Jan. 14, 1936. P. G. ANDRES 2,027,413

METHOD OF MAKING ELECTRICAL RESISTANCE ELEMENTS

Filed Jan. 31, 1933

Fig. 1

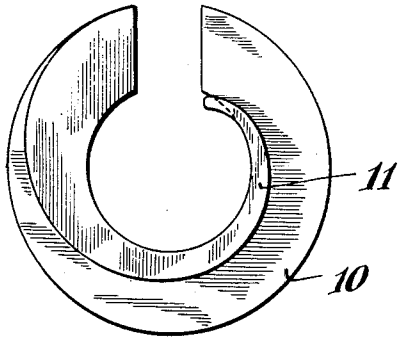
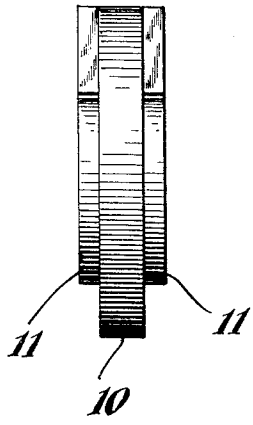


Fig. 2



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Patented Jan. 14, 1936 2,027,413

UNITED STATES PATENT OFFICE

2,027,413

METHOD OF MAKING ELECTRICAL RESISTANCE ELEMENTS

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Application January 31, 1933, Serial No. 654,425

3 Claims. (Cl. 201—76)

This invention relates to a method for adjusting the resistance of an electrical resistance element and the article produced thereby and has for a general object the provision of a method which can readily and efficiently be practiced to adjust the resistance of at least a part of a resistance element including a metallic conductive oxide and such resistance element having the resistance of at least a part adjusted by such method.

A more specific object of the present invention is the provision of such a method characterized by subjecting at least a part of a resistance element including a metallic conductive oxide to the action of heat to alter the resistance of the heat-treated part.

A further object of the invention is the provision of such a method characterized by subjecting to an over-amperage flow of current at a relatively high voltage at least a part of a resistance element formed from a composition comprising a ceramic glass and a metallic conductive oxide, preferably cadmium oxide, to reduce the resistance of the part to a predetermined value.

An additional object of the invention is the provision of resistance elements of the type specified having the specific resistance of at least a part thereof altered by the practice of such method.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the article possessing the features, properties, and the relation of elements, which are exemplified in the following detailed disclosure and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is a top plan view of one form of resistance element and a device used in connection therewith to adjust the resistance of a portion thereof in accordance with the present invention; and

Fig. 2 is a side view of the structure depicted in Fig. 1.

In accordance with the present invention the resistance of at least a part of a resistance element is altered or adjusted by heat. Resistance materials which include metallic conductive oxides, for example copper oxides, iron oxides, manganese dioxide, lead peroxide, cadmium oxide, etc., are used.

By subjecting parts of an elongated resistance element formed from such resistance materials to different heat treatments a resistance element is obtained which has various parts of different specific resistances. This feature may be utilized to obtain resistance elements having a gradually increasing resistance per unit length commonly known as a "tapered" resistance, and such "tapering" may be readily accomplished according to any desired rate of change of resistance in the successive portions of any particular heat treated part.

The heat may be applied to the resistance element directly by means of a flame, or by the use of a furnace preferably provided with a hydrogen atmosphere. In either case parts may be shielded from the heat to prevent alteration of the resistance in such parts or with the direct application of a flame some parts may for longer periods of time be subjected to the action thereof.

The adjustment or alteration of the resistance is also accomplished by subjecting the resistance element, or parts thereof, to a flow of current at a relatively high voltage and an amperage much greater than that at which the element is designed to operate. The flow of current is usually allowed to continue for a relatively short period of time. For example, including the time allowed for the element to heat up gradually under slowly increasing amounts of current before the maximum current is allowed to pass through the elements to avoid physical destruction thereof, the period of time usually is about 4 or 5 minutes. If the resistance has not been reduced by the current flow to the desired value additional periods of current flow are used.

Resistance elements which are stable and can be accurately adjusted in resistance are preferably made from materials which will form a composition consisting mainly of ceramic glass and an electrically conductive metallic oxide not readily absorbed by or chemically reactive with the ceramic glass when heated, for example, cadmium oxide. Such resistance elements are preferably formed from ingredients including a ceramic material such as koalin, and one of the materials sodium silicate and the vitreous enamels.

With the use of such resistance elements, the resistance of the entire element, or parts thereof, may be accurately adjusted, i. e., accurately reduced to a predetermined value by the use of

an over-amperage current at a relatively high voltage. In the adjustment of a resistance element of this type, designed particularly for operation with currents of the order of about one-half milliampere, a treatment current of about 40 milliamperes is used. Voltages as high as 2300 volts have been used for this treatment. This voltage, however, in accordance with the preferred method, is varied to obtain the desired amperage of the current.

The following is given by way of example: A C-shaped resistance element of the type depicted in Fig. 1, having an outside diameter of about 1.25 inches, an inside diameter of about .625 inch and a thickness of about .14 inch and having an initial resistance of about 105,000 ohms, was subjected to a current flow of about 40 milliamperes for about three minutes. One terminal of the electrical circuit was then moved along the element to remove from the circuit a relatively small part having a resistance of 27,000 ohms. The remaining major part was subjected to a current flow of about 60 milliamperes for about 15 seconds. The resistance element was then found to have a resistance of 25,500 ohms for the small part and a resistance of 29,000 ohms for the major part.

To form a resistance element having a "tapered" resistance, a contact member may be used which contacts decreasingly less area of the resistance element along its length. Referring to Figs. 1 and 2, preferably adjacent each of the two faces of a C-shaped resistance element 10 is disposed a contact member 11 which covers decreasingly less area of the resistance element 10 along its length. The contact members 11 are used as the terminals of an electrical circuit. That part of the resistance element between the terminals 11 is altered in its specific resistance.

A metallic member similar to the contact member 11 may be used in the direct application of heat to a resistance element to obtain a tapered resistance. Preferably two of such members are arranged as indicated in Fig. 2 and the heat is directly applied to that part of the resistance element not covered by the metallic members. These metallic members serve to conduct heat away from that part of the resistance element which they cover.

In either of these ways the part which is subjected to the action of the greatest amount of heat has the specific resistance thereof altered or reduced the most.

It will thus be seen that the objects set forth above are attained in an efficient manner.

Since certain changes may be made in the article and in the process of manufacturing described above without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A method of altering the resistance of an elongated resistance element including a metallic conductive oxide, which consists of placing adjacent the element a metallic member of high thermal and electrical conductivity shaped to cover a part of the element and to leave another part uncovered and subjecting one of the two parts of the element to the action of heat to reduce the resistance of the part subject to heat.

2. A method of altering the resistance of an elongated resistance element including a metallic conductive oxide which consists of placing adjacent the elongated element a metallic member of high thermal and electrical conductivity shaped to cover decreasingly less area of the element along its length to form an uncovered part and a covered part and subjecting one of the two parts to the action of heat to reduce the resistance in the treated part so as to obtain a tapered resistance element.

3. A method of altering the resistance of an elongated resistance element formed from ceramic glass and cadmium oxide which consists of placing adjacent each of the opposed faces of the elongated element a metallic contact member of high electrical conductivity shaped to contact decreasingly less area of the element along its length, and passing electric current between the contact members until the resistance of the portion of the element between the contact members is reduced to a predetermined value.

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