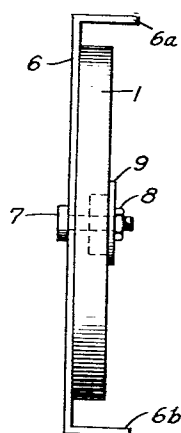
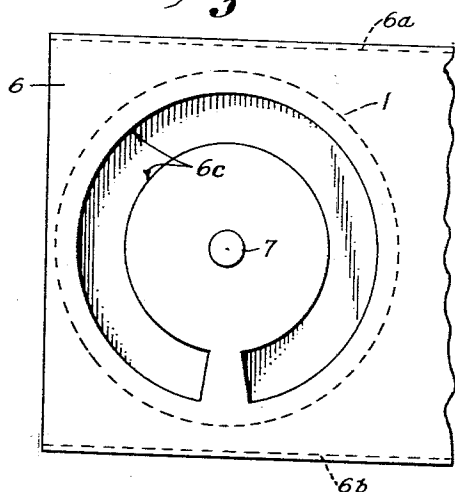
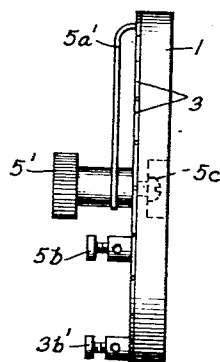
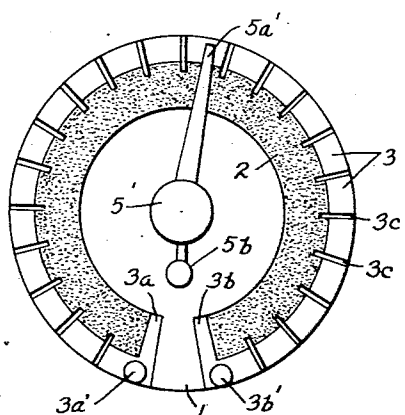
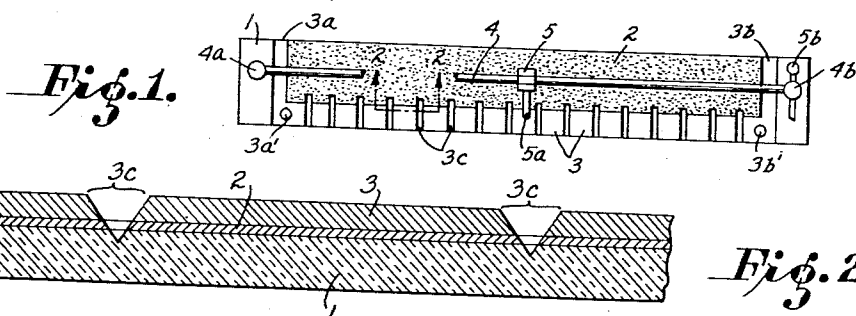


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H. W. SCHLEUNING
METALLIC FILM VARIABLE RESISTOR

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METALLIC FILM VARIABLE RESISTOR

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This invention relates to variable resistors and to the method of making the same. The resistors of the present invention are useful either as potentiometers or as rheostats, or for any purpose requiring the use of a resistor with a sliding contact.

An object of the invention is to devise a multi-tap resistor in which the resistance values between the different taps may be adjusted with great accuracy and to any desired value within certain limits.

A further object of the invention is to devise a novel arrangement of a resistance element and a series of spaced contacts connected to the resistance element at different points along the length thereof.

The objects of my invention are accomplished by forming the resistor of a pair of contiguous, parallel bands of conductive material arranged on a dielectric carrier, one of the bands being of low resistance and forming a commutator for the movable contact, the other being of high resistance and forming the resistance element of the resistor. The spaced contacts of the resistor are formed by segmenting the band of low resistance by forming transverse cuts through the band at spaced points along the length thereof, thereby providing spaced contact segments of low resistance connected to different linear sections of the band of high resistance. The resistance value between any pair of adjacent segments is controlled by extending the transverse cut into the high resistance band to the extent necessary to secure the desired value of resistance. The two bands of resistance material may be formed as straight parallel bands, or they may be formed as concentric circular segmental bands.

The invention is illustrated in the accompanying drawing in which Figure 1 is a plan view of one form of variable resistor in which the resistance element is formed of a linear band of thin metallic film deposited on the elongated carrier plate, and the commutator segments or contacts are formed from a linear band arranged along one edge of the resistance element;

Figure 2 is a section view of Figure 1 taken along the cutting line 2—2 and shown on a greatly enlarged scale;

Figure 3 is a plan view of a second form of the invention in which the variable resistor is constructed in circular form;

Figure 4 is a side elevational view of Figure 3 as seen from the right;

Figure 5 is a plan view of a masking plate or shield used in the manufacture of the arrangement shown in Figures 3 and 4; and

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Figure 6 is an end view of Figure 5 as seen from the right.

Referring to Figures 1 and 2 of the drawing, numeral 1 indicates the insulating carrier plate formed of glass or other suitable dielectric material, and 2 is a band or strip of thin metallic film deposited on the upper face of the plate 1 in any suitable manner but preferably by thermal evaporation in a vacuum chamber. The thermal process of depositing metallic film is well known and need not be described in detail here. By using the process disclosed in the copending application of Weber et al., Serial No. 699,546, filed September 26, 1946 (now Patent No. 2,586,752), the resulting films are atomically bonded to the glass and are very stable and rugged. The resistance film 2 may be formed over the entire width of the plate 1, or it may cover a band of less width than the plate. Preferably the film 2 is formed over the entire width of the plate and it extends over the length of the plate except for two end sections which are left bare. The value of the resistance of film 2 is controlled by the nature of the metal and by thickness of the film which is determined mainly by the duration of the evaporation process. The film may be formed from a pure metal or from an alloy of metals such as "Nichrome" alloy. The film 2 may also be formed by baking on a thin coating of a metal solution, such as a solution of a platinum-palladium alloy in atomic percentages of 60 to 50 percent platinum and 40 to 50 percent palladium. Such process is more fully disclosed in the application of Weber et al., Serial No. 540,347, filed June 14, 1944 (now Patent No. 2,529,436). A practical range for the total resistance of band 2 is from 100 ohms to 10,000 ohms or higher.

After the film 2 is deposited on the plate 1, a low resistance band or strip of metal 3 is deposited along one edge of the film 2 throughout the length of the film 2 and preferably lateral extensions 3a and 3b forming low-resistance terminal elements are provided at the ends of the film 2 extending entirely across the high resistance band. Two connection terminals 3a' and 3b' are provided at the ends of band 3. In Figure 2 the plate 1 and the films 2 and 3 are shown in sectional elevation on a greatly enlarged scale. The metal band 3 may be formed by repeated deposits by thermal evaporation, but I prefer to form this film by painting on a coating of metal solution and then fixing or burning-in the metallic film by the usual baking operation. I prefer to use a platinum-gold alloy solution in forming band 3. It is necessary that band 3 have contact

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with band 2 along the length thereof but it is not necessary that band 3 be formed entirely on resistance band 2. Also, low-resistance band 3 may be applied first and then the high resistance band 2 may be applied to the carrier with one edge in contact with the band 3.

After the two film bands are deposited, spaced grooves 3c are formed across the two films across the strip covered by band 3 to divide the low-resistance band into commutator segments as shown in Figure 2. This may be done by means of a diamond cutter operated either manually or by machine. The separated segments of the metallic band 3 constitute spaced tap contacts connected to the resistance band 2 at spaced points along the length thereof. As will be seen in Figure 1, the grooves 3c are extended into the high resistance band 2 to a distance necessary to provide the proper amount of resistance between adjacent contact elements. The desired amount of resistance between adjacent contacts may be obtained by passing a known current between the two connection terminals 3a' and 3b' and measuring the potential drop on opposite sides of the cut while it is being formed. The cutting is stopped as soon as the potential difference reaches the desired value. The length of the cut determines the resistance between the contact segments on opposite sides of the cut as well as the resistance value between terminals 3a' and 3b'.

The resistor is provided with a slide bar 4 for supporting a slide 5 having a resilient contact finger 5a (preferably formed of silver) which engages the spaced contact segments formed in the band 3. The bar 4 is supported above the surface of the plate 1 by a pair of supporting standards 4a and 4b mounted on the two bare end sections of plate 1. A connection terminal 5b is provided on one bare end section of plate 1 and is connected to one of the supporting standards of bar 4.

In Figures 3 and 4 I have shown a construction in which the high and low resistance metallic bands are arranged in circular form, and the sliding contact is replaced by a rotary contact arm. In this arrangement the parts which serve the same function as corresponding parts in Figures 1 and 2 are indicated by the same reference numerals. As will be seen, the carrier plate 1 is of circular form and the two metallic bands 2 and 3 are formed as concentric circular segments around the outer edge of the plate. The rotary contact arm 5a' is supported on a rotary knob 5' which is mounted at the center of the disc 1 by means of a screw 5c passing through a hole formed through the center of the circular plate 1.

The resistance film 2 may be restricted to the desired part of the plate 1 by means of a mask or shield 6 shown in Figure 5. In this arrangement the shield is formed of a plate of metal having two side flanges 6a and 6b as shown in Figure 6, and is provided with an opening 6c formed of a circular segment of the same general shape as the resistance band 2 in Figure 3. The inner circular edge of the opening 6c will have the same radius as the inner edge of the band 2 in Figure 3, but the outer edge of the opening 6c should have a somewhat greater radius than the inner radius of the band 3 in Figure 3, so that the band 3 will overlap the outer edge of the resistance band 2 when applied to the disc 1. A mounting screw 7 is secured to the plate 6 at the center of the opening

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6c and extends to the rear of the plate as shown in Figure 6. The carrier plate 1 is mounted on the screw 7 and is clamped against the back face of the plate 6 by means of a nut 8 bearing against the washer 9. The masking shield 6 may be elongated and provided with a number of openings 6c spaced along the length thereof to accommodate a number of carrier plates 1 at any given time. After the plates are mounted in the shield, one or more of such shields are placed within the vacuum chamber of the coating apparatus and the plates are exposed to the metal vapor through the openings 6c. It will be understood that only the exposed portions of the carrier plates 1 would be coated with the resistance film. After the plates are removed from the vacuum chamber, the low resistance metal coating 3 may be applied to the outer portion of the disc by painting on a suitable metal solution and then fixing the film on the glass plate by the usual baking operation. As already explained, the low resistance band 3 may be applied first and then the high resistance film 2 applied with at least edge contact with band 3. In this case, when the high resistance film is applied through the opening in shield 6, the outer edge portion of the resistance film will overlap a portion of the low resistance band 3 which was previously applied. Also, the position of the two bands may be reversed if desired, that is, the band 2 may be formed outside of band 3.

It will be seen that my invention provides for the individual adjustment of the resistance between each pair of adjacent contact segments, and this feature is very useful for obtaining the desired relation between the resistance values of different linear sections of the resistor. It is obvious that by controlling the lengths of the cuts across the two metallic bands, the resistance values of successive sections may be made the same or they may be caused to vary progressively or in any other desired manner from one end of the resistor to the other. Furthermore, the method of forming the contact segments makes it possible to form a large number of segments in a small space or length. Also, it is possible, by re-coating the resistance band, to change the characteristic of an already formed resistor.

I claim:

1. The method of forming a highly stable tapped resistor which consists in depositing on one face of a glass plate a band of thin metallic film by subjecting said plate to radiations from a source of vaporized metal, forming a second band of metallic film parallel with said first band and in contact with one edge thereof by depositing on said plate a film of metallic solution and burning-in said deposited film, said second metallic band having relatively low resistance value with respect to said first band, segmenting said low resistance band only along its length by cutting transverse grooves therein at spaced points, and extending said grooves only partly into said thin metallic film to provide a desired resistance-displacement characteristic between the spaced low-resistance segments in contact with different linear sections of the uncut longitudinal portion of said first band.

2. The method of forming a highly stable tapped resistor which consists in forming on one face of a dielectric base, a pair of parallel contiguous bands of metallic film, one of said bands being relatively thin and having a high resistance value and the other being relatively thick and having a low resistance value, said thin band

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being formed by subjecting said base to radiation from a source of vaporized metal in a vacuum space, said thick band being formed by depositing on said base a film of metallic solution and burning-in said deposited film, and segmenting said thick band only by cutting transverse grooves thereacross at spaced points along its length, whereby the segments of said thick band provide spaced low-resistance contact members having contact with the continuous high-resistance band at different points along its length.

3. A tapped resistor comprising a base of dielectric material, a movable contact mounted for movement along a predetermined path over the surface of said base, a low-resistance commutator band carried on said base and forming a track for said movable contact, said commutator band being formed of a relatively thick metallic film bonded directly to the surface of said base, said band being divided into commutator segments by spaced grooves cut transversely across said band at spaced points along its length, and a resistance band carried by said base and comprising a relatively thin metallic film bonded directly to the surface of said base and having a continuous linear portion arranged parallel with said commutator band, portions of said thin metallic film being on top of portions of said commutator segments, whereby said segments are connected to said resistance band at spaced points along its length.

4. In an adjustable resistor device including a movable contact, a resistor element having a predetermined resistance-displacement characteristic comprising: a form of insulation material; a low-resistance film formed on and bonded to said form, said film being segmented to form a series of adjacent aligned insulated commutator elements; and a thin high-resistance film formed directly on portions of said commutator elements to form bridging connections between said elements and being bonded to said elements and to said form, the exposed portions of said commutator elements serving as a commutator for a movable contact.

5. In an adjustable resistor device including a movable contact, a resistor element having a predetermined resistance-displacement characteristic comprising, a glass disc, an annular low-resistance film formed on and bonded to said form, said film being segmented to form a series of ad-

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jacent aligned insulated commutator elements, and a thin high-resistance film formed directly on portions of said commutator elements and bonded thereto and to said form, the exposed portions of said commutator elements serving as a commutator for a movable contact.

6. In an adjustable resistor device including a movable contact, a resistor element having a predetermined resistance-displacement characteristic comprising, a form of insulation material, a low-resistance film formed on and bonded to said form, said film being segmented to form a series of adjacent aligned insulated commutator elements with unsegmented terminal portions, a thin high-resistance film formed directly on portions of said commutator elements and bonded thereto and to said form, the exposed portions of said commutator elements serving as a commutator for a movable contact, and a pair of terminals individually bonded to said terminal portions.

7. In an adjustable resistor device including a movable contact, a resistor element having a predetermined resistance-displacement characteristic comprising, a form of insulation material, a low-resistance pure metallic film formed on and bonded to said form, said film being segmented to form a series of adjacent aligned insulated commutator elements, and a high-resistance pure metallic film formed directly on portions of said commutator elements and bonded thereto and to said form, the exposed portions of said commutator elements serving as a commutator for a movable contact.

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