

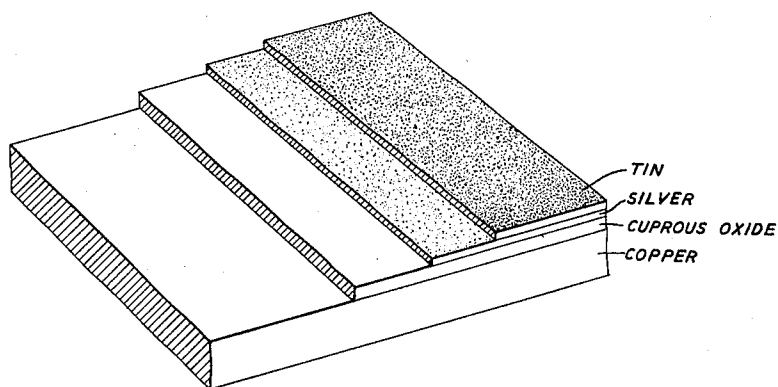
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ELECTRICALLY CONDUCTIVE DEVICE AND ITS MANUFACTURE

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ELECTRICALLY CONDUCTIVE DEVICE AND ITS MANUFACTURE

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4 Claims. (Cl. 175—366)

This invention relates to unidirectional current carrying devices and to their manufacture. More particularly, it relates to rectifier units of the dry contact type and to methods of producing such units.

In rectifier units of this type, of which the familiar copper-cuprous-oxide rectifier is illustrative, the impedance and rectifying characteristics are determined to a considerable extent by the nature of the contact means employed. These devices generally comprise a conductive material having a semiconductive material in rectifying contact therewith. One of the chief difficulties with such devices resides in making a satisfactory contact with the exposed surface of the semiconductive material. Of these difficulties, variations of contact resistance with use and the introduction of a rectifying junction that opposes action of the main junction, having been particularly troublesome.

An object of this invention is a conductive means including a semiconductive portion and a low resistance, conductive portion making low resistance, substantially non-rectifying contact therewith.

A further object of this invention is to apply relatively inexpensive metallic material to a semiconductor in such a manner that the foregoing characteristics are attained.

A feature of this invention is the application, to a surface of the semiconductive portion of a dry rectifier, of a conductive portion making low resistance substantially non-rectifying contact to said surface and having a sufficiently low resistance to allow of making circuit connections to the conductive portion within a small region thereof.

A further feature of the invention is the manufacture of a metal oxide rectifier unit including the application of a thin layer of a metal, such as silver or gold to a selected area of the oxide surface by vaporizing or other suitable process and subsequently applying a further metallic layer of a metal such as tin, zinc, aluminum or cadmium or a low melting point alloy to the vaporized layer by spraying, such as by the "Schoop" process.

Other and further objects and features of the invention will appear from the following description thereof taken in connection with the drawing in which:

The single figure shows a portion of a rectifier unit in accordance with the invention with parts broken away to show details of the structure. The thickness of the various layers has been exaggerated in the interest of clarity. The mate-

rials indicated are illustrative of suitable materials.

Since the copper-cuprous-oxide rectifier is a relatively familiar example of the type of dry rectifier involved in this invention, the following description will, for convenience, refer to it.

The drawing shows a rectifier unit as made up of several layers. The base may be a sheet or disc of copper having suitable characteristics. A layer of cuprous oxide is applied to a surface of the copper by known means. A contact, which is applied to the surface of the oxide, comprises two films or layers of metal. The layer adjacent the oxide surface is a thin film of a metal such as gold or silver that may be deposited thereon from a vapor. Other metals, such as aluminum, zinc, cadmium or copper may be employed. This film may be applied by any method that will produce a very intimate contact with the oxide. By intimate contact it is meant that the contact must have very low resistance and be substantially non-rectifying as well as making a good mechanical bond to the oxide. A method preferred at present is that disclosed in application No. 167,714 to J. A. Becker and W. H. Brattain.

A further metallic contact layer is applied over the first layer by spraying. This layer may comprise tin, cadmium or other non-tarnishing metals or alloys that can be deposited from a Schoop spray. This second layer may be made relatively thick as compared to the first layer. The vaporized film or first layer may be of a thickness of the order of 0.1-mil and the sprayed film or second layer of a thickness of from 1 to 9 mils.

When Schoop spraying the metal may be applied by making several passes over the surface with the Schoop gun. It is desirable to keep the rectifier unit as cool as possible during spraying in order to avoid injury thereto.

In practicing this invention relatively large rectifier plates have been treated. Several three inch by five inch copper-cuprous-oxide plates were coated with a vaporized film of gold on the oxide surface. The electrical characteristics were then measured. The gold film was then coated with a sprayed film of tin. Several passes of the spray gun were made keeping the plates as cool as possible. The final film of tin was from 5 to 9 mils thick. It was found that the tin coating adhered very tenaciously to the underlying vaporized film. It was also found that the electrical characteristics were not injured by the spraying process. When large currents were passed through the unit, the voltage drop across

the unit was appreciably smaller than before the tin coating was applied. This is due to the lower resistance of the combined coating to that of the vaporized film alone. The resistance of the combined film was so low that satisfactory contact could be made to it in a small region. Other units have been prepared employing silver as the vaporized film and a sprayed tin film of from 3.5 to 4.5 mils thick.

The units were tested by assembling some of them into rectifiers. In some cases the rectifiers were greatly overloaded and run under more severe conditions than would prevail in commercial practice. In no case did the sprayed coating show any tendency to peel off and there was no indication that the outer metal contacts had deteriorated.

It may well be asked why the tin or other metal is not sprayed directly onto the oxide surface. This method has been investigated and the contacts obtained have not been satisfactory. Although a good mechanical bond to the oxide was obtained, the contact resistance was found to be considerably higher than is desirable in devices such as these. In order to achieve good results with sprayed contacts, it appears to be necessary to first apply to the oxide surface at least a thin film of contact material which makes low resistance substantially non-rectifying contact with said surface and then apply said sprayed contacts. The character of the first film must also be such that the sprayed film will adhere thereto tenaciously and make satisfactory electrical contact. A vaporized metallic film is one adequate means of meeting these conditions.

Some of the advantages of the sprayed-on film are: (1) it decreases the electrical resistance of the contact layer so that larger currents may be

passed; (2) it serves as a protection against corrosion for the underlying film.

Although the foregoing description has referred to specific embodiments of the invention, it is to be understood that it is not limited thereby but by the scope of the appended claims only.

What is claimed is:

1. The method of applying a contact to the oxide surface of a copper-copper oxide rectifying unit which comprises vaporizing silver and condensing a thin adhering layer thereof on the surface of the oxide and then spraying an adherent coating of tin onto the surface of the silver while maintaining the unit at a sufficiently low temperature to retain its electrical properties.

2. The method of applying a contact to the oxide surface of a copper-cuprous oxide rectifier that comprises, first applying a thin adhering film of gold to the oxide surface by vaporization and condensation and then spraying an adhering coating of tin onto the surface of the gold.

3. A copper-cuprous oxide rectifier unit comprising a copper body having a layer of cuprous oxide thereon, a thin adherent, vapor deposited film of silver on the oxide and making low resistance substantially non-rectifying contact therewith and an adherent film of spray deposited tin on the silver film.

4. A conductive unit comprising a sheet of copper, a layer of cuprous oxide in rectifying contact with the copper, a film of vapor deposited silver of the order 0.1 mil thickness adhering to the oxide, and a layer of spray deposited tin from 1 to 9 mils thickness adhering to the vapor deposited film.

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