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CERAMIC-TO-METAL SEAL

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Fig. 1.

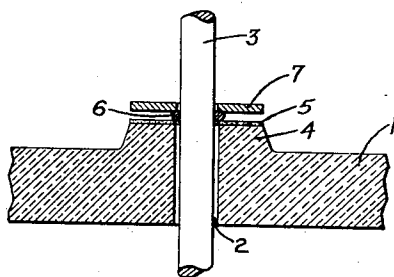
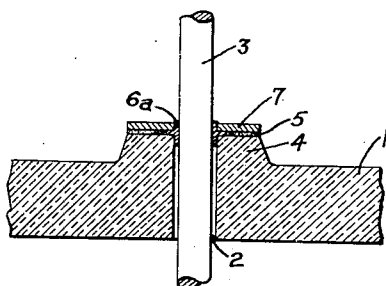


Fig. 2.



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UNITED STATES PATENT OFFICE

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CERAMIC-TO-METAL SEAL

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Application November 22, 1937, Serial No. 175,959
In Germany November 28, 1936

4 Claims. (Cl. 49—81)

The present invention relates to ceramic-to-metal seals, and has as its object to provide certain improvements and modifications in making such seals.

Usually there is a material difference in the coefficient of thermal expansion of the lead-in wires of tubes of electric discharge devices and tube portions made wholly or partly of ceramic substances through which such wires pass. It is therefore difficult to form a vacuum-tight seal between the metallic lead-in conductors and the ceramic substance.

My invention provides an improved seal between, for example, lead-in conductors of an electric discharge device and a ceramic tube portion of such device.

The novel features of the invention are set forth in the appended claims. The invention itself, however, will be understood most readily by reference to the following description when considered in connection with the accompanying drawing wherein Fig. 1 represents a view, partly in section and partly in elevation, of a part of a metallic conductor which is to be sealed to a part of a ceramic body and showing the arrangement of component parts before the seal has been made; and Fig. 2 represents a similar view of component parts after the seal has been made.

In carrying the present invention into effect a ceramic body 1, is provided with an opening 2 for passage therethrough of a metallic conductor 3, which may be elongated in form and made of a refractory metal such, for example, as molybdenum, tungsten or the like. When the ceramic body 1 constitutes a portion of an electric lamp or discharge device, such body advantageously may be provided with a ceramic tube-forming attachment 4, which may be arranged centrally of, and coextensive with said body. The upper surface of the tube-forming attachment 4, or a corresponding surface of ceramic body 1 where apparatus design is such as to make unnecessary such an attachment, is provided with a thin adhering layer 5 of refractory metal powder which is disposed about the opening therein.

Metal powder layer 5 may be formed as set forth in my co-pending application Serial No. 166,902, filed October 1, 1937, and in the co-pending application of Hans Pulfrich and Richard Wagner, Serial No. 175,960, filed concurrently herewith, both of which applications are assigned to the same assignee as the present invention. As more fully pointed out in these applications it is desirable, when sealing together metallic and ceramic members, to provide the ceramic sur-

face with a refractory metal powder layer which is adhesively held or anchored in the ceramic material. This layer serves as a base for the solder used in sealing together the ceramic and metallic members. In all cases the metallic powder employed in forming this layer is one that will not soften or fuse at the melting temperature of the solder used, or at the melting point of the eutectic of lowest melting point that is present in the ceramic substance. Powdered or finely divided tungsten, molybdenum or rhenium are examples of refractory metal powders which may be employed in forming layer 5. Such refractory metals have melting points materially above 2000° C. More particularly, molybdenum melts at approximately 2620° C., rhenium at approximately 3000° C., and tungsten at approximately 3370° C. Advantageously the metallic powder is applied to the ceramic material in the form of a dispersion in a suitable suspension medium, for example collodion. It is then fused or sintered to the surface of the ceramic body in such a manner that, although the formed layer adheres solidly to the base, the individual grains are only loosely connected with each other.

With metallic conductor 3 fitted in opening 2, a ring or a perforated disc of a suitable solder 6 is placed around said conductor in closely fitted relationship therewith and in such manner that said ring or disc rests on metal powder layer 5. For purpose of illustration solder 6 is shown in Fig. 1 in the form of a ring.

As more fully pointed out in the aforementioned Pulfrich and Wagner application Serial No. 175,960, it is advantageous to use a solder which yields unelastically and which flows, under tensile stress, before the tensile strength of the ceramic part is exceeded. Of course the solder must flow as a uniform mass so that no openings will be formed that would cause the soldered connection to permit the passage of gas therethrough. The tearing limit of the solder may lie above the tensile strength limit of the ceramic body. It is desirable to use a solder the flow limit of which is not detrimentally affected by the absorption of metal from the metal powder layer 5 or from the soldered metal part. As a general rule it is advantageous to use a solder having a melting point below the eutectic of lowest melting point formed by components of the ceramic body. Silver has proved to be a good solder for joining a tungsten-coated ceramic body to a metallic disc of iron-nickel alloy and with the aid of such disc to a molybdenum wire. For some applications silver-copper-nickel solders or

alloys may be used. In all cases the solder must be one that effectively wets those metal surfaces, to be sealed together, with which the solder comes in contact.

5 A thin metallic disc 7, having a suitable opening therein, is placed around metallic conductor 3 and allowed to rest on solder 6. The disc may carry a hull-forming attachment or collar that surrounds conductor 3. Under certain conditions
10 it is possible to prepare conductor 3 and disc 7 from a single piece. It has been found desirable that ceramic body 1 and disc 7 have coefficients of thermal expansion which are as nearly alike as possible. The disc may be prepared, for ex-
15 ample, from iron-nickel alloy.

With regard to the choice of the metallic conductor 3, it is not necessary that it be similar in thermal expansion coefficient to that of the ceramic body, since the conductor and the ceramic
20 do not touch each other. Conductor 3 may be prepared from metals or alloys having a larger or smaller expansion coefficient than the ceramic. It may be made, for instance, from molybdenum, tungsten or similar heat-refractory metals.

25 Solder 6 may be melted by means of direct fire, by high frequency heating, or by heating the assembly in an oven. The solder melts and, when cold, rigidly unites metal powder layer 5 and metallic disc 7 to each other and also seals each to
30 metallic conductor 3. In this manner a vacuum-tight seal, that is a seal which is impenetrable by gases, is formed between conductor 3 and the ceramic tube-forming attachment 4 of ceramic body 1.

35 Fig. 2 illustrates the ceramic-to-metal assembly after the seal has been made. In this figure the solder forming the seal has been designated as 6a to indicate its change in form from the ring of solder 6 of Fig. 1.

40 In a preferred embodiment of the invention, metallic conductor 3 is formed of molybdenum; metal powder layer 5, of powdered tungsten; solder 6, of silver; and metallic disc 7, of an iron-nickel alloy. Ceramic body 1 advantageously may
45 be one which contains an oxide of the class consisting of titanium oxide, zirconium oxide, hafnium oxide and thorium oxide as more fully set forth in the aforementioned Pulfrich and Magner application Serial No. 175,960. As stated in this
50 co-pending application, a ceramic composition

containing zirconium oxide has proved particularly effective in making metal-to-ceramic joints that are vacuum-tight, an illustrative example of such a composition being

	Per cent by weight	
Zirconium oxide (approximately)	4	5
Kaolin (approximately)	11	
Soapstone (approximately)	85	

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a ceramic body, a metallic conductor passing through an opening in said body, an adhering layer of powdered refractory metal having a melting point materially above 2000° C. on the upper surface of said body and disposed about the opening therein, a metallic disc over said layer of powdered metal, and a mass of solder rigidly uniting said layer and said disc to each other and each to said conductor, said solder being capable of flowing under tensile stress before the tensile strength of the ceramic part is exceeded and having a melting point below the eutectic of lowest melting point formed by components of the ceramic body.

2. In an article of manufacture, the combination of a ceramic body, an elongated refractory conductor passing through an opening in said body, a layer of powdered tungsten adhesively held on the upper surface of said body and disposed about the opening therein, a metallic disc over said powdered tungsten layer, and a silver solder rigidly uniting said layer and said disc to each other and also sealing said layer and said disc to said conductor.

3. In an electric discharge device, the combination of a ceramic body, a wire of refractory metal passing through an opening in said body, a layer of loosely connected grains of powdered tungsten anchored in the upper surface of said body and disposed about the opening therein, a disc formed of iron-nickel alloy over said powdered tungsten layer, and a mass of silver rigidly uniting said layer and said disc to each other and also sealing said layer and said disc to said conductor.

4. In an article of manufacture, the combination as in claim 2 wherein the ceramic body contains an oxide of the class consisting of titanium oxide, zirconium oxide, hafnium oxide and thorium oxide.

HANS PULFRICH.