

Nov. 27, 1928.

1,692,998

S. RUBEN

LEADING-IN CONDUCTOR

Filed Sept. 8, 1927

*Fig. 1.*

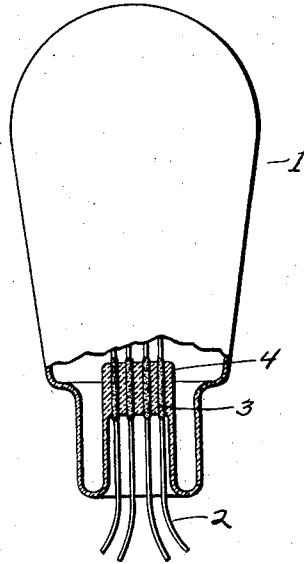
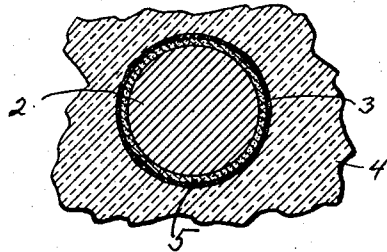


*Fig. 2.*



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## UNITED STATES PATENT OFFICE.

SAMUEL RUBEN, OF NEW YORK, N. Y.

## LEADING-IN CONDUCTOR.

Application filed September 8, 1927. Serial No. 218,495.

This invention relates to a leading-in conductor, and more particularly it relates to a conductor element to be encased as a conductive lead through the seals of envelopes of glass or vitreous material, to elements in the space confined therewithin.

The object of my invention is the provision of a low cost conductor adapted to conduct electrical energy through an encasing seal of glass or vitreous material of a closed vessel, and with no gas path between the conductor and the seal.

The conductors of the prior art used for this purpose are platinum, metal alloys and composite metal elements, which have their respective disadvantages and in common have a further disadvantage of offering relatively high resistance when current of more than a very low value is discharged therethrough. This is due to the specific resistance of the platinum, or that factor in one of the constituents of the metal alloys or the composite metal conductors. Neither disadvantage is present in the material of my invention which comprises a copper metal having a coating formed thereon of fused cuprous oxide, the outer portion of which forms a compound with the encasing glass or vitreous material at the temperature at which it is sealed. This affords a conductor having a very complete union with the seal material, a like close union being also established between the copper and the fused cuprous oxide.

The coefficients of expansion of the copper and the seal material differ considerably but the union therebetween is so complete that no gas path is established as the conductor is heated. As the encasing seal contacts with the fused cuprous oxide coating of the copper conductor at a relatively high temperature, a chemical reaction between the glass or vitreous material and the fused cuprous oxide occurs, a portion forming a compound with the encasing material, but leaving a thin layer of fused cuprous oxide fused to the copper which acts to take up the difference between the two expansions. By reason of this and the close union between the base and the coating material, a close approximation in rate of expansion of the conductor and the seal becomes of less importance. There is such a tenacious union between the two that the intervening layer is able to withstand such tension as is applied. Further, the rate of

expansion of the copper-glass compound, or copper silicate, is a mean between the glass and copper.

The fusing of a copper oxide coating on copper with a glass seal is old in the art; but due to the porosity of the copper oxide and its low conductivity (as contrasted to the opposite characteristics of the fused cuprous oxide), the inoperativeness of such a seal has been established. To employ copper in a gas tight seal of vitreous material, the oxide must not be porous and it must be fused with the copper as well as with the sealing material. For the oxide coating to be non-porous, it must be fused throughout between the conductor metal itself and the point at which the oxide combines with the vitreous material.

The conductivity of the copper being considerably greater than that of the conductors of the prior art, the relative tension between the seal and the conductor is less, due to the lower heat of the conductor, and due to the nature of the reaction between the fused cuprous oxide and the sealing material, a negligible gaseous product is released to remain in the seal adjacent the conductor. As the compound with the glass is formed the area of the seal presents a bright red color.

Various attempts have been made in the art to effect a close fitting seal between copper and glass. The oxide formed on the copper surface, being scaly, is not adherent to either surface and the oxide being very porous, these endeavors have always been unsuccessful. It is only by the presentation of a fused cuprous oxide surface to the glass at the right temperature that the desired union between the materials can be effected.

The copper is preferably prepared by slowly drawing it through a furnace at 1000 degrees centigrade, the rate of travel being so regulated that fused cuprous oxide of suitable thickness is formed; and thereafter the body is slowly cooled. A uniformly distributed coating of fused cuprous oxide crystals is formed on the surface which is firmly adherent to the base. A light and superficial layer of cupric oxide may be formed on the surface of the cuprous oxide, but this is readily removed by physical or chemical means.

As it is desirable to have the wire, extending beyond the glass-seal area, present a clean metal surface to facilitate its welding with

the contacting conductors, also to there present a flexible conductor, the leading-in conductor may be prepared in various ways, such as by heating in the furnace to develop the cuprous oxide coating over approximately only so much of the material as will be encased within the seal, leaving the ends exposed to cooler temperatures; or by coating the entire member with the cuprous oxide and then removing the coating from the ends by heating in an atmosphere of hydrogen or the equivalent.

By the employment of this conductor of low specific resistance, it is practicable to use the metal in larger cross section than is now done, and in round or flattened form, and to apply energy of much higher values than those commonly discharged through the conductors now so used.

Reference is made to the accompanying drawings illustrating one embodiment of the invention, in which Fig. 1 represents a vacuum tube, cut away and showing a part in sec-

tion, and Fig. 2 shows a sectional view of the leading-in conductor encased in a seal.

In Fig. 1, at 1, is a vacuum tube having four leading-in wires 2, surrounded by a compound of cuprous oxide, and the surrounding portion of the glass seal 4. In Fig. 2, at 5, is shown a thin coating of such fused cuprous oxide as may not be compounded with the vitreous material about it. The uncoated leading-in wires are shown projecting behind the seal for connection with other conductors.

What I claim is:

1. A leading-in wire comprising a body of copper the surface of which is composed of fused cuprous oxide.

2. A leading-in conductor comprising a metal body with a layer of cuprous oxide integrally formed with the said metal body.

In testimony whereof, SAMUEL RUBEN has signed his name to this specification this 29th day of August, 1927.

SAMUEL RUBEN.