Dec. 29, 1953

L. R. PETERS

2,664,180

QUARTZ-TO-METAL SEAL

Filed May 1, 1948

Fig. 1.

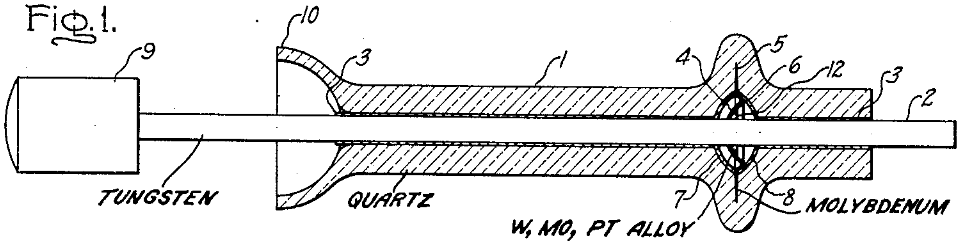


Fig. 3.

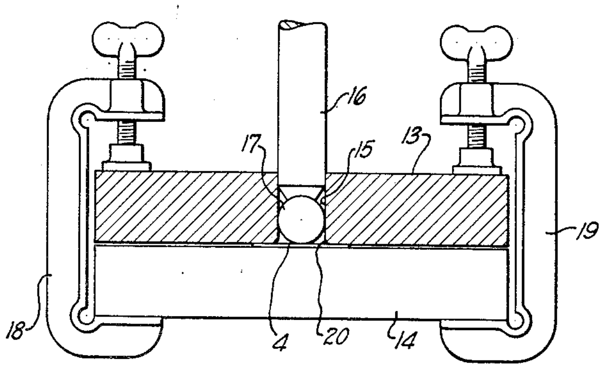


Fig. 2.

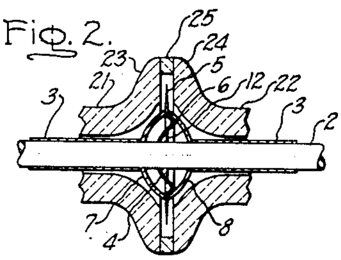
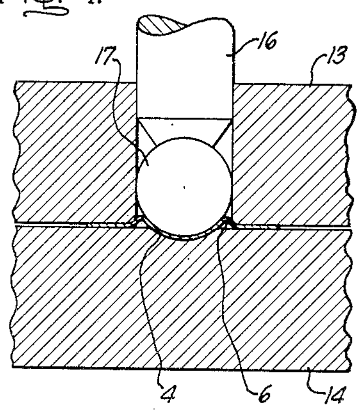


Fig. 4.



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Patented Dec. 29, 1953

2,664,180

UNITED STATES PATENT OFFICE

2,664,180

QUARTZ-TO-METAL SEAL

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Application May 1, 1948, Serial No. 24,522

4 Claims. (Cl. 189—36.5)

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My invention relates to quartz-to-metal seals for electric devices, such as electric discharge lamps.

Seals of this type, in which the quartz is fused directly to tungsten wires or molybdenum sheets of thin cross section to make gas-tight joints, have been known for many years. The current-carrying capacity of such seals is limited, however, to about one or two amperes because of the small size of the metal conductor. Where heavier currents, such as 10 amperes, are used it has been the practice commercially to employ seals including a multiplicity of molybdenum foils connected in parallel. Such seals are of large-size, complicated structure and are difficult and expensive to fabricate.

In the co-pending Greiner application Serial No. 24,523 of even date herewith and assigned to the assignee of the present application, now Patent 2,504,521, issued April 18, 1950, a high capacity seal of small size and simple structure using but one large conductor, such as a tungsten rod, for carrying the current and passing through the quartz part of the seal is disclosed and claimed. The quartz is not fused to the rod, instead, a seal member in the form of a molybdenum thimble around the rod and hermetically united therewith is provided. The thimble has a thin sealing edge embedded in the quartz and to which the quartz is fused to make a gas-tight joint. Such seals are made in the form of stems for the quartz envelopes of high pressure mercury vapor discharge lamps having a power consumption of the order of kilowatts and a vapor pressure of many atmospheres.

The hermetic joint between the tungsten rod and the molybdenum thimble in such seals should be resistant to high temperatures and pressures and it is an object of my invention to provide such a hermetic joint and a method of making it. Another object of my invention is to provide a refractory juncture between tungsten and molybdenum seal members. A further object of my invention is to provide a quartz-to-metal seal in the form of a stem for a quartz envelope of an electric device.

Further objects and advantages of the invention will appear from the following detailed description of species thereof taken in conjunction with the accompanying drawing in which Fig. 1 is an elevational, partly sectional, view of a stem embodying my invention; Fig. 2 is a fragmentary view of the stem before the vitreous parts thereof are joined to the metal parts; Fig. 3 is a schematic view of an apparatus for shap-

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ing a metal part of the stem; and Fig. 4 is a similar view of the apparatus after the said part has been shaped.

Referring to Fig. 1 of the drawing, the stem comprises a quartz stem tube 1 having a tungsten conductor rod 2 extending therethrough. Thin molybdenum foil 3, the thickness of which is exaggerated in the drawing, is wrapped around the rod 2 to prevent the quartz fusing with and adhering thereto during fabrication of the stem. A molybdenum disc 4 is positioned around the rod 2 and its thin tapered sealing edge 5 is embedded in the wall of the quartz tube 1 which is fused to said edge 5 to make a gas-tight joint therewith. The disc 4 has an annular corrugated or bellows portion 6 to relieve the radial strains set up in the disc because of the different rates of expansion of the rod 2, the disc 4, and the quartz tube 1 under manufacturing and service conditions. A pair of opposed dished washers or cups 7 and 8 of molybdenum are also disposed around the rod 2 with their concave sides facing each other and their edges bearing against the disc 4 between the bellows 6 and the sealing edge 5 to form a chamber about the bellows. The cups 7 and 8 prevent the plastic quartz from fusing with the bellows part of the disc during fabrication so that said bellows part may flex under varying temperature conditions during service. A tungsten electrode 9 is mounted on the rod 2.

The stem tube 1 is provided with a flare 10 at one end for fusion with the sides of an opening in a quartz envelope to close said opening. When the envelope is that of an electric discharge lamp operating at an elevated temperature, the joint between the disc 4 and the rod 2 must be gas-tight at temperatures ranging from room temperature to perhaps hundreds of degrees centigrade. I have found that a brazed platinum joint meets these requirements and is mechanically strong enough to withstand pressures of many atmospheres. The brazed joint is shown at 12 in Figs. 1 and 2.

In making the joint between the rod 2 and the disc 4, the rod is supported on end in an evacuated hard glass bottle. The perforated disc 4 is positioned on the rod 2 with the cavity formed by the bellows 6 opening upward toward the short end portion of the rod and disposed approximately one inch from the end of the rod. A single ring of platinum wire is dropped over the end of the rod 2 and into the cavity. The bottle is then evacuated and the rod, disc and platinum ring are heated by a high frequency current to just below the melting temperature of the platinum. This heating is continued until all gases are driven off from these metal parts and clean metallic surfaces are obtained. The power is then increased to heat the metal parts to a temperature at which platinum wets the disc and the rod and forms an alloy of tungsten, molybdenum and platinum which makes a perfect brazed hermetic joint bonding the rod 2 and the disc 4. Obviously, a solid disc may be used by joining the ends of two rods to its opposite sides. Thin discs of platinum may be placed between the ends of the rods and the molybdenum disc and the brazed joints formed as described above.

When the seal member is a molybdenum thimble around the rod 2 rather than the disc 4, the platinum is placed inside the thimble, which opens upward, and the same steps are performed to make the brazed joint between the molybdenum thimble and the tungsten rod. The thimble and the disc are mounted on the rod with their cavities opening outward from the lamp envelope to expose the minimum of brazing material inside the envelope.

After the disc 4 has been hermetically united with the rod 2, the tapered sealing edge 5 is formed by electrolytically etching the edge portion of the disc. A three per cent potassium hydroxide (KOH) solution and an alternating current of about 3 amperes per square inch of the submerged portion of the disc surface is effective. The disc is connected as one electrode and is rotated about its axis with its edge portion submersed a suitable distance in the electrolyte. The other electrode may be constituted by a semicircular molybdenum strip about 1½ inches in diameter.

The bellows 6 is formed before disc 4 is united with rod 2. The apparatus shown in Figs. 3 and 4 of the drawing is effective for forming the bellows and includes two steel plates 13 and 14 between which the disc 4 is positioned. The upper plate 13 has an opening 15 to accommodate the plunger 16 bearing against the hard steel ball 17 and the plates are held together by clamps 18 and 19. The inner edge 20 of the opening 15 is flared outward so that an annular portion of the disc 4 may move upward when the ball 17 is pressed down by the plunger 16 against the center of the disc 4. This forms the ring bellows 6 as shown in Fig. 4. The bellows 6 may be increased in size by placing thin sheets of softer material, such as nickel or brass, between the molybdenum disc 4 and the lower plate 14. This softer material, along with the disc, is pressed or squeezed away from the high pressure point into the zone defined by the ball 17 and the flared end 20 of the opening 15 and further raises the natural degree of bellowing. After being so shaped, a hole is punched in the center of disc 4 to accommodate rod 2.

The dished washers or cups 7 and 8 engaging opposite sides of the disc 4 may be formed in the same manner, that is, by pressing a steel ball of suitable dimensions into a molybdenum sheet to form the sheet into a cup. A hole is then punched in the bottom of the cup to accommodate the rod 2.

In making the seal, the cups 7 and 8 are positioned on the rod 2 and against the disc 4 brazed to the rod as shown in Figs. 1 and 2. The portions of the rod 2 extending outward from the cups 7 and 8 are then wrapped with molybdenum foil 3. This assembly is then inserted into two quartz tubes 21 and 22 which extend beyond the ends of the rod and each of which has a flare 23 and 24 at one end, as shown in Fig. 2. One of the flares, which may be flare 23, has a ring 25 of quartz fused to its face which bears against the other flare 24 to space the flares 23 and 24 apart and acts as a baffle to slow the escape of gas from the chamber formed by the two tubes 21 and 22 in the position shown in Fig. 2.

With the tubes in this position inactive gas, such as nitrogen, at slight pressure is forced into the chamber through the ends of both tubes 21 and 22 and escapes through the space between the ring 25 and the opposite flare 24 carrying with it the air present in the tubes. The ring 25 is then fused to the other flare 24 to splice the tubes, care being taken to avoid fusing the quartz to sealing edge 5 of the disc 4. The assembly is then cooled to room temperature and the chamber is evacuated by sealing one end of the chamber and connecting the other end to a high vacuum system. During exhaust the metal parts are heated by high frequency current to an elevated temperature to remove any oxide and liquid air is used to trap all remaining vapors. The assembly is then tipped off the vacuum system and placed in a glass lathe.

While the assembly is rotated in the lathe the quartz on both sides of the sealing edge 5 of the disc 4 is heated by gas flames to its softening point until it collapses onto and fuses with both sides of the sealing edge 5 of the disc simultaneously to avoid deforming the edge 5. This forms a gas-tight joint between the quartz and the sealing edge 5 and joins the tubes 21 and 22 to form the stem tube 1. The quartz surrounding the portions of rod 2 covered by foil 3 is then heated to its softening temperature to collapse it onto the foil wrapping. After cooling to room temperature the stem is completed by opening one end of the chamber to the atmosphere and then removing the excess quartz to expose the ends of the rod 2. The flare 10 for sealing the stem to the lamp envelope is formed by blowing out a bulge in the tube 21 before assembly and cutting the bulge in half to expose the end of the rod 2 in completing the stem. The electrode 9 is then mounted on the exposed end of the rod 2 and the stem is then ready for mounting on a quartz envelope in the usual manner.

A specific embodiment of the seal which has given good results has a ground tungsten rod ⅛ inch in diameter and 5¼ inches long and a punched molybdenum disc ¾ inch in diameter and 3½ mils thick at its center portion with its edge electrolytically etched so as to taper down from a thickness of not more than 1 mil at a radial distance of $\frac{3}{16}$ inch from its edge to form the sealing edge 5. The molybdenum cups 7 and 8 have a thickness of 3 mils and the foil a thickness of .5 to .7 mil. The foil was spot-welded to the rod along one of its edges and the welded edge covered by the loose end of the foil. The quartz tubing used to form the stem tube had a bore of about 3.5 to 4.0 millimeters and a wall thickness of about 4 to 5 millimeters. The quartz ring 25 had a thickness of $\frac{1}{16}$ inch and an inner diameter of ⅞ inch. The platinum ring for brazing was shaped from a wire having a diameter of .025 of an inch.

In forming flares 23 and 24 on tubes 21 and 22, I prefer to first form a bulge in a single quartz tube and compress the bulge axially of the tube. The bulge is then severed by an abrasive wheel at its largest diameter to form the two flared tubes 21 and 22 from the single tube.

Palladium may be substituted for platinum as the braz'ng material at the joint 12.

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

1. A stem comprising a vitreous support, a metal rod extending through said support, a metal disc hermetically united with said rod and said support, said rod being of a metal from the group consisting of tungsten and molybdenum; and said disc being of the other metal of said group, said disc having a bellows portion for relieving radial strain in said disc, and metal cups on opposite sides of said disc providing a chamber in said stem and about said bellows portion for free flexing of the latter.

2. A stem comprising a quartz stem tube, a tungsten rod extending through said tube, a molybdenum disc hermetically united with said rod and said tube and having a bellows portion for relieving radial strain in said disc and molybdenum cups positioned around said rod and on opposite sides of said disc to form a chamber about said bellows for free flexing of the latter.

3. A stem comprising a quartz stem tube, a metal rod extending through said stem tube, an annular metal disc around said rod and hermetically united with said rod and said tube, said rod being of a metal of the group consisting of tungsten and molybdenum and said disc being of the other metal of said group, the hermetic union between said rod and said disc consisting of a metal alloy of tungsten and molybdenum and a metal of the group consisting of platinum and palladium, said disc having a bellows portion for relieving radial strain in said disc, and metal cups on opposite sides of said disc providing a chamber in said stem tube and about said bellows portion for free flexing of the latter.

4. A stem comprising a quartz stem tube, a tungsten rod extending through said tube, a molybdenum disc hermetically united with said rod and said tube and having a bellows portion for relieving radial strain in said disc and molybdenum cups positioned around said rod and on opposite sides of said disc to form a chamber about said bellows for free flexing of the latter, said disc being annular and positioned around said rod, the hermetic union between said rod and said disc consisting of an alloy of tungsten, molybdenum and platinum.

LEO R. PETERS.

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