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METHOD OF FORMING CONTACTS ON
METAL OXIDE-METAL RECTIFIERSEdgar E. Wright, Whitestone, N. Y., assignor to
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1 Claim. (Cl. 204—23)

This invention relates to metal-metal oxide and similar solid type rectifiers having semiconductive portions, and more particularly to a method of and means for forming a contact on the semiconductive portion of such rectifiers.

Since the cuprous oxide-copper rectifier is a well-known example of the type of device herein involved, much of the specific disclosure will be in terms thereof.

The making of a contact to a semiconductor is not without difficulty. For example, in the case of the cuprous oxide-copper rectifier, there is a tendency for the contact to the oxide to be rectifying in the wrong direction and also highly resistant. One type of such contact which has been found reasonably satisfactory, is the electrolytically reduced copper contact. Some difficulties have, however, been encountered in the formation of such contact.

In electrolytic reduction processes heretofore used, the rectifier unit has been made the cathode in a suitable electrolyte, by connecting the copper portion thereof to the negative pole of the current source. Since the cuprous oxide layer on these rectifiers is very thin, the reduction process must be carefully controlled to avoid short-circuiting the rectifying junction. When using a cathode connection to the copper or what may be called a back contact, it has been found difficult to control the "penetration" of the action. That is, the reduction has been much more rapid at some points on the surface under treatment than at other points. This has resulted in a non-uniform layer of oxide and of reduced copper and in many cases penetration of the reduced copper to the rectifying junction, thereby forming a short-circuit path or paths in the unit.

An object, therefore, of this invention is to so control the electrolytic reduction of the semiconductive material on solid type rectifiers, that satisfactory contact is made thereto without impairing the rectifier action.

A feature of this invention resides in the use of a connection from the negative pole of the current source to the semiconductive portion of the rectifier, i. e., a front contact in place of or in addition to a back contact.

Other and further objects and features of this invention will be more clearly and fully understood from the following description of illustrative embodiments thereof taken in connection with the appended drawing in which:

Fig. 1 shows in perspective one illustrative embodiment of the invention;

Fig. 2 is an enlarged section of a portion of the apparatus shown in Fig. 1;

Fig. 3 is a sectional view of another illustrative embodiment of the invention;

Fig. 4 is a perspective view illustrating a means for supporting and making contact to rectifier units to be processed in accordance with the invention; and

Fig. 5 is an enlarged fractional section of a rectifier unit showing one means of edge masking.

Referring now to the drawing and particularly to Figs. 1 and 2, 10 is a rack for supporting the units to be processed. The rack 10 may be supported by members 11 from a support bar 12. An anode element 13 may be supported in spaced relation to the rack 10. The dot-dash line 14 represents a tank or receptacle which contains a suitable electrolyte.

Cathode and anode connections are represented by leads 15 and 16, respectively. These connections may be made through the supports or otherwise as is desired.

The rack 10 comprises a pair of similar, mating plates 17 and 18 having registering orifices 19 and 20 therein. The adjacent portions of orifices 19 and 20 are each counterbored or otherwise enlarged to provide shoulders to retain units 21 in the rack. Washers 22 and 23 of soft rubber or other suitable material are interposed between the units and the retaining shoulders. These washers assure proper clamping of the units in the rack and sealing of their edges against processing.

If desired the counterbores in orifices 19 and 20 may be made of sufficient depth so that two units may be racked in back-to-back relation, that is, with their oxide faces outwards.

Contact may be made to the units by means of spring contact members 24 and 25 secured to connector bars 26 (Fig. 1). The bars 26 may be suitably connected to cathode lead 15.

As illustrated in Fig. 2, with a single unit in the orifice the member 24 making contact with the copper is the back contact and the member 25 in contact with the oxide is the front contact. In the case of double racking, i. e., two units back to back, 24 and 25 are both front contacts. A back contact may be placed between the units if desired.

The plates 17 and 18 of rack 10 may be held together by any suitable means such as bolts 28 and nuts 29.

As previously noted, the edge of the rectifier unit is masked, to protect it from the reducing action, by means of the soft washers 22 and 23.

This is necessary to avoid the formation of a short-circuit path of reduced copper over the edge of the rectifier unit.

Other masking means may also be employed to protect the edges of the unit. One other way of masking is illustrated in Fig. 5 in which 30 is the copper, 31 the oxide and 32 the masking material. A suitable material is a varnish or lacquer which is not affected by the bath or by the electrolytic action. Organic finishes, such as lacquers of cellulose derivatives, are suitable. A suitable adhesive tape may also be used for masking.

If a type of mask that is supported on the rectifier unit is employed, e. g., mask 32 of Fig. 5, other means of racking may be used as illustrated in Figs. 3 and 4.

In Fig. 3 the unit 40 may be masked as in Fig. 5 or similarly and inserted oxide face outward in the rack shown. This rack may comprise a plate or sheet of insulating material 41 having a thickness about the same as that of the unit to be processed. Plate 41 is secured to a backing plate 42 also of insulating material by fastening means, such as bolts 43. If a back contact is to be used, a metallic plate 44 is inserted between plates 41 and 42. Plate 41 is provided with through orifices to accommodate the units 40. The units are held in place and contact is made to the oxide portion thereof by means of spring members 45. The springs 45 are secured to a support 46 which may be mounted on bolts 43. Support 46 and springs 45 may be made integral. For example, 46 may be a plate of bronze with the springs 45 struck out from its surface.

A pair of L-shaped hangers 47 may be secured to the rack by the bolts 43. The bolts 43 may electrically interconnect support 46, metallic plate 44 and hangers 47 so that these hangers may be used as the cathode connection or lead. The anode 48 is mounted in spaced relation to the rack and may be supported by any suitable means such as hangers like 47. The anode connection 49 may be of any suitable form. In this modification where the rack is mounted horizontally the anode is also in a horizontal position and should be above the rack for best results.

In the modifications illustrated in Figs. 1 and 3 the racks are shown as accommodating only a few units. However, for manufacturing purposes the number of units handled in one operation may be multiplied considerably by using large racks.

As shown in Fig. 4, the units may be individually racked by means of clip type hangers 50 supported on a bar 51 which may be the cathode bar. The hangers 50 serve both as supports and connectors. The units, of course, will be masked by means similar to that shown by Fig. 5.

In all of the illustrated modifications the various connectors and contact means should be insulated from the solution by a suitable varnish, lacquer or other covering material. The contact springs will not be covered where they bear against the units.

Although the foregoing description has dealt with the use of both front and back contacts it must be remembered that the front contact is essential to uniform and reasonably controllable reduction. For a given set of conditions a front contact alone appears to give somewhat better results than a front and back contact combined. However, by making minor adjustments of factors such as time and current density, equivalent results may be obtained either way. Since the process involving this invention is often one of a series of processes requiring racking of the units, some of said process requiring a back contact, it is convenient in such cases to use both a front and a back contact.

An electrolyte which has been found particularly suitable for this work is ammonium sulphate. Other electrolytes, such as ammonium chloride, or sulphuric acid, may be employed. A suitable current density is between .5 and 1.0 ampere per square inch.

Although the invention has been disclosed with reference to specific embodiments thereof it will be understood that it is not restricted thereto but is limited in scope by the appended claim only.

What is claimed is:

In the method of forming a copper contact on the surface of the copper oxide portion of a copper oxide-copper rectifier by electrolytically reducing the surface portion of the oxide to copper, the step of inhibiting penetration of the reduction beyond the surface portion of the oxide, that comprises making contact from the negative pole of the current source to a small portion of the surface of the oxide at the approximate center thereof, and stopping the reduction as soon as the surface portion only of the oxide is reduced to copper.

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