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S. J. WAITROB

2,399,773

METHOD OF MAKING ELECTRICAL RECTIFIERS AND THE LIKE

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Fig.1.

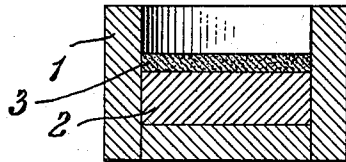


Fig.2.



Fig.3.

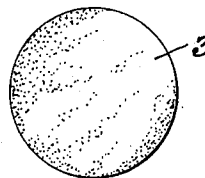


Fig.4.

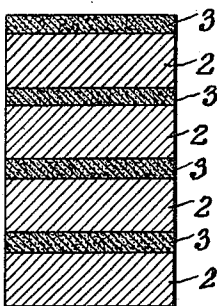


Fig.5.

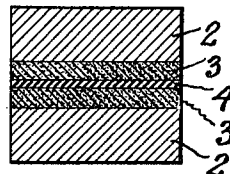
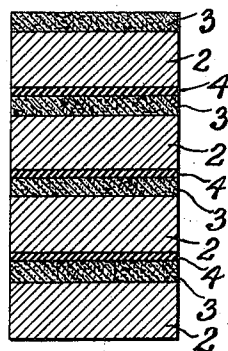


Fig.6.



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UNITED STATES PATENT OFFICE

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METHOD OF MAKING ELECTRICAL RECTIFIERS AND THE LIKE

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4 Claims. (Cl. 175-366)

This invention relates to the production of electrical rectifiers, resistances, and other elements adapted for use in various environments in electrical devices.

One of the well-known types of electrical rectifiers consists of several dry metal disks of unlike metals, one of which has the unidirectional low-resistance path, and the other is conductive in either direction. One of these disks consists chiefly of copper provided on one of its faces with an oxide coating. The present invention relates to the production of a disk of this character, and particularly to one in which the desired oxide coating may be provided integrally with the body of the disk, thereby becoming an inseparable part of it, and may be regulated as to thickness.

An object of the invention, therefore, is to provide means by which an oxide coating or layer may be effectively applied to the surface of a copper disk or other copper body in such a manner as to permanently unite the oxide with the copper, thereby providing a rectifier disk or other electrical element of a highly-efficient and long-lasting construction.

In the accompanying drawing, wherein an embodiment of the invention is shown:

Fig. 1 is a sectional view through a small mold, showing how one of the disks is formed therein; Fig. 2 is a sectional view through the finished disk;

Fig. 3 is a face view of the disk, with the oxide face uppermost;

Fig. 4 is a sectional view through a multi-layered rectifier or resistance;

Fig. 5 is a sectional view in which two of the disks are united, with a lead spacer interposed between them; and

Fig. 6 shows a number of the disks united with lead spacers interposed between them.

In the formation of a disk or other element of the character described, a mold, a simple illustrative form of which is shown at 1, is employed. Into this mold is placed copper powder in sufficient quantity to make the copper portion 2 of the disk of the required thickness. This copper powder is then tamped down lightly within the mold, and then a mixture of cupric oxide powder and copper powder, in sufficient quantity to provide an oxide layer of the requisite thickness, as indicated at 3, is placed into the mold on top of the tamped copper powder already therein. The entire mass is now compacted to conform to the interior shape of the mold or die and is heat treated in an inert atmosphere, dry nitrogen, or in a vacuum or partial vacuum, to diffuse the

cupric oxide and copper to cuprous oxide, to thereby form a bond between the layers and to sinter the copper.

The resultant article is as shown in Fig. 2, where it will be seen that the same consists of a copper base layer 2 and an oxide layer 3 fused to the copper layer, and forming an integral part thereof, and extending over and completely covering one face of the base layer, whereby an extremely satisfactory rectifier disk is the result.

In the formation of the oxide layer 3, the proportions of the cupric oxide powder and the copper powder used in said layer were approximately 55.2% cupric oxide powder, and 44.8% copper powder, to produce a cuprous oxide upon the diffusion of the two. However, these proportions are not critical, and I have secured entirely satisfactory results with a mixture of 70% cupric oxide powder and 30% copper powder to produce the cuprous oxide layer, the resultant disk produced giving extremely good rectification on tests made with an oscilloscope set at 35 volts.

In the production of a disk of copper provided with an integral cuprous oxide layer, I employed for the production of said layer 55.2 grams cupric oxide powder mixed with 44.8 grams copper powder. This was placed in a mold on top of copper powder previously tamped down therein, and the mold contents were then compressed at a pressure of thirty tons per square inch. The mold contents were heat treated at approximately 1025° C. for fifteen minutes in a dry nitrogen atmosphere. The specimen produced was almost homogeneous and gave good rectification. Very similar results were secured when a mixture of 70 grams of cupric oxide powder and 30 grams of copper powder were mixed and employed to produce the cuprous oxide layer.

By the formation of the entire disk from powder in the manner described, the layers 2 and 3 of the resultant product are intimately bonded into an integral whole. Due to the intimate bonding of the cuprous oxide layer with the copper layer, a much better electrical contact is secured than is possible with the employment of mechanical means for attaching the oxide disks to the copper disks. Since the thickness of the oxide layer is governed by the amount of oxide-forming powder employed in the mold, the oxide layer can be made in any reasonable thickness.

In Fig. 2 of the drawing is illustratively shown a disk composed of a layer of copper and a layer of the oxide, the two layers being bonded as described. Since the product is produced by molding or compressing in a die and the application

of heat, it will be obvious that the production of a multi-layered rod or bar adapted for use, for example, as a full-wave rectifier, is relatively simple. Such a multi-layered rod or bar is shown in Fig. 4, wherein layers of oxide 3 alternate with the copper layers 2, the entire rod or bar being integral and being produced by placing copper powder in the mold and tamping it; then placing therein a mixture of cupric oxide and copper powder in the proportions described and tamping it; then placing a second quantity of copper powder in the mold and tamping it; and then another layer of the mixture of cupric powder and copper powder. This continues until the requisite number of layers have been placed in the mold. The batch therein is then heated, as previously described, and the result is a rod or bar, as shown in Fig. 4.

In certain types of rectifiers or resistances, it may be found desirable to interpose separators between the copper-oxide disks. An example is shown in Fig. 5, wherein two bi-layered disks are placed with the oxide layers of each facing toward one another, with a layer of lead 4 fused between and separating the oxide layers. Another example is shown in Fig. 6, wherein the lead layers 4 are shown as being interposed between the oxide layers 3 and the copper layers 2, the entire block or rod thus formed being fused into an integral whole.

While I have herein set forth the product formed by following the process herein described as being especially adapted for use as a rectifier or resistance, it is understood that the product may be capable of many additional uses, and particularly in the electrical industry. I therefore do not wish to be understood as limiting the article to the use set forth, but wish the invention to comprehend any uses to which an oxide-coated element of this character may be successfully adapted.

For example, in making a resistor consisting of

a bar or rod of cuprous oxide, it is merely necessary to compress and heat in the manner described a mixture of the cupric oxide and copper powder, and the result is a cuprous oxide bar or rod of the desired shape and size according to the mold in which the mixture is compressed.

What I claim is:

1. The method of making a solid oxide-coated copper disk consisting in placing copper powder in a mold and compacting the same, placing a mixture of copper powder and cupric oxide powder in the mold on top of the first layer, compacting the mixture, and then heating the mold contents under non-oxidizing conditions.

2. The method of making a bi-layered solid, one-piece disk consisting in placing a quantity of copper powder in a mold, compacting the same therein, placing a quantity of a mixture of cupric oxide powder and copper powder into the mold on top of the compacted copper powder previously placed therein, compressing the mold contents, and heating the mold contents at a temperature of approximately 1025° C. in a non-oxidizing atmosphere.

3. The method of making a multi-layered one-piece rectifier, resistor or the like, consisting in placing alternate layers of copper powder and mixtures of cupric oxide powder and copper powder in a mold, compressing the mold contents, and heating said contents under non-oxidizing conditions to thereby produce an element composed of alternate copper layers and cuprous oxide layers.

4. The method of making a solid oxide-coated body of copper consisting in placing copper powder in a mold, placing a layer consisting of a mixture of copper powder and cupric oxide in the mold and in contact with the powder therein, compacting the mixture, and then heating the mold contents under non-oxidizing conditions.

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