May 8, 1956

C. C. CALDWELL

2,744,986

POTENTIOMETER AND METHOD OF MAKING

Filed Feb. 6, 1953

Fig. I.

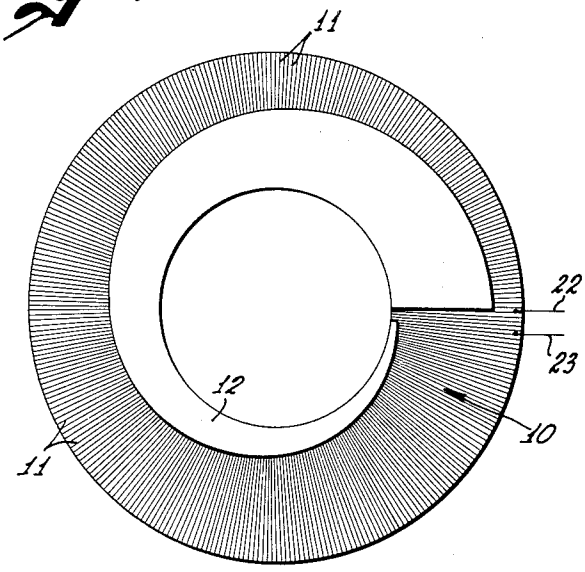


Fig. II.

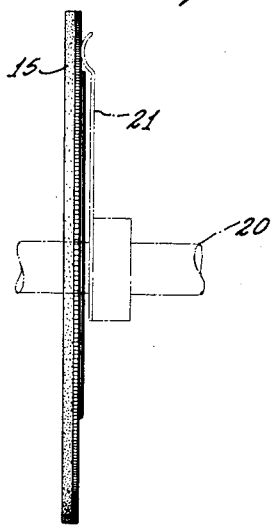


Fig. III.

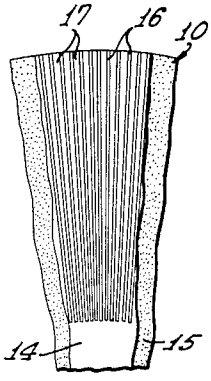


Fig. IV.

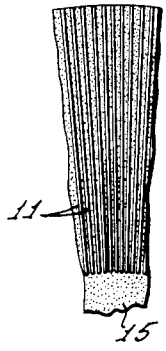


Fig. V.

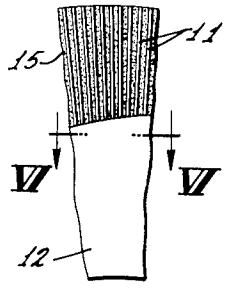


Fig. VII.

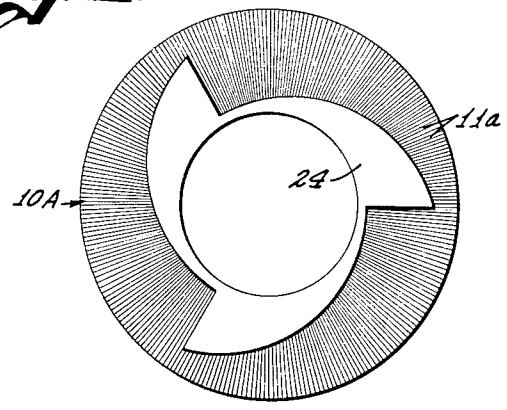
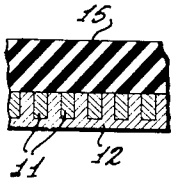


Fig. VI.



INVENTOR.

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POTENTIOMETER AND METHOD OF MAKING

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Application February 6, 1953, Serial No. 335,537

2 Claims. (Cl. 201—60)

My invention relates in general to potentiometers and more specifically to potentiometers having non-linear characteristics and to the method of making the same. A non-linear potentiometer is a potentiometer in which the resistance is a non-linear function of the displacement of the moveable contact.

In recent years with the development of high speed aircraft, guided missiles and other devices requiring a high degree of accuracy, electronic control systems must be designed to operate and control the devices according to the true non-linear equations applicable rather than approximate linear functions. Therefore, it becomes necessary to devise components such as potentiometers having non-linear characteristics.

Non-linear potentiometers are well known in the art, however, such potentiometers usually take the form of a winding on a tapered core or a tapered wire on a cylindrical or linear core. In either case, the difficulty of manufacturing, in order to hold the necessary tolerances, are almost prohibitive. One of the objects of my invention is to produce a non-linear potentiometer capable of being produced within extremely close limits at a relatively low price.

Most of the non-linear potentiometers, known to the art, are essentially hand made items which by their nature are expensive and inaccurate.

A further objective of my invention is to provide a non-linear potentiometer capable of being reproduced on a mass production basis with a high degree of accuracy.

In order to vary the functions of the non-linear potentiometers heretofore known to the art, it has been necessary to change the taper of the core of the taper of the wire being used, both of which resulted in rather expensive retooling operations.

A further objective of my invention is to provide a potentiometer in which the linearity characteristics can readily be changed by a simple expedience of making a new drawing and to photographing the same.

The potentiometers, heretofore known to the art, were subject to excessively high rates of rejection because, when made, they cannot be calibrated or changed.

A further object of my invention is to provide a new and novel method of producing potentiometers, particularly of the non-linear type, which results in a substantial reduction in the cost of production and materially increases the reliability of uniform results.

A further objective of my invention is to provide a potentiometer which can very easily and cheaply be calibrated to the desired accuracy.

Other and further objects and advantages of my invention will become apparent from the drawings and specifications relative thereto.

In the drawing.

Figure I is a top plan view of a potentiometer embodying the principles of my invention.

Figure II is a side elevation of the potentiometer illustrated in Figure I.

Figure III, IV and V are fragmentary plan views illustrating the three steps in the production of a potentiometer embodying the principles of my invention.

Figure VI is a sectional view taken on line 6—6 of Figure V.

Figure VII is a top plan view of a modification of the potentiometer illustrated in Figure I.

In Figure I, I have illustrated a disc of dielectric material, designated generally **10**, formed with a plurality of radially disposed conductive segments **11** and having an overlay of conductive high resistance material **12** in electrical contact with each of the segments **11**.

Referring to Figures III, IV and V, it will be noted that I start with the disc **10** which is formed with a sheet of copper **14**, securely bonded to a dielectric back **15**. I imprint on the copper surface **14** a plurality of radial lines or surfaces **16**. The lines **16** may be applied to the copper surface by any one of several well known methods such as photographically or by means of a silk screen and are of any desired width depending on the width of the segments **11**. By either of the photographic or silk screen processes, a thin, clearly defined layer of protective material can be placed on the copper. This, in effect, leaves a plurality of radial surfaces **17** of copper exposed around the surface of the disc.

The disc with imprinted lines **16** is then placed in a suitable etching bath, such as ferric chloride, which dissolves all exposed copper. The disc is then washed and the protective coating removed by any suitable solvent, thereby leaving the commutator segments **11** around the surface of the disc. A layer of resistance material **16** is then superimposed over the top of the copper segments **11** by any well known printing method such as off-set print or silk screening. The resistance material **16** can be of any suitable resistance ink such as is well known to the art.

It is well known to the art that such resistance inks may have their resistance characteristics changed at will by the method of compounding.

Again referring to Figure I, it will be noted that the width of the resistance overlay **12** varies as it progresses rotationally around the disc. It is, therefore, apparent that the total of the progressive resistance from one end to the other will vary in a non-linear function as contact is made around the surfaces, thereof.

The potentiometer is provided with a control shaft **20** having a wiper contact **21** which contacts the outer end portion of the segments **11**, which said segments are electrically connected to the resistance overlay **12**. A pair of contacts **22** and **23** are electrically connected to appropriate segments **11**.

It is, therefore, readily apparent that the resistance value of a circuit connected across the wiper and one of the contacts **22** or **23** will vary in a non-linear function upon rotation of the wiper **21**.

It is also readily apparent that by changing the composition of the resistance overlay **12**, the total resistance value of the potentiometer can readily be changed. This can be accomplished at no cost for tooling changes. It is also readily apparent that the potentiometer can be easily calibrated by checking the resistance at different rotational positions and grinding away or adding to the resistance overlay **12**. It is, therefore, apparent that the rejection rate for failure to meet the required tolerance would be considerably decreased.

Figure VII illustrates a modification and comprises of a disc designated generally **10A**, having a plurality of radial commutator segments **11*a*** and a resistance overlay **24** which is formed with three different spirals. Each of the spiral segments can be separately applied and may have different resistance characteristics to thereby increase the total range of resistance available.

It is also readily apparent that the configuration of the spirals which controls the non-linear characteristics of the overlay **12** or **24** can readily be varied to change the function desired in the potentiometer. This can be done by a relatively simple process of making a new drawing, photographing the drawing and producing a new silk screen for the purpose of applying such overlay.

I claim:

1. The method of making a potentiometer comprising the steps of applying a protective coating in a pattern to define a plurality of spaced segments on the surface of a conductive material, placing said coated material in an etching bath to thereby remove the uncoated conductive surface to form a plurality of electrically disconnected conductive segments, cleaning said protective coating from said segments to thereby expose a conductive surface of each of said segments and applying a continuous layer of high resistance coating in contact with the conductive surface of each of said segments and leaving a section of each of the segments free of said high resistance coating for making electrical contract without disturbing said high resistance coating.

2. The method of making a potentiometer comprising the steps of etching a pattern on the surface of a dielectric copper clad material to form a plurality of spaced electrically disconnected conductive segments and applying a continuous layer of high resistance coating in contact with the conductive surface of each of said segments and leaving a section of each of the segments free of said high resistance coating for making electrical contact without disturbing said high resistance coating.

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