

Jan. 9, 1951

W. R. JACK ET AL
VARIABLE RESISTANCE DEVICE

2,537,671

Filed March 10, 1950

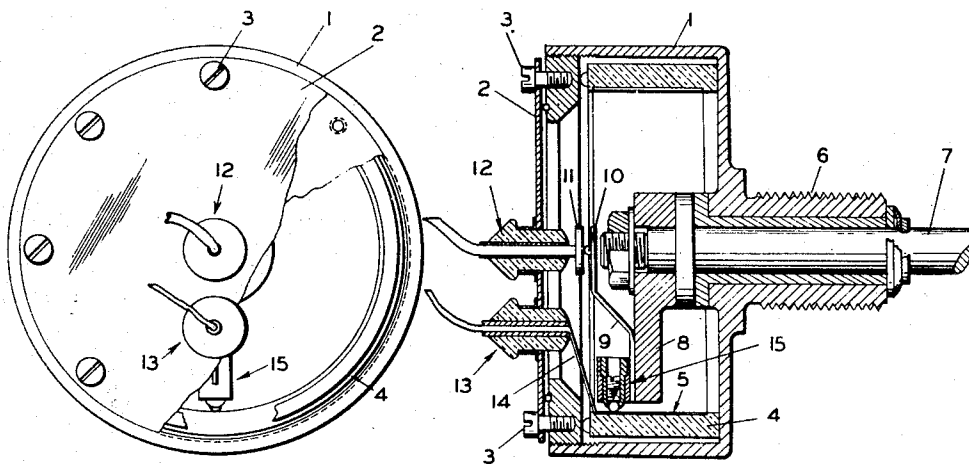


Fig. 1-

Fig. 2-

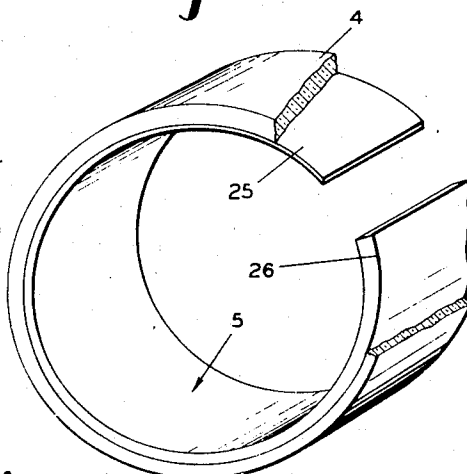
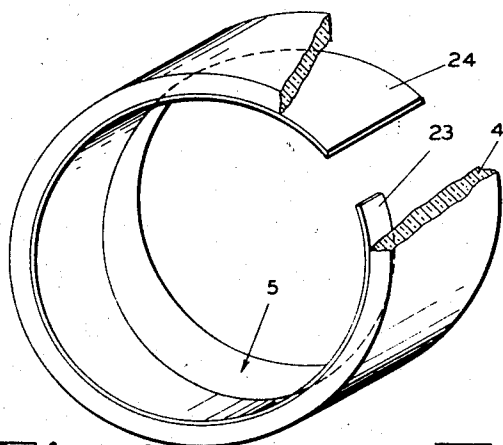


Fig. 3-

Fig. 4-

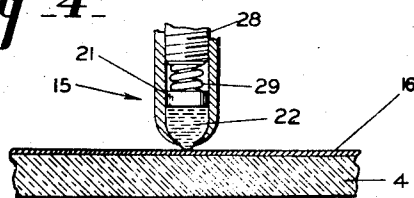
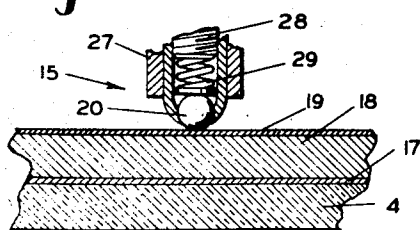


Fig. 6-

Fig. 5-

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2,537,671

VARIABLE RESISTANCE DEVICE

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Application March 10, 1950, Serial No. 148,894

19 Claims. (Cl. 201—55)

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This invention relates to 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 resistance elements 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 excessive wear by the contactor, leaving it difficult, if not impossible to obtain uniformity of the variable resistance device or its accurate control.

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

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 with a resistance material structure of uniform thickness and varying width;

Figure 4 is a similar view in which the resistance material structure is of varying thickness and uniform width;

Figure 5 is a schematic view showing a resistance device in which there are multiple layers of resistance material applied to the base and a contactor having a ball and socket suspended contacting member; and

Figure 6 is a similar view of a base with one layer of resistance material and a contactor with a contacting member formed of a globule of mercury.

Referring more particularly to the drawings, the variable resistance device may comprise a cylindrical casing 1 having a cover plate 2 re-

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movably 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 contactor, generally indicated at 15, urged into constant contact with the inner surface of the resistance material structure on the inside of the potentiometer ring.

While the base 4 may be ceramic, glass, or other 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 thereof. 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, platinum will be discussed as preferable. In order to evaporate the platinum on to and into the glass we heat the platinum to a temperature above its boiling point in a vacuum and apply a potential between the evaporating metal and the glass bowl. 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. Such evaporated metal processes are readily controllable to insure imbedding of the platinum into the glass bowl and provide a coating whose thickness and width is also readily controllable for any desired pattern of varying thickness or width or both. A single layer resistance material structure is shown in Figure 6, in which the glass bowl is shown at 4 and the single platinum layer is shown exaggerated in thickness at 16.

As an example of a multiple layer resistance material structure, we have shown in Figure 5 in which the glass bowl is shown also at 4. To the glass bowl we apply a thin coating by evaporating thereon nickel or aluminum, 17 as an excellent adhesive binder. On the binder 17 we evaporate a thick layer 18 of resistance metal such as Nichrome alloy and to layer 18 we evaporate a very thin layer 19 of platinum.

The contactor, generally referred to at 15 in

Figures 1 and 2, may take various forms, two of which are illustrated in Figures 5 and 6. In Figure 5 there is shown a portion of a carrying arm 27, inside of which is a screw plug 28, a spring 29 and a ball and socket suspended platinum ball contactor 20. In Figure 6 is the same arm 17, screw plug 18 and spring 19 with a piston 21 and globule of mercury 22.

In Figure 3 the resistance material structure, generally referred to at 5, is intended to represent such a structure, whether of a single or multiple layers, that varies in width from its narrow end 23 to its adjacent relatively wider end 24.

In Figure 4 the resistance material structure, generally indicated at 5, is intended to represent such a structure, whether of a single or multiple layers, that varies in thickness from its thin end 25 to its adjacent relatively thicker end 26. It is to be understood that any pattern of varying thickness and width, or both, may be employed.

In connection with the single layer resistance material structure shown in Figure 4, platinum was selected as an excellent choice inasmuch as it may be evaporated into and onto the glass bowl to form a coating that will not oxidize and form a good contact surface for either the platinum rolling ball 20 or the mercury globule 22 without wear or chemical attack.

In connection with the multiple layer resistance material structure shown in Figure 3, the thin aluminum layer 17 is an excellent adhesive binder on the glass bowl 4 and the thick Nichrome alloy layer 18 is an excellent resistance metal for use in variable resistance devices. However, Nichrome alloy is readily bonded by evaporation to aluminum but not as much so to glass as is aluminum. Moreover, as good a resistance metal as Nichrome alloy is, it is subject to oxidation and other atmospheric effects and also subject to chemical attack by mercury, if a contactor, such as shown in Figure 6, were used. Hence, we evaporate a very thin layer 19 of platinum on the Nichrome alloy layer 18 and the platinum and aluminum layer 19 may be so thin as to not appreciably interfere with the good resistance characteristics of the Nichrome alloy layer. The thin platinum layer 19 also affords an excellent contact surface for the frictionless engagement of either the ball and socket platinum ball 20 or the mercury globule 22.

Thus, whether the resistance metal is the single layer of Figure 6, the multiple layer of Figure 5, the varying width type of Figure 3, the varying thickness type of Figure 4 or one in which the pattern of the resistance structure varies both in thickness and width, the top layer being of platinum, it is suitable for engagement by either ball 20 or globule 22, as neither of the latter are abrasive nor do they produce chemoelectrical or thermoelectrical forces or oxidation.

It will be seen from the foregoing that we have provided an efficient continuously variable resistance device of permanent non-wearing and non-deteriorating characteristics capable of carrying high currents for use for any mathematical function, whether linear or non-linear.

We claim:

1. A variable resistance device including a base provided with a resistance structure consisting solely of resistance metal evaporated on said base and a movable contacting member to engage said evaporated resistance metal.

2. A variable resistance device including an insulating base provided with a resistance structure consisting solely of resistance metal evaporated on

said base and a movable contacting member to engage said evaporated resistance metal.

3. A variable resistance device including an insulating base provided with a resistance structure consisting solely of resistance metal impervious to oxidation evaporated on said base and a movable contacting member to engage said evaporated resistance metal.

4. A variable resistance device including an insulating base provided with a resistance structure consisting solely of resistance metal impervious to oxidation evaporated on said base and a movable contacting member to engage said evaporated resistance metal, said evaporated resistance metal varying in thickness throughout its length.

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

6. A variable resistance device including an insulating base provided with a resistance structure consisting solely of resistance metal impervious to oxidation evaporated on said base and a movable contacting member to engage said evaporated resistance metal, said evaporated resistance metal varying in thickness and width throughout its length.

7. A variable resistance device including a base of glass provided with a coating of platinum as a resistance metal evaporated on said base and a movable contacting member to engage said platinum coating only.

8. A variable resistance device including a base of glass provided with a coating of platinum as a resistance metal evaporated on said base and a movable contacting member to engage said platinum coating only, said contacting member being of platinum.

9. A variable resistance device including a base of glass provided with a coating of platinum as a resistance metal evaporated on said base and a movable contacting member to engage said platinum coating only, said contacting member being of mercury.

10. A variable resistance device including an insulating base provided with a resistance structure consisting solely of resistance metal impervious to oxidation evaporated on said base and a movable contacting member to engage said evaporated resistance metal, said evaporated resistance metal and said contacting member being impervious to chemical reaction by each other by reason of contact.

11. A variable resistance device including an insulating base provided with a resistance metal structure consisting solely of an initial thin coating of metal having high adhesive qualities for said base, said initial coating being evaporated on said base, a second thick coating of metal of desired resistance characteristics evaporated on said initial coating, a third thin layer of resistance metal impervious to oxidation evaporated on said second coating and a movable contacting device to engage said third coating.

12. A variable resistance device including an insulating base provided with a resistance metal structure comprising an initial thin coating of metal having high adhesive qualities for said base, said initial coating being evaporated on said base, a second thick coating of metal of desired resistance characteristics evaporated on said initial coating, a third thin layer of resist-

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ance metal impervious to oxidation evaporated on said second coating and a movable contacting device to engage said third coating, said resistance metal structure varying in width throughout its length.

13. A variable resistance device including an insulating base provided with a resistance metal structure comprising an initial thin coating of metal having high adhesive qualities for said base, said initial coating being evaporated on said base, a second thick coating of metal of desired resistance characteristics evaporated on said initial coating, a third thin layer of resistance metal impervious to oxidation evaporated on said second coating and a movable contacting device to engage said third coating, said resistance metal structure varying in thickness throughout its length.

14. A variable resistance device including an insulating base provided with a resistance metal structure comprising an initial thin coating of metal having high adhesive qualities for said base, said initial coating being evaporated on said base, a second thick coating of metal of desired resistance characteristics evaporated on said initial coating, a third thin layer of resistance metal impervious to oxidation evaporated on said second coating and a movable contacting device to engage said third coating, said resistance metal structure varying in thickness and width throughout its length.

15. A variable resistance device including a glass base provided with a resistance metal structure comprising an initial thin coating of aluminum evaporated on said base, a second thick coating of Nichrome alloy evaporated on said aluminum coating, a third thin coating of platinum evaporated on said Nichrome alloy coating and a movable contacting member of platinum to engage said platinum coating.

16. A variable resistance device including a glass base provided with a resistance metal structure comprising an initial thin coating of aluminum evaporated on said base, a second thick coating of Nichrome alloy evaporated on said aluminum coating, a third thin coating of platinum evaporated on said Nichrome alloy coating and a movable contacting member comprising a globule of mercury for contacting said platinum coating.

17. A variable resistance device including a glass base provided with a resistance metal struc-

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ture comprising an initial thin coating of aluminum evaporated on said base, a second thick coating of Nichrome alloy evaporated on said aluminum coating, a third thin coating of platinum evaporated on said Nichrome alloy coating and a movable contacting member of platinum to engage said platinum coating, said resistance metal structure varying in thickness and width throughout its length.

18. A variable resistance device including a glass base provided with a resistance metal structure comprising an initial thin coating of aluminum evaporated on said base, a second thick coating of Nichrome alloy evaporated on said aluminum coating, a third thin coating of platinum evaporated on said Nichrome alloy coating and a movable contacting member comprising a globule of mercury for contacting said platinum coating, said resistance metal structure varying in thickness and width throughout its length.

19. A variable resistance device including a glass base provided with a resistance metal structure comprising an initial thin coating of aluminum evaporated on said base, a second thick coating of Nichrome alloy evaporated on said aluminum coating, a third thin coating of platinum evaporated on said Nichrome alloy coating, said resistance metal structure varying in width and thickness throughout its length and a movable contacting member of a metal chemically non-reactive with platinum for engaging said platinum coating.

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