

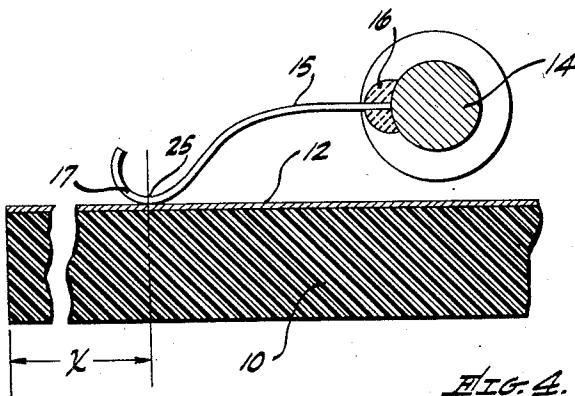
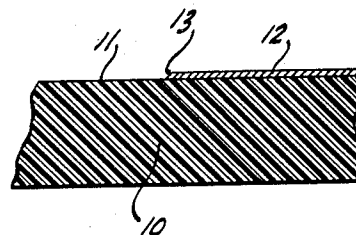
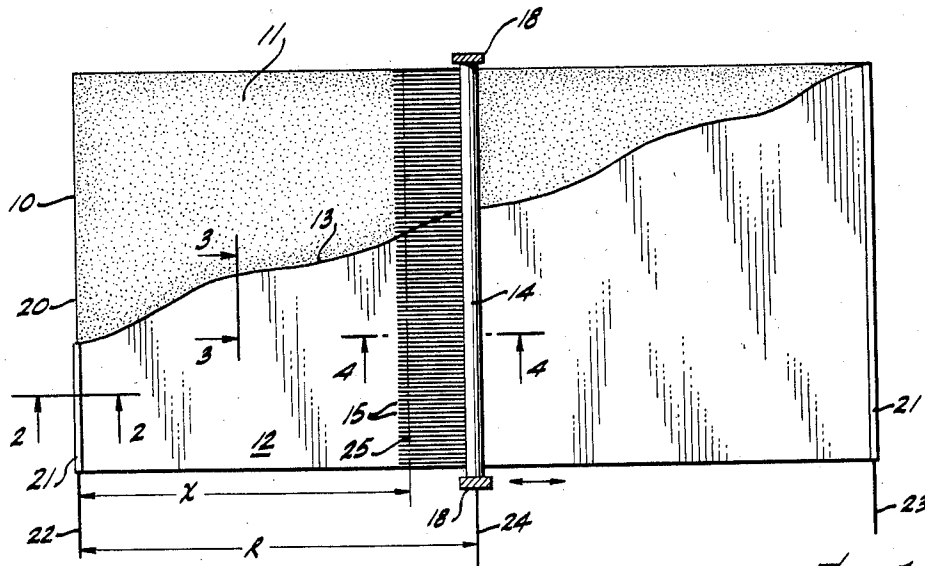
Jan. 21, 1958

B. KLESTADT

2,820,873

VARIABLE ELECTRICAL RESISTANCE DEVICE

Filed March 25, 1955



INVENTOR
BERNARD KLESTADT,
BY
Henry Heyman
ATTORNEY.

1

2,820,873

VARIABLE ELECTRICAL RESISTANCE DEVICE

Bernard Klestadt, Beverly Hills, Calif., assignor to Hughes Aircraft Company, Culver City, Calif., a corporation of Delaware

Application March 25, 1955, Serial No. 496,793

4 Claims. (Cl. 201—60)

The present invention relates generally to potentiometers and relates more specifically to non-linear types of potentiometers or like structures.

In potentiometers, and other like electrical resistance elements, it is often desirable to provide considerable electrical resistance and to provide non-linear characteristics as far as the movement of a contact means over a surface of resistance material is concerned. In wire wound types of resistance elements, non-linear characteristics are frequently obtained by winding of the wire about a card or support material having variable cross sectional areas. In the devices of this type, considerable difficulty is encountered relative to the necessity for mounting and moving a contact member over the wound card through planes other than a single plane. The structure necessary for operation of these devices is generally quite complex, and when attempts are made toward miniaturization, such complex components are necessarily quite fragile.

In prior devices utilizing a point contact technique, in which resistance wire pitch or conductive plastic cross section is varied, serious limitations are encountered in regard to the restricted functions that can be obtained through use of devices of this character. Other prior devices, utilized to provide non-linear resistivity, include such devices as resistive paddlers disposed across ordinary linear resistance elements. In most of these prior devices designed to perform similar functions, the ultimate electrical function desired from the device must be either continuous or have at least continuous derivatives, and such derivatives must not exceed certain upper limits.

Accordingly, it is one important object of the present invention to provide a novel resistance element having non-linear characteristics.

It is another important object of the present invention to provide a novel means for constructing non-linear potentiometers wherein derivatives for the electrical function of the device may considerably exceed limits which normally restrict other like arrangements.

It is a still further important object of the present invention to provide a novel variable resistance element having non-linear characteristics and which is extremely small, light in weight, effective in use and inexpensive in manufacture.

Other and further important objects of the present invention will become apparent from the disclosures in the following detailed specification, appended claims and accompanying drawing, wherein:

Figure 1 is a plan view of the potentiometer of the present invention;

Fig. 2 is a greatly enlarged fragmentary sectional view of an edge portion of the present potentiometer, as taken substantially as indicated by line 2—2, Fig. 1;

Fig. 3 is an enlarged fragmentary sectional view across a junction between conductive and nonconductive areas of a support plate, taken as indicated by line 3—3, Fig. 1; and

Fig. 4 is an enlarged fragmentary sectional view show-

2

ing the contact members, as taken substantially as indicated by line 4—4, Fig. 1.

With reference to the drawing, the electrical resistance devices of the present invention is shown as including a base member 10 that may be made from any suitable non-conductive material such as plastic, phenolic resin or other like suitable material. The base member 10 has a planar surface 11 on which a coating 12 is applied. The coating 12 is of conductive material such as, for example, metal or conductive plastics. As shown in Fig. 1, portions of the coating 12 may be etched away or otherwise removed from the surface 11, thus to expose an area of the surface 11 and to define a junction line 13 along an edge of the coating 12. The slope and characteristics of the line 13 may be any desired shape and may be either linear or non-linear. As shown in the drawing, the line 13, defined by the edge of the conductive material 12, is non-linear with there being generally increasing transverse area of the surface covered by the conductive material 12 from one longitudinal end of the base member 10 to the other.

A rod or contact carrying member 14 is disposed transversely over and in spaced relationship to the surface of the electrically conductive coating 12. The rod 14, as shown in Figs. 1 and 4, serves to support a plurality of contact members 15 that are connected to the rod 14 as by any suitable means such as, for example, soldering as indicated at 16. The contact members 15 may be made from suitable spring material, are curved as at 17 and are biased into contact with the exposed surface of the coating 12. The contact members 15 are disposed transversely across the entire surface of the coating 12 and exposed area 11 of the base member 10. The outer ends of the rod 14 may be provided with suitable connections 18 which may be connected to suitable structure for effecting longitudinal movement of the rod and contact members 15 over the surface of the base member 10 and conductive coating 12.

As shown primarily in Figs. 1 and 2, the longitudinal ends of the coating 12 and edges 20 of the base member 10 are coated with a layer of conductive material 21 which may be in the form of conductive paint or the like. The layers of conductive material 21 serve not only to bond the ends of the coating 12 to the base member 10, but also serve to retain leads 22 and 23 in electrical contact and connection with the conductive material 12. A center tap lead 24 is attached to one end of the rod 14 and/or connections 18, thereby providing a connection with the contact members 15.

It may thus be seen that, upon establishment of connection between one of the end leads 22 or 23 and the center tap lead 24, variable non-linear resistance may be established by movement of the rod 14 and contact members 15 longitudinally over the length of the material 12 and surface 11, due to the increased resistivity afforded by the necessity for flow of electrical energy through the electrical resistive material of the coating 12.

To obtain the desired variation of resistance, which may be indicated as $R(x)$, with the position of the line of contact 25 of the contact members 15 being indicated as (x) from one end of the unit, and R indicating the distance from one end of the unit to the center line of the rod 14, the function over the length of the potentiometer may be plotted as follows:

$$\frac{K}{\frac{d}{dx}R(x)}$$

The resulting curve will be that defined by the edge line 13 of the material 12 which divides the surface of the potentiometer into conductive and nonconductive regions, as shown. To illustrate that the function defined by the

3

line 13 actually does result in the required resistance variation, the following will apply. The distance transversely across the strip of conductive material 12, having a width expressed as dx , is

$$\left(\frac{\frac{dx}{K} K}{\frac{d}{dx} R(x)} \right)$$

where K is the resistivity of the conductive material 12 in ohms/square. Then, the resistance from 0 to x is clearly

$$R \int_0^x \frac{K \frac{dx}{K}}{\frac{d}{dx} R(x)} = \int_0^x d[R(x)] = R(x)$$

In using the above method of obtaining the desired electrical function, the only restriction on the resistance or voltage variation obtainable by this method, resides in the fact that the desired function has piece wise continuous first derivatives. There are no restrictions on continuity of the function or upper limits on it or its derivatives.

While the present base material is shown as being flat, it is to be understood that it is also practical to form the base material and the conductive coating thereon into a cylinder or a cylindrical helix. Additionally, the particular form of contact members may be altered without departing from the spirit and scope of the present invention and such members may be replaced by one or more rollers or the like. Furthermore, the conductive layer along the edges of the conductive coating may be of material other than conductive paint or the like and may take the form of plating, if so desired.

Having thus described the invention and the present embodiment thereof, it is desired to emphasize the fact that many modifications may be resorted to in a manner limited only by a just interpretation of the following claims.

I claim:

1. A variable non-linear potentiometer comprising, in

4

combination: an elongated plate of non-conductive material and having a planar surface; an electrically conductive coating on said surface, a portion of the area of said coating being removed, whereby to expose an area of said plate material, said coating having a generally increasing transverse width from one longitudinal end of said plate to the other; a layer of conductive material disposed over end portions of said coating lying along said longitudinal edges and over said edges, said layer serving to retain and electrically connect leads to each of said ends; a transversely disposed rod positioned to overlap said coating in spaced relationship thereto, said rod being adapted for longitudinal movement over said coating; a plurality of contacts carried by said rod, said contacts being disposed in contact with said coating; and a further lead attached to said rod, a variable non-linear resistance to flow of electrical energy being established by connection across said further lead and one of said first mentioned leads upon movement of said rod through a plane parallel to said surface.

2. A variable non-linear potentiometer according to claim 1 wherein said contacts are of spring material whereby to permit their bias toward said coating.

3. A variable non-linear potentiometer according to claim 1 wherein a sharp line is defined between said conductive coating and said exposed surface of said plate material.

4. A variable non-linear potentiometer according to claim 1 wherein said layer of conductive material comprises a metalized paint, said plate is of a phenolic material and said coating is permanently attached to said phenolic material.

References Cited in the file of this patent

UNITED STATES PATENTS

432,131	Flemming	July 15, 1890
1,819,246	Jones	Aug. 18, 1931
2,529,123	Arnold	Nov. 7, 1950