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## MANUFACTURE OF COPPER OXIDE RECTIFIERS

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Our invention relates to the manufacture of copper oxide rectifiers, and particularly to a method of preparing copper blanks for oxidation to produce such rectifiers.

There are three principal characteristics by which the performance of copper oxide rectifiers is judged. These are the rectifying ratio, the forward resistance stability, and the reverse resistance stability. The rectifying ratio may be defined as the ratio between the forward resistance measured under specified conditions and the reverse resistance, usually measured under different specified conditions. The forward resistance stability is concerned with the variations in the forward resistance of the rectifier over a period of time, usually a year or more, following its manufacture. The reverse resistance stability is similar. The term "forward resistance" is used to describe the resistance of the rectifier to current flow in the low resistance direction and the term "reverse resistance" is used to describe the resistance of the rectifier to current flow in the high resistance direction.

It is well known that rectifiers produced by the same process from different samples of copper vary widely in respect to these three characteristics. The cause of this variation is not known, but it is commonly attributed to the presence in the copper of minute quantities of impurities whose exact nature has not been determined. It is known that the quality of rectifiers varies with the source of the copper, that is, copper from one mine will consistently produce good rectifiers, whereas copper from a different mine will consistently produce poor rectifiers. It is also known that copper from the beginning of the pour from the smelter will produce better rectifiers than copper from the end of the pour.

It is an object of the present invention to provide a process of manufacturing rectifiers whereby the performance characteristics of the rectifiers may be improved.

We shall describe a process embodying our invention, and shall then point out the novel features thereof in claims.

In the practice of our invention, we take copper blanks and clean them in any suitable manner. For example, they may be cleaned in a solution of 50% normal nitric acid. The blanks are then treated to remove all traces of the cleaning reagent, preferably by rinsing them in distilled water. These cleaning and rinsing steps are old in the art.

We then perform the step which embodies our present invention, and which consists in dipping

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the blanks in a dilute water solution of hydriodic acid. We have found that a concentration of from 1.8 to 3.6 parts hydrogen iodide per million parts of solution produces a satisfactory result. The length of the dipping is not critical, but we have found that good results are obtained by dipping the blanks in the acid solution for at least thirty seconds. When the blanks are removed from the dipping solution, they are shaken to remove excess solution and are then dried in an air blast.

Immediately after the dipping and drying steps, we proceed to oxidize the blanks. In a typical process, the blanks are oxidized at a temperature in the neighborhood of 1030° C. for approximately 13 minutes, and are then cooled in air to a temperature in the neighborhood of 550° C. Then they are annealed for approximately 10 minutes at substantially the latter temperature, after which they are quenched in running tap water to produce the finished rectifiers. The process steps just described, after the dipping and drying steps, are well known in the art.

We have found from tests that rectifiers produced in accordance with the process described above have an improved rectifying ratio. This improvement is especially noticeable on rectifiers produced from end of pour copper. This improvement in the rectifying ratio results from an increase in the forward resistance and a disproportionately greater increase in the reverse resistance. We have also found that the process improves the forward resistance stability. It has little or no effect on the reverse resistance stability. In those tests where a change in the reverse resistance stability was found, that stability was improved.

As a result of the increased resistance characteristics and the increased rectifying ratio, it has been possible to increase the voltage rating of rectifiers produced in accordance with this process by as much as 50% over the voltage rating of rectifiers produced from the same copper by previous processes.

We have found that the improved results described above are especially noticeable in tests conducted at high temperatures, in the neighborhood of 70° C.

Although we have herein shown and described only one process embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. A method of manufacturing copper oxide rectifiers from copper blanks comprising the steps of dipping the blanks in a hydriodic acid solution having a concentration of approximately 1.8 to 3.6 parts hydrogen iodide per million parts of water, drying the blanks, and then oxidizing the blanks.

2. A method of manufacturing copper oxide rectifiers from copper blanks comprising the steps of dipping the blanks in a hydriodic acid solution having a concentration of approximately 1.8 to 3.6 parts hydrogen iodide per million parts of water for a period of at least 30 seconds, drying the blanks, and then oxidizing the blanks.

3. A method of manufacturing copper oxide rectifiers from copper blanks comprising the steps of cleaning the blanks to remove surface impurities, dipping the blanks in a water solution of hydriodic acid having a concentration of from 1.8 to 3.6 parts hydrogen iodide per million; drying the blanks; oxidizing the blanks at a temperature in the neighborhood of 1030° C. for



approximately 13 minutes; cooling the oxidized blanks in air to a temperature in the neighborhood of 550° C.; annealing the oxidized blanks for approximately 10 minutes at the latter temperature; and quenching the oxidized blanks in running tap water to form finished rectifiers.

4. A method of manufacturing copper oxide rectifiers from copper blanks comprising the steps of cleaning the blanks to remove surface impurities; dipping the blanks in a water solution of hydriodic acid having a concentration of from 1.8 to 3.6 parts hydrogen iodide per million; drying the blanks; and then oxidizing the blanks.

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