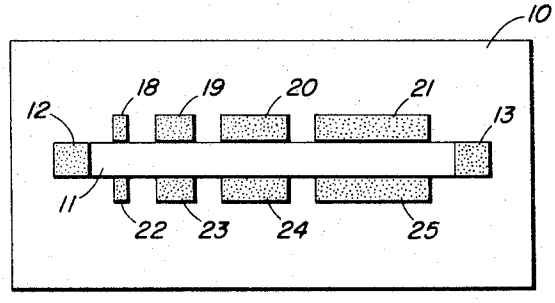


FIG 7

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United States Patent Office 3,329,921 Patented July 4, 1967

3,329,921

ADJUSTABLE CENTER TAP RESISTOR

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Filed Oct. 16, 1964, Ser. No. 404,214
1 Claim. (Cl. 338—308)

This invention relates in general to microminiature circuits and in particular to circuits formed by the deposition of tantalum and other materials on an inert background.

The requirement to make circuits smaller and smaller has led to the development of microminiature circuits deposited on a plastic or other inert background which can be made very small. Generally, a film of material is deposited on a plastic background. The present invention makes it possible to produce a variable resistor pattern in a microelectronic circuit which could be used as a potentiometer or rheostat or for any purpose requiring the use of a resistor with a selectable center tap along the body of the resistor. The variable resistor of this invention can be readily used in microelectronic circuits since it can be made very small. The device can be fabricated at the same time as other thin film circuit elements but its use is not limited only to thin film circuit since it could, for example, be formed on top of an integrated circuit by first growing an oxide over the circuit to serve as a carrying device for the variable resistor and as a dielectric between it and the other integrated components.

The resistor of this invention can be designed especially for its application in a given circuit at no additional cost. Its resistance to mechanical vibration is excellent because it has no sliding contacts for the center tap adjustment. The resistor of this invention can be formed on any low conducting material such as glass, ceramic, plastic, or other suitable dielectric material.

A feature of this invention is found in the provision for a thin metallic film of resistive material which is deposited on an insulating material. Conducting tabs are formed along the sides of the main body of the resistor and at the ends to allow various resistive values to be obtained.

Further objects, features and advantages of this invention will become apparent from the following description and claim when read in view of the accompanying drawings, in which:

FIGURE 1 illustrates a resistor according to this invention which can be used as a potentiometer;

FIGURE 2 is the schematic equivalent of FIGURE 1;

FIGURE 3 illustrates a resistor according to this invention which can be used as a rheostat;

FIGURE 4 is the schematic equivalent of FIGURE 3;

FIGURE 5 illustrates a precision resistor according to this invention;

FIGURE 6 is the equivalent circuit of FIGURE 5; and,

FIGURE 7 illustrates a variable conductance device.

FIGURE 1 illustrates a backing material **10** upon which the microelectronic circuit of this invention is formed. The backing material could be glass, ceramic, plastic or other suitable dielectric material. A rectangular strip of thin metallic film **11** is formed on the backing material in a conventional microelectronic process such as is well known to those skilled in the art. Such material might, for example, be tantalum or nichrome alloy. The value of the resistance from end to end is controlled by the nature of the metal, the thickness of the film which in turn is determined by the duration of the deposition process and to the geometry of the strip. To the main body of the resistor **11** are attached the end tabs **12** and **13** and side tabs **14** and **16** of conducting material. Such end and side tabs could be made of gold and aluminum, for example, and could be deposited by thermal evaporation or cathode sputtering in a well-known manner.

It is to be noted that the tabs on opposite sides of the resistor in FIGURE 1 are offset such that a tab **14** on one side is placed where a space appears on the other side. This allows fine resolution of the resistance of the component.

The structure FIGURE 1 can be used as a center tap potentiometer as shown in FIGURE 2. The resistance between points A and B will remain constant. A selectively adjustable center tap output C may be obtained by connecting an electrical lead to one of the tabs **14** or **16** along the main body portion **11** of the resistor. Of course, it is to be realized that a number of outputs may be obtained at different ohmic values by connecting leads to different tabs **14** and **16**.

FIGURE 3 illustrates the device of FIGURE 1 in use as an adjustable rheostat. The device is an adjustable resistor between points A and C with point C being connected to a selected tab **14** or **16** to obtain the desired resistance.

FIGURE 4 is the electrical equivalent of FIGURE 3.

FIGURE 5 illustrates the resistor of this invention with a first contact point A on the end tab **12** and an output contact D on a tab **14** on one side of the resistor. A shorting lead **17** connects the tab of terminal D to a tab C (**16**) on the opposite side of the main body portion **11**. By adjusting the lead **17** and the position of the output contact D, incremental changes in resistance between A and D can be obtained. This in effect constitutes a paralleling of resistance A–D and A–C to obtain a fine adjustment of the resistance between the output terminals.

FIGURE 6 illustrates this schematically.

Although the output lead D is shown connected to one terminal, it is to be realized that the output terminal may be connected across two adjacent tabs and the resistance obtained is analogous to the paralleling of two resistors.

The structure of FIGURE 7 has been constructed with tabs **18–21** and **22–25** of varying widths on opposite sides of main body portion **11**. This allows variable resistances to be selected by connecting output leads to tabs on opposite sides of the main body portion **11**. In other words, the resistance between tabs **20** and **23** would be less than the resistance between tabs **19** and **22** since the area of resistive material between the tabs **20** and **23** is greater than the area of resistant material between the tabs **19** and **22**. This is true because resistance is determined by the formula:

$$R=\frac{\rho l}{A}$$

where

l is length of conducting path,
A is the cross-sectional area, and
ρ is the resistivity of the material.

Since the resistance varies inversely as the area, by choosing wider tabs the resistance can be made small. All the connections to the microminiature device of this invention may be welded and the device will stand up very well under mechanical shocks. This is an advantage over conventional slide contact rheostats and potentiometers which are subject to change under shock due to movement of the mechanical contact.

It is seen that this invention provides a simple and easily constructable structure. Although it has been described with respect to particular embodiments, it is not to be so limited, as changes ad modifications may be made therein which are within the spirit and scope of the invention as defined by the appended claim.

I claim:

A variable impedance device comprising a backing plate of insulating material, a film of resistive material of generally rectangular shape formed on said backing plate,

said resistive material being extended to form a first plurality of tabs along one side thereof and a second plurality of tabs along the opposite side thereof, said first plurality of tabs being spaced so as to be offset from the second plurality of tabs such that each of said first plurality of tabs is disposed symmetrically opposite the spacing between adjacent ones of the second plurality of tabs, a pair of end tabs formed respectively as extensions from the ends of said film of resistive material, each of said first and second plurality of tabs and said end tabs having deposited thereon a low resistance metallic film, a selected one of said first plurality of tabs being electrically shorted to a selected one of said second plurality of tabs, one of said shorted tabs comprising a first terminal of said impedance device and one of the remaining unshorted tabs comprising a second terminal of said impedance device.

References Cited

UNITED STATES PATENTS

1,093,968	4/1914	Bicknell	338—325 X
1,729,874	10/1929	James et al.	338—127
2,632,831	3/1953	Pritikin et al.	338—325 X
2,688,679	9/1954	Schleuning	338—194 X
2,915,728	12/1959	Page et al.	338—194 X
2,994,848	8/1961	Rayburn	338—308 X

FOREIGN PATENTS

220,811	7/1957	Australia.
898,324	11/1953	Germany.

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