

June 30, 1953

W. R. JACK ET AL

2,644,064

VARIABLE RESISTANCE DEVICE

Filed Jan. 2, 1952

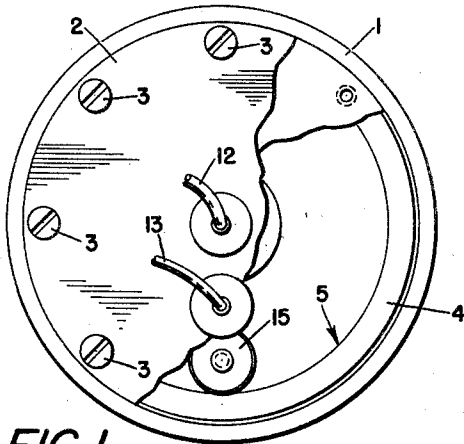


FIG. 1

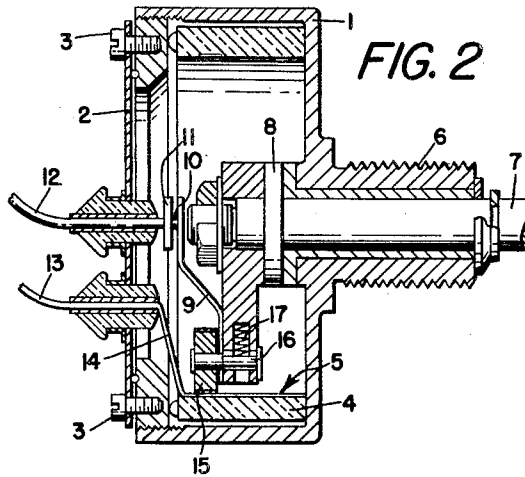


FIG. 2

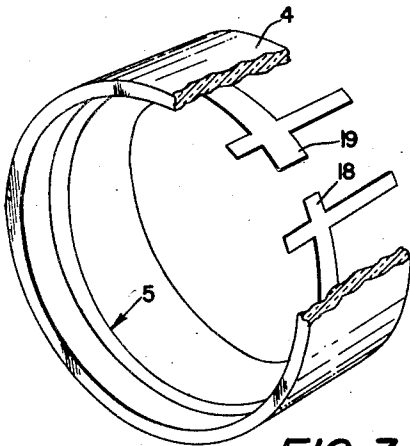


FIG. 3

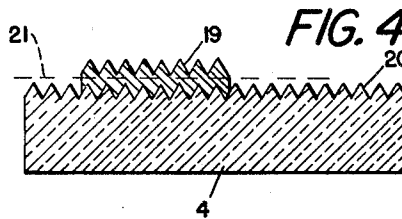


FIG. 4

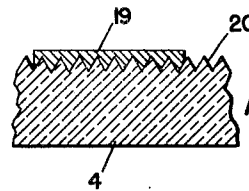


FIG. 5

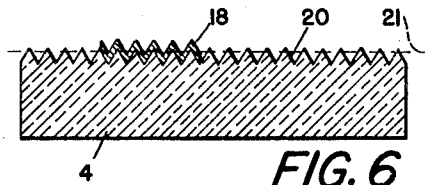


FIG. 6

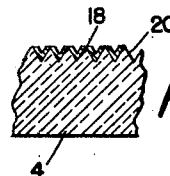


FIG. 7

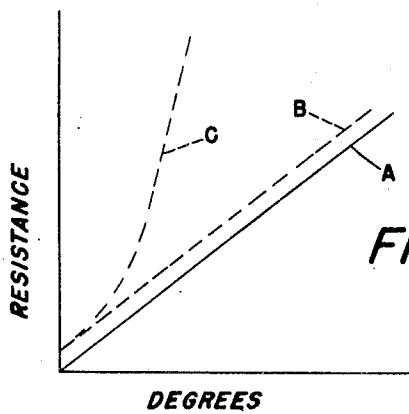


FIG. 8

INVENTORS
WILLIAM R. JACK &
LYSLE D. CAHILL
BY

Frank H. Harmon
ATTORNEY

UNITED STATES PATENT OFFICE

2,644,064

VARIABLE RESISTANCE DEVICE

William R. Jack and Lysle D. Cahill, Chagrin Falls, Ohio; said Cahill assignor to said Jack

Application January 2, 1952, Serial No. 264,454

7 Claims. (Cl. 201—55)

1

This invention relates to variable resistance devices and has for one of its primary objects to provide a variable resistance device capable of permanent operation and having a wide range of resistance.

In the conventional variable resistance devices resistance elements of various materials are employed as single or multiple coatings on a ceramic base. Due to the selection of resistance materials and the methods employed in applying them to the base, inherent weaknesses in the resistance materials develop due to heat, oxidation and other atmospheric effects and by reason of excessive wear by engagement with the contactor, leaving it difficult, if not impossible to obtain uniformity of the variable resistance device or its accurate control. This is especially true in such devices employing bases wrapped with wire, whether the bases contain any other material in addition to the wire.

It is therefore an object of this invention to provide a variable resistance device in which the resistance structure is so applied to the insulating base as to be virtually an integral part of the base, constitute a permanent resistor impervious to oxidation and other atmospheric effects and present an efficient wear resisting contacting surface for the movable contactor.

Another object is to provide a variable resistance device in which the surface of the base is purposely predeterminedly roughened and the resistance metal structure is so predeterminedly applied thereto as to be of progressively varying width or thickness, or both, so that the wear on the resistance metal resulting from the engagement therewith by the movable contact, will be at a constant percentage throughout its length, rather than at a constant amount, so as to insure longer wear and greater accuracy in performance.

With the foregoing and other objects in view, the invention resides in the combination of parts and in the details of construction hereinafter set forth in the following specification and appended claims, certain embodiments thereof being illustrated in the accompanying drawings, in which:

Figure 1 is an end view of the variable resistance device, with the cover plate shown partly broken away;

Figure 2 is a view in longitudinal section of the same;

Figure 3 is a view in perspective of the ring, partly broken away, showing a potentiometer formed of a base provided with a resistance material structure of varying thickness and width;

Figure 4 is a view in cross section taken through

2

the base and the widest and thickest portion of the resistance metal, the maximum wear line being indicated in dotted lines;

Figure 5 is a similar view showing the metal to have been worn off down to the wear line of Figure 4;

Figure 6 is a view in cross section taken through the base and the thinnest and narrowest portion of the resistance metal, the maximum wear line being shown in dotted lines;

Figure 7 is a similar view showing the metal to have been worn off down to the wear line of Figure 6; and

Figure 8 is a graph laid out in resistance versus degrees showing our device's performance on original calibration and calibration after wear as compared to standard wire wound potentiometers.

Referring more particularly to the drawings, the variable resistance device may comprise a cylindrical casing 1 having a cover plate 2 removably secured to the casing by screw bolts 3. Suitably positioned within the casing 1 is a cylindrical potentiometer ring comprising a base 4 and a resistance material structure, generally indicated at 5, on the inside surface of the base. The casing also has an externally screw threaded sleeve 6 for the proper mounting of the unit wherever desired and shaft 7 is mounted to be rotatable therein. Shaft 7 carries a flange 8 that carries a resilient arm 9 provided with a ball 10 urged against contact element 11 of terminal 12. Terminal 13 has a resilient member 14 in contact with the potentiometer ring. Flange 8 also carries a roller contactor 15 mounted on a pin 16 and resiliently urged into constant contact with the inner surface of the resistance material structure on the inside of the potentiometer ring by a spring 17.

While the base 4 may be ceramic, glass, or other suitable material, for purposes of illustration it will be referred to as a glass cylinder. As previously stated, we desire to obtain a potentiometer ring having a resistance material structure that is virtually an integral part of the glass ring 4. This we propose to accomplish, for instance, by evaporating a resistance metal on to the inner surface of the glass ring. For purposes of illustration, Nichrome will be discussed as a preferable example. In order to evaporate the Nichrome on to and into the glass ring, we heat the Nichrome to a temperature above its boiling point in a vacuum and apply a potential between the evaporating metal and the glass ring. An alternate method is known as "sputtering" in which the cathode material is not heated, but a high

potential between the anode and the cathode is used. We have found that such an evaporated metal process is readily controllable to insure imbedding of the Nichrome into the glass ring and provide a coating whose thickness and width is also readily controllable for any desired resistance metal pattern of varying thickness or width or both. A single layer resistance metal structure is shown in Figure 3 at 5 as progressively increasing in width and thickness from a thin narrow end 18 to a thick wide end 19. In Patent No. 2,537,671 we mention the possibility of employing a contactor arm carrying a ball of mercury as the element that actually engages the resistance metal structure because of its frictionless non-wearing characteristics in order to protect the thin coating of resistance metal against wear and deterioration.

In our present invention we may employ a roller such as shown at 15 as the movable contactor. However, we have found that when a roller is used as the contacting element of the movable contactor, either in the conventional wire wound type of potentiometer, or even the type of resistance metal structure, and the method of applying it to the glass ring, disclosed in our above mentioned patent, the wear on the resistance metal structure is constant in amount throughout the length of the resistance metal structure pattern and hence calibrations in potentiometers of non-linear characteristics after a short usage of the device shows it to be entirely unreliable for its intended purposes. Hence, we have evolved an improved method of applying the resistance metal by evaporation thereof under vacuum conditions on the glass ring so that the resulting wear on the resistance metal by the roller will be constant in percentage throughout the length of the resistance metal pattern, rather than constant in amount. In order to accomplish this we purposely roughen the inside surface of the glass ring, by lapping or etching or the like, such roughened surface being indicated at 20 in Figures 4 to 7, inclusive. Moreover, this roughening operation on the surface is under fine degree control. By controlled evaporation of the resistance metal on the roughened surface 20 we are able to control such metal deposit to form any desired pattern, such as one that progressively increases from a thin-narrow end 18 to a relatively thick wide end 19. As shown in Figure 4, the resultant deposit, shown at 19, shows the resistance metal at the thick wide end to initially fill the hollows of the roughened surface 20 and to protrude thereabove equidistantly in the amount that it fills the hollows 20 of the roughened glass ring 4. As stated before, the pattern of resistance metal deposit on the roughened surface 20 of the glass ring 4 may progressively decrease in width and thickness towards the opposite end 18, this opposite end 18 being shown in Figure 6 by comparison with the other thick wide end 19 of Figure 4. In both Figures 4 and 6 we have indicated in dotted lines 21 the wear line of the roller to be such that occurs when the roller eventually wears through the resistance metal to be in contact with the glass ring, as shown in Figure 7. It will be seen, however, that when this occurs at the thin narrow end 18 in Figure 7 there is a considerable thickness of resistance metal at the thick wide end 19 above the roughened surface 20 of the glass ring, as shown in Figure 5. Thus we obtain a constant percentage, as distinguished from a constant

amount, of wear and thus increase the life of the potentiometer as well as the reliability of the performance of the device. As an example, we may elect to use Nichrome as the resistance metal and employ a roller 15 or the like, made of copper coated with silver.

In Figure 8 we have shown a graph for comparison with curves plotted resistance versus degrees where resistance is a log function. Line A represents our improved device after original calibration, and dotted line B represents calibration of our device after wear, the degrees of wear and resistance being shown to be substantially parallel in our device after wear of the resistance metal from that shown in Figures 4 and 6 to that shown in Figures 5 and 7. By comparison we have shown the dotted line C which represents the wear pattern of standard wire wound potentiometers after a like amount of wear. Such a calibration shows such a conventional device where the wear is constant in amount throughout the length of the resistance metal pattern rather than constant in percentage as we obtain in our device.

We claim:

1. A variable resistance device including an insulating base having a roughened surface provided with a resistance metal structure consisting solely of resistance metal structure deposited on said roughened surface, said resistance metal structure being deposited on said roughened surface by controlled evaporation to predeterminedly obtain a constant percentage physical resistance to wear throughout its length by moving engagement therewith of said contacting member, and a movable contacting member to engage said resistance metal structure.

2. A variable resistance device including an insulating base having a roughened surface provided with a resistance metal structure consisting solely of Nichrome as a resistance metal structure deposited on said roughened surface, said resistance metal structure being deposited on said roughened surface by controlled evaporation to predeterminedly obtain a constant percentage physical resistance to wear throughout its length by moving engagement therewith of said contacting member, and a movable contacting member to engage said resistance metal structure.

3. A variable resistance device including an insulating base having a roughened surface provided with a resistance metal structure consisting solely of resistance metal deposited on said roughened surface, said resistance metal structure being deposited on said roughened surface by controlled evaporation to predeterminedly obtain a constant percentage physical resistance to wear throughout its length by moving engagement therewith of said contacting member, and a movable contacting member to engage said resistance metal, said resistance metal structure varying in thickness throughout its length.

4. A variable resistance device including an insulating base having a roughened surface provided with a resistance metal structure consisting solely of resistance metal deposited on said roughened surface, said resistance metal structure being deposited on said roughened surface by controlled evaporation to predeterminedly obtain a constant percentage physical resistance to wear throughout its length by moving engagement therewith of said contacting member, and a movable contacting member to

5

engage said resistance metal, said resistance metal structure varying in width throughout its length.

5. A variable resistance device including an insulating base having a roughened surface provided with a resistance metal structure consisting solely of resistance metal deposited on said roughened surface and a movable contacting member to engage said resistance metal, said resistance metal structure varying in thickness and width throughout its length.

6. A variable resistance device including a base having a roughened surface provided with a resistance metal structure consisting solely of resistance metal deposited on said roughened surface, said resistance metal structure being deposited on said roughened surface by controlled evaporation to predeterminedly obtain a constant percentage physical resistance to wear throughout its length by moving engagement therewith of said contacting member, and a movable contacting member comprising a rolling wheel to engage said resistance metal structure.

7. A variable resistance device including an insulating base having a roughened surface provided with a resistance metal structure consist-

6

ing solely of Nichrome as a resistance metal deposited on said roughened surface, said resistance metal structure being deposited on said roughened surface by controlled evaporation to predeterminedly obtain a constant percentage physical resistance to wear throughout its length by moving engagement therewith of said contacting member, and a movable contact device including a rolling wheel to engage said metal, said resistance metal structure varying in thickness and width throughout its length.

WILLIAM R. JACK.
LYSLE D. CAHILL.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,537,671	Jack et al.	Jan. 9, 1951

FOREIGN PATENTS

Number	Country	Date
342,300	Great Britain	Jan. 28, 1931

OTHER REFERENCES

Curtis, Review of Scientific Instruments, December 1933, vol 4, pages 679-680.