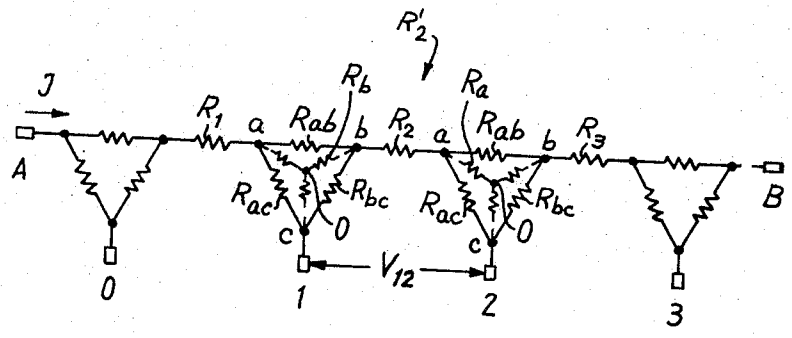
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PRINTED RESISTORS

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PRINTED RESISTORS

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1 Claim. (Cl. 338—308)

This invention relates to high-accuracy printed resistors adapted to be used, for example, in measuring instruments.

At present the resistors of the kind referred to which are in the form of resistor units are made from a single sheet of resistor material or foil by photochemical, electro-erosion or some other such methods. These resistors may be supported on insulating boards where necessary for strength.

In mass-production of resistor units, the adjustment of resistors forming the unit presents particular difficulties. Adjusting is carried out, for example, by decreasing the cross-sectional area of a foil conductor, which enables one to change the value of resistance so that it may only increase. On the other hand, the conventional method of reducing resistances of resistor units by shortening the conductor and soldering the lead cannot be used since the solder and copper deteriorate the homogeneity, temperature characteristics and time stability of the resistors. As a result, an error made in manufacturing or selecting a resistor unit, which brings at least one resistor beyond the positive tolerance, cannot be corrected and results into rejecting the entire unit composed of tens and sometimes of hundreds of resistors.

It is an object of the present invention to eliminate the above-mentioned disadvantage.

It is another object of the invention to provide printed resistors integral with connections, current and potential leads from one sheet of resistor material in a manner which not only permits the resistors to be increased but but also decreased in value without deteriorating the homogeneity of the material.

The above-mentioned objects are attained by connecting the resistors with each other, as well as with current and potential leads by means of three Δ-connected additional resistors. Such an arrangement of printed resistors not only allows an increase but also a decrease in the value of resistors to be adjusted by decreasing the cross-sectional area of conductors, which simplifies the adjustment and reduces down the number of rejected parts.

The invention will now be described in connection with an exemplary embodiment, reference being made to the accompanying drawing wherein a circuit diagram of the proposed printed resistors is given.

Main resistors R_1, R_2, R_3, etc. are made integral in the form of a resistor unit by the use of current leads A and B and potential leads **0**, **1**, **2**, etc. from one sheet of resistor material. The connection of the main resistors R_1, R_2, R_3, etc. with each other, as well as with the leads A, B, **1**, **2**, etc. is effected by means of three Δ-connected additional resistors R_{ab}, R_{ac}, and R_{bc}.

The value of resistance of, for example, the second section R_2' is determined by the ratio of voltage V_{12} between the potential leads **1** and **2** to current I flowing through the resistor circuit. This resistance can be expressed by the formula:

$$R_2' = R_2 + \Delta_2' + \Delta_2''$$

where Δ_2' and Δ_2'' are resistances added by the triangle

abc formed by the additional resistors. Reconnecting Δ *abc* into Y, there is obtained the expression

$$\Delta_2' = R_b = \frac{R_{ab} \cdot R_{bc}}{R_{ab} + R_{bc} + R_{ac}}$$

$$\Delta_2'' = R_a = \frac{R_{ab} \cdot R_{ac}}{R_{ab} + R_{ac} + R_{bc}}$$

where Δ_2' is the resistance of the star branch to the left of the selected resistor, and Δ_2'' is the resistance of the star branch to the right of said resistor. As the value of the resistors to the left of the selected one (selection going from left to right) cannot be varied, so that the resistance of an already selected section should not change, further on we shall consider Δ_2'' only.

As seen from the formula, a decrease in the cross-sectional area of the conductors of the resistors R_{ab} and R_{ac}, that is, an increase in the values of these resistors, will result into an increase in the value of Δ_2'' and consequently, in the total resistance of the section R_2'.

Conversely, a decrease in the cross-sectional area of the conductor of the resistor R_{ac} results in a decrease in the total resistance of the section R_2'. This brings about the solution of the problem since a decrease in the cross-sectional area of the conductors without deteriorating the homogeneity of the material makes it possible either to increase or decrease the value of the resistor being adjusted.

The range of the possible variation in the value of the selected resistor is defined by the number of main and additional resistors. In order to extend this range the value of the main resistors R_1, R_2 and R_3 can be reduced to zero, while the value of the additional resistors R_{ab}, R_{bc} and R_{ac} must be increased so that the present value of resistance of the section R_2' will be as required.

The proposed printed resistors with current and potential leads may contain any quantity of main resistors.

What is claimed is:

A resistor unit comprising an electrically insulative support and a sheet of resistance material mounted on said support and including discrete quantites of resistance material forming a plurality of spaced interconnected main resistors constituting a main circuit including current leads, and plurality of delta connections each including three additional resistors connected between main resistors and including respective voltage taps, whereby the electrical resistance in said circuit between said taps is selectively decreasable in value in response to an increase in value of selected of said additional resistances.

References Cited

UNITED STATES PATENTS

1,093,968	4/1914	Bicknell	338—325 X
2,629,166	2/1953	Marsten et al.	338—309 X
2,730,567	1/1956	McConnell	323—74 X
2,769,137	10/1956	Crevsere	338—325 X
2,641,675	6/1953	Hannahs	338—307 X
2,758,256	8/1956	Eisler	317—101
2,777,039	1/1957	Thias	338—309 X
2,994,848	8/1961	Rayburn	338—328

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