Feb. 26, 1946. W. F. KANNENBERG ET AL 2,395,743

METHOD OF MAKING DRY RECTIFIERS

Filed Dec. 22, 1942

FIG. 1

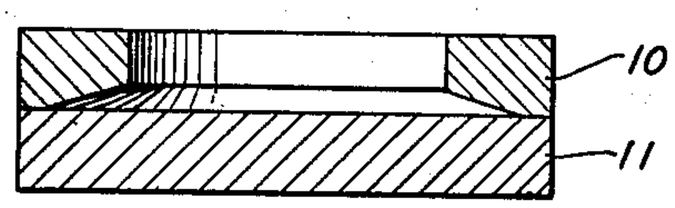
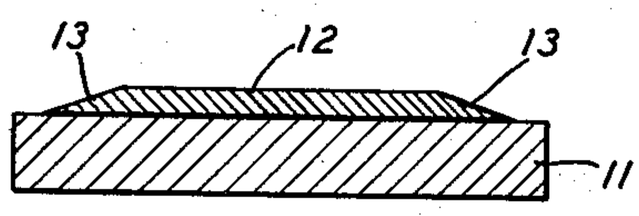


FIG. 2



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METHOD OF MAKING DRY RECTIFIERS

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5 Claims. (Cl. 175—366)

This invention relates to the application or production of adherent superficial layers of material on certain bodies or base members. More particularly, it relates to a means for and a method of producing a dry rectifier, such as a metal oxide-metal rectifier, in which the edge or edges of the oxide or other similar layer are tapered.

The invention may be used to obtain tapered edges on layers or coatings of spray deposited, vapor deposited, or electrolytically deposited metal, oxidized metal, paint and the like, which are applied to or formed in a layer on the surface of a body. A particularly useful application of the invention, as above indicated, is in the manufacture of dry rectifiers.

Dry rectifiers such as, for example, those comprising a layer of cuprous oxide on a copper backing, depend for their operation on the fact that they offer a relatively high resistance to current flowing through them in one direction and a comparatively low resistance to current flowing in the other direction. In the manufacture of these devices effort is made to increase the ratio of the high or reverse resistance to the low or forward resistance. An important factor contributing toward a lower reverse resistance than is desired is the so-called edge leakage. That is, studies of this type of rectifier have shown that a large portion of the current flowing in the reverse direction is concentrated at the edge of the oxide layer. Thus anything that contributes to the reduction of edge leakage considerably increases the reverse resistance. It has been found that tapering the edge of the oxide reduces edge leakage.

It is an object of this invention to produce on or apply to a body or base member, a substantially uniform layer of material having a tapered edge or edges.

It is a further object of this invention to produce a metal oxide-metal rectifier in which the oxide is of substantially uniform thickness throughout most of its area with the exception of a small portion adjacent the edge of the oxide, which portion is tapered to substantially zero thickness at the edge.

A feature of this invention resides in the use of an internally tapered mask on the surface of the backing or base member during the stage of the processing wherein the layer of material is produced or applied.

Other and further objects and features of this invention will appear more fully and clearly from the following detailed description of an illustrative embodiment thereof taken in connection with the appended drawing in which:

Fig. 1 is a sectional view showing a metal blank or disc with a tapered mask applied to the blank in accordance with this invention; and

Fig. 2 is a sectional view of an oxidized blank showing the tapered edge of the oxide as produced by the method of this invention.

In both of these figures the thicknesses and the taper are somewhat exaggerated in the interest of clarity of illustration.

The process of this invention will be described with respect to the making of a disc type, copper oxide-copper rectifier element. Obviously this process may be carried out on a plurality of discs at once, although it is more conveniently described with respect to the processing of a single disc. Furthermore, it may be applied to other devices than a copper oxide-copper rectifier as previously indicated.

Referring to Fig. 1, the mask 10 is secured by any suitable means to one face of a disc 11 of copper. As may be seen in the drawing the mask is tapered on the side which is applied to the copper disc. This mask is annular with a relatively large central opening so that most of the face of the disc is easily accessible to the oxidizing atmosphere. In the illustrated modification the outer portion of the mask fits tightly against the disc to prevent oxidation adjacent the edge of the disc and to inhibit it to a gradually decreasing degree from adjacent the edge toward the center. The edges and the other face of the disc may be masked with suitable means if desired. If the special tapered mask only is used the oxide may be removed from the edges and back of the disc by any suitable method or means.

Any suitable process may be employed for oxidizing the discs. Such a process may comprise heating in a furnace having an oxidizing atmosphere, at about 1000° C. for approximately eight minutes, transferring to another furnace maintained at about 500° C. for about five minutes and then quenching in cold water, the mask remaining on the disc throughout both the heating and the cooling portions of the heat treatment. As illustrated in Fig. 2 this process provides the disc 11 with an oxide layer having a central portion 12 of relatively uniform thickness and a marginal portion 13 tapering to substantially zero thickness at the edge of the oxide.

It is believed obvious that the process of this invention is not limited in its application to oxidation of copper discs but may be employed with other atmospheres, other materials and other

shapes. In other words, it is applicable generally to the making of devices comprising a body having a layer of material thereon, said layer having tapered edges and capable of formation by exposure of the body to a suitable medium. Some other exemplary conductive devices that come to mind are composed of iron with a layer of iron oxide thereon, brass with a layer of the oxides of its components, and copper having a layer of copper sulphide on a portion of its surface. The material which comprises the layer, may be applied to the surface rather than by changing the character of said surface as by oxidation. For example, various paints or metals may be applied by spraying and other methods. Instead of discs there may be used square, rectangular or other polygonal shaped plates and various bodies with curved surfaces. In the case of these various different shapes, a mask conforming to the teaching of this invention and of suitable configuration to secure a tapered edge on the applied layer would be employed. It is not intended that the invention be limited by the specific embodiments described herein, but by the scope of the appended claims only.

What is claimed is:

1. In the manufacture of rectifiers comprising a metal body having a layer of a compound of said metal thereon, said metal compound being formed by exposure of the metal to a suitable atmosphere, the method of producing a layer of said metallic compound of substantially uniform thickness but having tapered edges, that comprises securing to a surface of said body a mask, and exposing the masked body to an atmosphere that will form thereon the desired metallic compound, said mask having its central portion orificed and its marginal portion adjacent said body tapered, the marginal portion having its outer edges in contact with the body and sloping away from said body to define a tapered space in which the action of the treating atmosphere is restricted to a greater and greater degree as the edge of the mask is approached.

2. In the manufacture of metal metal-oxide rectifiers comprising the oxidation of a surface of a metal plate, the method of producing a layer of oxide of relatively uniform thickness except at its edges, which taper to substantially zero thickness adjacent the edge of the plate, that comprises securing a mask to the plate, said mask having a tapered surface adjacent said plate, and a large central orifice, the mask bearing against the plate only adjacent the edge of said plate, and subjecting this assembly to an oxidizing atmosphere, whereby oxide is formed in gradually increasing thickness from adjacent the edge of the plate to the portion adjacent the inner edge of said mask and in substantially uniform thickness over the remainder of the plate surface.

3. In the manufacture of metal metal-oxide rectifiers comprising the oxidation of a surface of a metal disc, the method of producing a layer of oxide of relatively uniform thickness except at its edges, which taper to substantially zero thickness adjacent the edge of the disc, that comprises securing an annular mask to the disc, said mask having a tapered surface adjacent said disc and bearing against the disc only adjacent the edge thereof, and subjecting the masked disc to an oxidizing atmosphere, whereby oxide is formed in gradually increasing thickness from adjacent the edge of the disc to the portion adjacent the inner edge of said mask and in substantially uniform thickness over the remainder of the disc surface.

4. In the manufacture of copper copper-oxide rectifiers comprising the oxidation of a surface of a copper disc, the method of producing a layer of copper oxide of relatively uniform thickness except at its edges, which taper to substantially zero thickness adjacent the edge of the disc, that comprises securing an annular mask to the disc, said mask having a tapered surface adjacent said disc and bearing against the disc only adjacent to the edge thereof, and subjecting the masked disc to an oxidizing atmosphere, whereby oxide is formed in gradually increasing thickness from adjacent the edge of the disc to the annular region adjacent the inner edge of said mask and in substantially uniform thickness over the remainder of the disc surface.

5. The method of making a metal metal-oxide rectifier having an oxide layer with a gradually tapered edge, that comprises securing a marginal mask to one surface of a metal body, and subjecting said body to an oxidizing atmosphere, while said mask is in place, said mask resting on said surface only adjacent the edge of said body, the remainder of the mask tapering gradually away from said surface toward the central portion thereof, the mask covering only a small marginal portion of said surface, whereby the remainder of said surface is uniformly oxidized and the marginal portion is oxidized to a gradually decreasing degree as the edge is approached.

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