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1,708,571

RECTIFYING ELEMENT

Filed Feb. 21, 1925

Fig. 1.

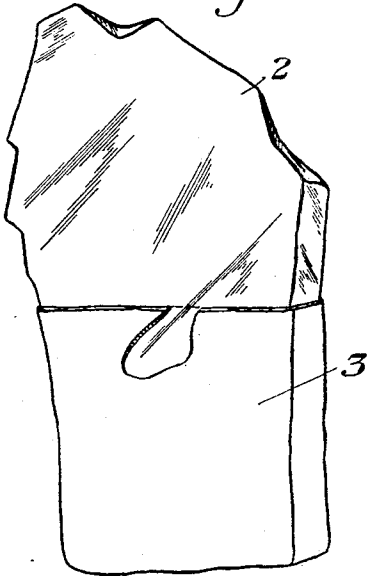


Fig. 2.

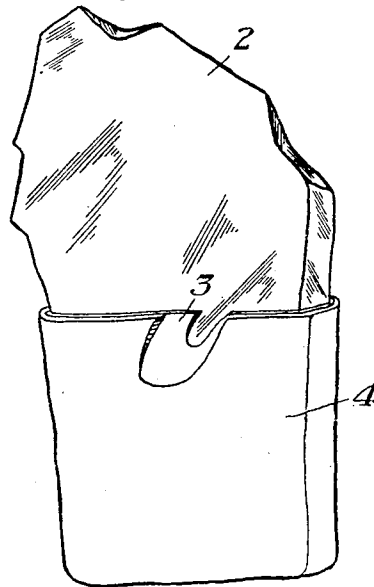
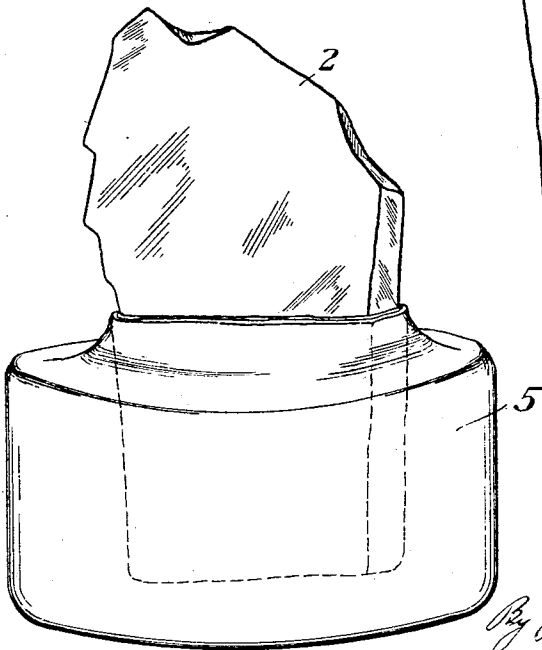


Fig. 3.



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UNITED STATES PATENT OFFICE.

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RECTIFYING ELEMENT.

Application filed February 21, 1925. Serial No. 10,794.

The present invention relates to detectors of the crystal type for high frequency electrical oscillations, such as those used in wireless or radio telephony and telegraphy, and more particularly to an improved rectifying element for use in such detectors.

It is well known that rectification of high frequency oscillating currents can be effected at the contact between two different specific materials, one of which is usually a natural mineral and the other a metal or another mineral pressed in light contact upon the first material. One of the most widely used rectifiers of this crystal type consists of a galena or lead sulphide fragment upon which rests with the lightest touch a small metallic wire and through this device high frequency alternating current, such as radio signals, are changed from alternating current to direct pulsating current. Other minerals and other contacting members have been used, but in all of these combinations the rectifying action takes place at the light contact between the two members. Inherent in this combination of two materials is a high electrical resistance, which, when incorporated in a receiving device for radio signals, introduces disadvantages which have heretofore not been overcome. The amount of current which will flow through the rectifying device is, of course, proportional to the resistance or impedance of the circuit and any decrease in this resistance or impedance will allow a greater current to flow and, consequently, produce a stronger signal in the receiving apparatus. In the several forms of rectifying device disclosed in our co-pending application, Serial No. 10,795, filed of even date herewith, we use a fragment of pure silicon carbide, as one of the rectifying elements, against which is pressed with a relatively heavy pressure a very hard steel plate. This combination of members with the heavy pressure acting between them gives of itself a low resistance rectifier. Our present invention, however, has to do not with the rectification contact, but with the terminals or other devices for carrying the current to and away from the rectifying contact, and more particularly with the treatment of the silicon carbide fragment to remove surface impurities and with the mounting of the fragment in a metal base. It is well known that ordinary silicon

carbide has a high contact resistance. That is, if it is desired to conduct an electrical current (without rectification) through a piece of silicon carbide, at the joint between the metallic conductor, for example, and the silicon carbide, there is an enormous joint resistance. Our present invention is directed particularly to the decreasing of this joint resistance at the other terminal of the fragment of silicon carbide not involved in the rectifying action.

In the drawings:

Figures 1, 2 and 3 are perspective views illustrating a silicon carbide fragment at successive stages in the coating and mounting thereof, as hereinafter specifically described, the parts being greatly magnified for clearness of illustration.

We have discovered that if a fragment of silicon carbide, such as the fragment 2 shown in the drawings, is carefully cleaned of all surface impurities by treatment, first, with a strong caustic solution, and, subsequently by acids, preferably an oxidizing acid which is a solvent for silica as for example, nitric acid and hydrofluoric acid, that a closely adhering coating 3 of some highly conductive metal, such as copper or silver, preferably by electroplating will provide intimate electrical contact between the surface of the silicon carbide and the metallic coating, thereby greatly reducing the joint resistance. Furthermore, by removing the surface impurities from the silicon carbide fragment, the resistance of the rectifying contact is also reduced. Also, by the removal of the normal surface impurities, the leakage path in the non-conduction direction of the crystal is removed. We do not restrict ourselves to the above cleaning agents for it is well known that other equivalent materials may be used to remove the normal surface impurities, which consist of carbides of iron, aluminum, calcium, and silicides and oxides of these metals and silica. Neither do we restrict our invention to electroplating the metallic coating or the especially cleaned silicon carbide fragment for it is also possible to spray metal over its surface, or to produce a closely adhering coat by several other well known methods. After the coating of copper or silver has been put upon about one-half the total surface of fragment, it is then coated

again or alloyed with a non-oxidizing metal 4, such as an alloy of tin and lead, in order to preserve the thin metallic film, which has been deposited electrolytically or by spraying 5 or otherwise, and also to facilitate ready contact with mounting metal as described below.

After the fragment of silicon carbide has been treated and prepared as above described, 10 it is set in an expanding alloy as, for example, solder, in a steel or metal mold so arranged and so rigid that upon cooling the metal is forced to contract around the fragment, thus providing a shaped metal base 5. 15 In thus effecting the solidification of the molten metal in a rigid container, the metal is squeezed into very close contact with the metal coated portion of the silicon carbide fragment, thereby producing practically perfect electrical contact. With suitable base 20 metals and coating metals, this intimate contact causes the alloying of the metal coated silicon carbide and the base metal.

The advantages of low electrical resistance. 25 exclusive of the rectifying contact, in a rectifying device will be apparent to those skilled in the art. Low electrical resistance allows the passing of a greater amount of current, whereby signals are more easily 30 made apparent either by the direct use of a telephone or by the use of one of the several known methods of audio frequency amplification, supplemented by some device reproducing sound from electrical impulses. 35 More efficient rectification results due to the low leakage path for high frequency currents, arising from the removal of the surface impurities. Ordinary crystals as heretofore employed will rectify currents efficiently only to values up to 100 microamperes, 40 whereas a crystal treated according to the present invention will rectify and stand up under current of a value up to at least 75 milliamperes.

45 While we have disclosed one preferred embodiment of our invention, it will be understood that the invention is not limited to its illustrated embodiment but may be otherwise embodied within the scope of the appended claims. 50

We claim:

1. A rectifying element comprising a fragment of silicon carbide whose surface is free 55 of those mineral impurities that are formed on the crystal in the manufacture thereof.

2. A rectifying element comprising a fragment of silicon carbide which has been cleaned with caustic solution and acid to remove such compounds on the surface of the 60 crystal which form a leakage path for high-frequency currents.

3. A rectifying element comprising a cleaned fragment of silicon carbide free of the surface impurities which form on the carbide during its manufacture and having a 65

coating over a portion of the surface thereof of metallic copper, and having a second coating of non-oxidizing metal over the first coating.

4. A rectifying element comprising a fragment of silicon carbide whose surface has been freed of the impurities which form thereon in the manufacture of the silicon carbide and which either increase the contact resistance of the silicon carbide or form a leakage path 75 for high-frequency currents in the non-conducting direction of the silicon carbide, said crystal having a coating of copper electroplated thereon over a portion only thereof and having a second coating of non-oxidizing 80 alloy over the copper coating.

5. A rectifying element comprising a cleaned fragment of silicon carbide free of surface impurities which form thereon during the manufacture of the silicon carbide 85 and which increase the contact resistance thereof or form a leakage path for high-frequency currents, said crystal having a coating over a portion of its surface of a metal which forms a good electrical contact with 90 the silicon carbide, a second protective coating of metal over the first coating.

6. A rectifying element comprising a fragment of silicon carbide whose surface is sufficiently free of those impurities which form 95 on the carbide in the process of its manufacture having a coating of metal over a portion only of the surface thereof which metal is in intimate contact with the silicon carbide and is a good conductor of electricity, and a metal 100 base in which the coated portion of the fragment is set.

7. A rectifying element comprising a fragment of silicon carbide coated over the surface of its lower portion with a metal, and 105 having a second non-oxidizing protective coating over the first coating, and having a metal base cast about the coated portion thereof, leaving the uncoated portion of the fragment exposed. 110

8. The method of making a low-resistance rectifying element comprising treating a fragment of silicon carbide with chemicals which remove normal surface impurities which are formed thereon in the manufacture of silicon carbide and which increase the contact resistance of silicon carbide or form a leakage path for high-frequency currents in the non-conducting direction of the silicon carbide, then coating a 120 substantial portion of the surface of said cleaned fragment with a conducting metal.

9. The method of making a low-resistance rectifying element which comprises treating a fragment of silicon carbide with chemicals 125 which remove normal surface impurities formed thereon in the manufacture of the silicon carbide, coating a substantial portion of the surface of said fragments with a metal which is a good conductor, then forming a 130

second coating over the first coating of a metal which is more resistant to oxidation than the first coating.

10. The method of making a low resistance rectifying element, comprising coating a fragment of silicon carbide with a conducting metal over a substantial portion of its surface, providing a second coating over the first coating of non-oxidizing metal, and
10 molding the coated portion of the silicon carbide fragment into a shaped metal base by pouring around the fragment molten metal, causing this to solidify in the outer portions,

thus creating a pressure forcing the still molten interior metal into intimate contact with the metal coated silicon carbide fragment.

11. The method of making a low-resistant rectifying element which comprises first treating a fragment of silicon carbide with an alkaline solution and then with acid.

In testimony whereof we have hereunto set our hands.

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