

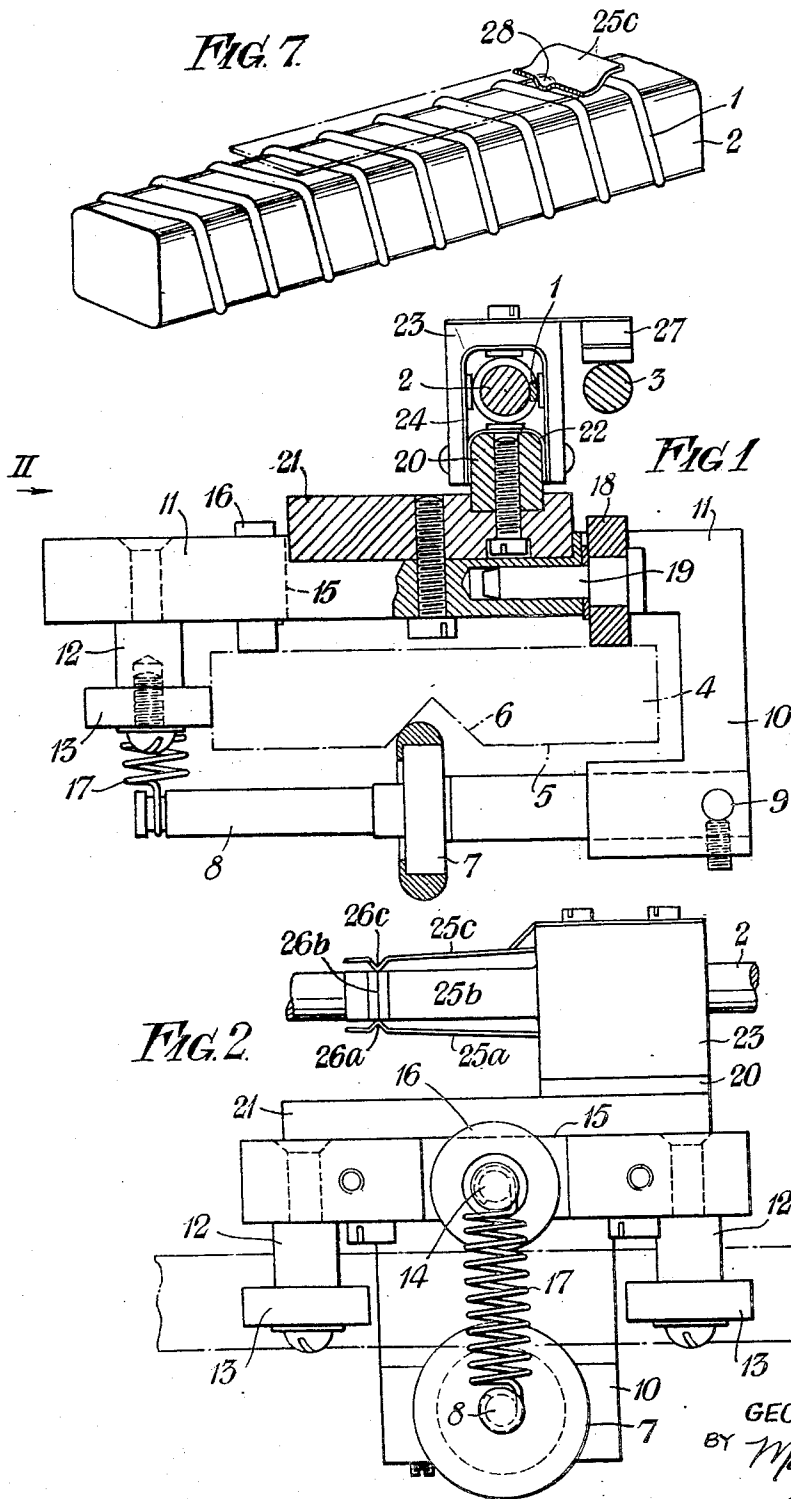
April 29, 1952

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VARIABLE RESISTANCE

2,594,796

Filed Sept. 15, 1950

2 SHEETS—SHEET 1



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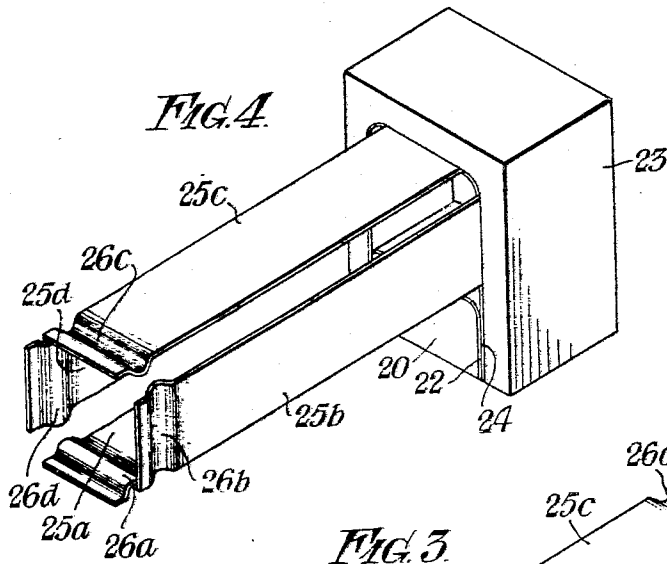
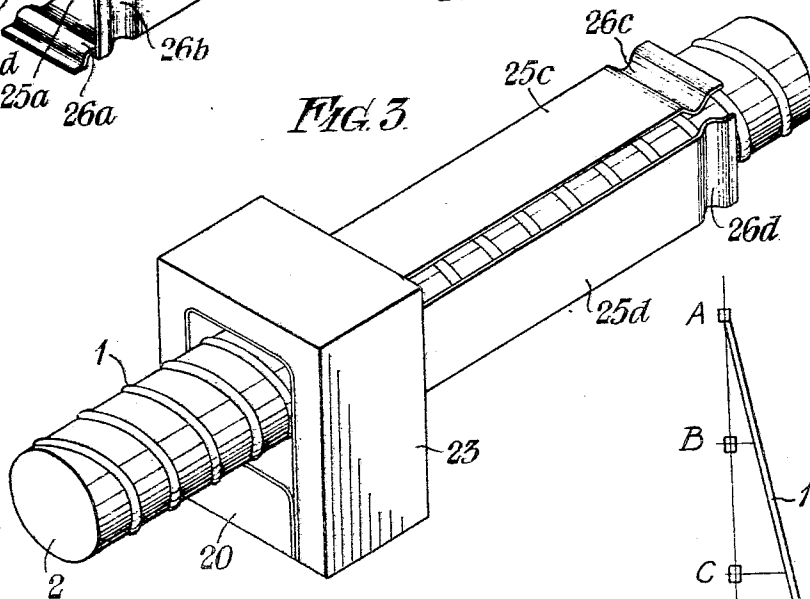
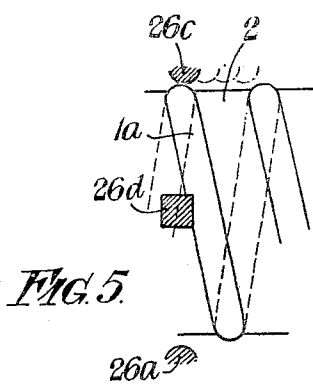
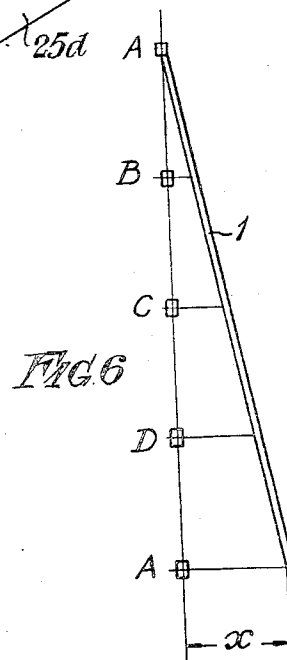
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2 SHEETS—SHEET 2



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VARIABLE RESISTANCE

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9 Claims. (Cl. 201-62)

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This invention concerns variable resistances and is more particularly, although not exclusively, concerned with such resistances or potential dividers of the kind in which the resistance element is wound on a straight former and the sliding contact is automatically adjusted to restore balanced conditions by means of a servo-motor energised, through amplifying means if necessary, in accordance with the out of balance potential.

When a variable resistance of low value is required to operate in a sensitive circuit, it is frequently difficult to obtain the desired degree of resolution owing to the change in value of the resistance upon moving from one turn to the next. This is particularly disadvantageous when the variable resistance is to be used as a potential divider in a servo-motor operated instrument, usually comprising balanced circuits, two arms of which are constituted by the two portions of a potential divider on either side of the point of contact of the slider, since the servo-motor tends to hunt due to the low degree of resolution.

It is an object of the present invention to overcome the disadvantage inherent in known types of variable resistances whereby the resolution can be substantially improved and the consequent tendency to hunting by the servo-motor largely reduced.

According to the present invention a variable resistance has a helically wound resistance winding, and a plurality of electrically bonded contact elements, non-rotatable about the axis of the winding slidable axially of the winding rigidly connected together, and spaced around the axis of the winding so that their points of contact with said resistance winding lie in a plane normal to said axis.

Preferably the sliding contact elements are equally spaced along the length of a turn of the winding.

Advantageously, each contact element is arranged to make contact with a turn of the resistance winding for an axial distance equal to $1/n$ th of the pitch of the windings, where n is the number of contact elements.

Each contact element may consist of a flexible strip, the free end of which is formed with a dimple or like formation.

Forms of variable resistance according to the invention, will now be described by way of example and with reference to the accompanying drawings, in which:

Figure 1 is an end view, partly in section, of the slider carriage,

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Figure 2 is a view of the carriage shown in Figure 1 taken in the direction of the arrow II.

Figure 3 is a perspective view of the contact elements engaging the resistance winding,

Figure 4 is a perspective view of the assembly shown in Figure 3 from a different position,

Figure 5 is an enlarged view of a small part of the resistance winding showing the contacts engaged therewith,

Figure 6 is a developed view of one turn of the winding, and the positions of the contacts relative thereto, and

Figure 7 is a perspective view of an alternative form of resistance winding former and contact.

A resistance winding 1 is wound helically upon a straight fixed former 2 of circular cross section. A straight contact bar 3 of circular cross section is also fixedly mounted parallel to the former 2. Below the former 2 and contact bar 3 is a rigid guide member 4 of rectangular cross section, whose longitudinal axis is parallel to that of the former 2. On the lower face 5 of the guide member 4 is a groove 6 of triangular cross section, also parallel to the axis of the former 2.

An arm 8, extending across the bottom of the guide member 4 is pivotally mounted at 9 in a depending portion 10 of a carriage 11. The arm carries a rotatable wheel 7 engaging one flank of the V-groove 6.

The wheel 7 is held in engagement with the flank by a tension spring 17 anchored to the free end of the arm 8 and to the carriage 11.

The carriage 11 extends across the guide member 4 and is positioned between the guide member and the former 2.

Two wheels 13 are mounted on respective bushes 12 on the lower side of the carriage 11 remote from the depending portion 10. These wheels 13 engage one side of the guide member 4. The spring 17 urges the spindle 8 and the carriage 11 together to cause the wheel 7 to be urged, by the engaged flank of the V-groove away from the wheels 13, thus holding these wheels firmly in engagement with the side of the guide member 4.

The top of the carriage 11 is slotted between the bushes 12, and a rod 14 is fixed to the carriage in the slot 15 to project parallel to the top of the guide member 4 and transversely of the longitudinal axis of the latter. A wheel 16 rotatably mounted on the rod 14 engages the top surface of the guide member 4 and the rod 14 constitutes the upper anchorage for the spring 17.

The carriage 11 is further supported upon the

top surface of the guide member 4 by two wheels 18 rotatably mounted on stub shafts 19.

Thus the carriage is guided for axial movement along the guide member.

An insulating terminal block 20 is rigidly mounted upon an insulating plate 21 secured in the top of the carriage 11. The top of the terminal block is covered by a U-shaped metal band 22, and a U-shaped insulating contact holder 23, having a metal band 24 extending over its inner surface the lower ends of the limbs of the U-shaped holder embracing the terminal block and being rigidly secured thereto. The U-shaped contact holder surrounds the wire-wound former 2, and the metal bands 22 and 24 are in good electrical contact.

A flexible metallic contact strip 25a is formed integral with the metal band 22, and projects therefrom parallel to the axis of the former 2. Towards the free end of the strip 25a a semi-cylindrical dimple 26a is formed and this contacts the winding 1 on the former 2.

Three similar flexible contact strips 25b, 25c and 25d are formed integral with the metal band 24. Two of these, 25b and 25d extend parallel to the axis of the former in planes at right angles to the contact strip 25a whilst the contact strip 25c extends parallel to the contact strip 25a. The contact strips 25b, 25c and 25d are thus electrically bonded. All the contact strips are of equal length and each has a corresponding dimple 26b, 26c, and 26d. The points of contact of all the dimples with the resistance winding are arranged to lie in a plane normal to the axis of the winding. Moreover, the contact strips are electrically bonded by means of the metal bands 22 and 24. The contacts 25a-d are electrically connected to the contact bar 3, by means of common contact strip 27 which is mounted on top of the U-shaped contact holder 23. The assembly of contact strips 25a-d and the holder 23 constitute the slides of the variable resistance.

As shown in Figure 5, the dimple 26c is in contact with one turn 1a of the winding 1, the remaining dimples being out of contact therewith. As the slider carriage 11 is moved along the winding 1, the dimple 26c breaks contact with the turn 1a and at the same time the dimple 26d contacts the same turn at a point displaced 90° from the point of contact of the dimple 26c. Similarly the dimple 26a contacts the turn 1a as the dimple 26d breaks contact therewith. Thus the least change of resistance in either part of the resistance winding 1 which can be obtained is equal to one quarter of the resistance of one turn. This alteration is one quarter of that which occurs between successive contacts, if only a single contact element is used. The variable resistance thus has a resolution of the order of four times that of a similar variable resistance having only one sliding contact element.

In order that contact may be continuous it is essential that any one dimple 26a-d continues in contact with the winding 1 until the succeeding dimple has made contact therewith. Referring to Figure 6, if the pitch of the winding is x , the contact A must remain in contact with a turn of the winding for an axial distance of $x/4$, until the contact B has engaged the winding. Each contact in turn engages the winding for an axial distance of $x/4$ until the contact A makes contact with the next turn. Thus at all times, contact is made with the winding 1.

More generally stated, each contact element makes contact with a turn of the winding for an

axial distance equal to $1/n$ th of the pitch of the winding, where n is the number of contact elements.

The former may be of rectangular cross section as shown in Figure 7, and in this case the dimple 26 will be hemispherical to give a small contact area with the resistance winding 1.

It will be understood that the former may be of curved or annular shape and any desired number of contact elements may be provided. The contact elements may be spaced other than equiangularly over the surface of the resistance winding.

In this specification, it is to be understood that a helically wound winding is one wound at a constant angle to a fixed direction which is parallel either to the axis of the winding, in the case of a straight winding, or to the direction of the said axis at the point on the winding considered in the case of a curved winding.

It will be realised that it is of advantage, in any system in which a variable resistance according to the invention is used, that the increments of resistance between the operation of successive contacts be equal and to achieve this object, the sliding contact elements may be spaced equally along the length of a turn of the winding.

What I claim is:

1. A variable electric resistance comprising an insulating support form, a single filamentary element of electrically resistive material applied to the form along a path extending substantially helically about the longitudinal axis of the form, a support displaceably mounted adjacent to the form, means constraining the support to move in a path disposed parallel with the said axis, means preventing rotation of the support around the said axis, electrically conductive means fixedly mounted on the said support, and a plurality of contact elements formed on the conductive means at locations which lie substantially in a common plane normal to the said axis but are angularly spaced around the said axis so that displacement of the support relative to the form will cause each contact element to engage the filamentary element at successive points along one of a number of lines parallel with the axis of the former, the effective length of each contact element being at least equal to the pitch of said helical filamentary element divided by the number of said contact elements.

2. A variable electric resistance according to claim 1, in which the contact areas on the conductive means are equiangularly spaced around the axis of the former.

3. A variable electric resistance according to claim 1, in which each contact area is of sufficient extent in a direction parallel with the axis of the former to remain in engagement with a point on the filamentary element, during the displacement of the support, in the interval between the cessation of the engagement of the previously engaged contact area and the commencement of the engagement of the contact area next to become operative.

4. A variable electric resistance according to claim 1, in which the electrically conductive means comprises flexible strips, and the contact areas comprise dimples formed on the free ends of the strips.

5. A variable electric resistance according to claim 1, wherein there is provided a stationary contact bar parallel to but spaced from the

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former, and common electrical contact means between the conductive means and contact bar.

6. A variable electrical resistance according to claim 1, wherein the former is of annular shape.

7. A variable electrical resistance according to claim 1, wherein the former is of rectangular cross-section.

8. A potential divider including a variable electrical resistance according to claim 1.

9. A variable electrical resistance comprising a helical resistance element, a contact element support movable lengthwise of said element, and a plurality of contact elements carried by said support and arranged to contact said resistance element at points spaced circumferentially thereabout and lying in a plane perpendicular to the axis of said helical resistance element, the effective axial length of each of said contact elements being at least equal to the pitch of said

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helical resistance element divided by the number of such contact elements.

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