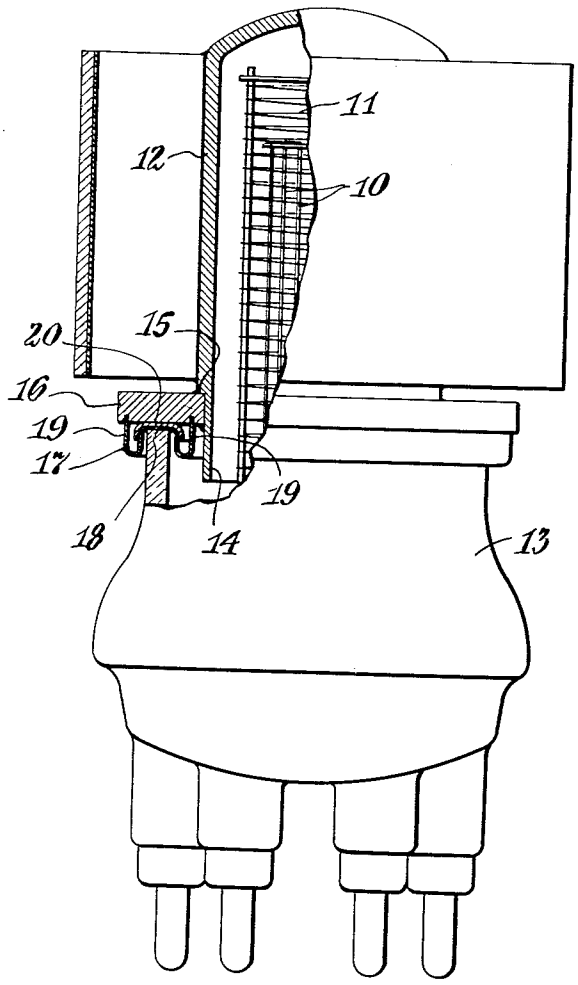
Oct. 18, 1955 H. J. DAILEY ET AL 2,720,997

SEAL FOR ELECTRON DISCHARGE DEVICE

Filed April 5, 1952

Fig. 1.



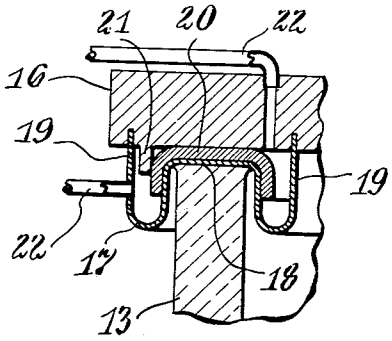


Fig. 2.

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SEAL FOR ELECTRON DISCHARGE DEVICE

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6 Claims. (Cl. 220—2.3)

At the present time there are two popular constructions for effecting seals between a metal part, exemplified herein by an anode, and a glass part, such as a basal bowl, of an electron discharge device. One, known as the Housekeeper seal, as shown in U. S. Patent 1,294,466 of February 18, 1919, utilizes a feather edge on the metal part which, by virtue of its thinness, can stretch or contract in conformity to the expansion and contraction of the glass to which it is attached. The other is one utilizing an alloy and a glass, such as defined in Patent 2,062,335 of December 1, 1936, wherein both materials have substantially equal coefficients of expansion. The metal of that patent is sold in the trade under the trademark designation of "Kovar" and the glass is one known as a borosilicate glass and identified in the trade as Corning glass No. 705. Example of a seal using these materials is illustrated in Patent 2,062,836 in which it will be observed the need for feathering the metal is avoided.

The "Housekeeper" type of seal requires that the metal part, such as a copper anode, be machined, drawn, ground or rolled to a thin cross-section before it is sealed to the glass, with the result that such seals are easily damaged and the anodes usually may not be salvaged or reused. This type of seal is resonably good for medium and low frequencies, but the thin edge may overheat at high frequencies due to skin effects or other causes, and generally is not acceptable in electron discharge devices involving high frequencies or in other devices where strength is needed or high temperatures prevail.

The alloy seal above referred to, has marked advantage over the "Housekeeper" seal, particularly for use in making seals with external electrodes and for large lead-in constructions, and also for use with high frequency devices and devices requiring strength or in those where a large heat variation is involved. Prior art seals of this character have two principal defects, namely (1) the alloy is magnetic, which results in high losses with radio frequency, and (2) the length of the alloy part between the glass and electrode, for instance which is generally of different metal, such as copper, has to be sufficiently extensive to avoid modification of the expansion of the alloy. In this respect, it is further a fact that as the desired diameter of the seal is increased, the length of the alloy portion also has to be increased.

The present invention is directed to the elimination of the noted disadvantages and to otherwise improve upon alloy seals between glass and another material. A more specific object of the invention is to minimize separation, by intervention of the alloy, of the glass and metal parts being sealed.

Another object is to accommodate differential of expansion between parts by sliding contact.

A closely related object is to provide a flexible seal spanning the sliding contact.

Other objects of the invention will appear to persons skilled in the art to which it appertains as the description proceeds, both by direct reference thereto and by implication from the context.

Fig. 1 is a sectional elevation of an electronic device having a seal in accordance with the present invention; and

Fig. 2 is a section of the seal with additional indication of a positioning rib and pipe connections for cooling purposes for the seal.

In the specific embodiment of the invention illustrated in said drawing, the arbitrarily selected electronic device is a triode having a filamentary cathode **10** surrounded by a grid **11** and having an external anode **12** which also constitutes part of the evacuated envelope. A glass bowl or basal portion **13** comprises another major portion of the evacuated envelope. The invention is directed more especially to the provision of a novel expansive seal between the anode and the glass bowl.

According to the present showing, the margin of the anode next its end opening into the bowl, is reduced somewhat in outside diameter thereby providing a neck **14** and an external shoulder **15** at the end of the neck next to the body of the anode. A flat ring **16**, which is preferably copper, is slid onto the neck and seats against the shoulder and is soldered or otherwise secured in that position with a vacuumtight joint. The mouth end of the glass bowl **13** is decidedly larger than the neck which accordingly projects into the said mouth end of the bowl, and the edge of the bowl accordingly underlies the flat surface of ring **16** inward from the outer circumference and outward from the inner circumference of the ring. An annular bridge or trough member **17** is provided with a reentrant annular groove or trough **18** to receive the end margin of the bowl, said bridge having side flanges **19** at its inner and outer peripheries, directed toward said flat surface of the ring and embedded and sealed therein. Said bridge is preferably of flexible metal such as thin copper, silver or the like and can both flex and stretch as required under influences of expansion or contraction of the ring and bowl.

In addition to the advantage included in the foregoing description, it may be further called to attention that since the bridge or trough member **17** is copper, silver or other electrically low resistance material, it will not have the high radio frequency resistance inherent in the two popular seals of the prior art referred to above. Furthermore, since the bridge member can flex readily and does not carry the weight of the bowl or anode or other elements of the device, it can be very thin, this characteristic being also permitted in view of the fact that the shortness of the flanges and doubling back of the material to obtain the reentrant formation, renders deformation by atmospheric pressure exceedingly unlikely. Again, it will be observed that since there is no edge-to-edge seal, such as in the mentioned prior art, there is no concentration of an electrostatic field at the seal, and thus the structure is beneficially employed in high frequency devices. Another advantage of the described seal is that the rounded or humped formation of the flanges with the reentrant portion of the bridge member at both sides of the seal constitute corona shields that minimize the number of electrostatic lines of force that can terminate on the metal-to-insulator seal. The bridge or trough member **17** bridges an annular area of the ring surface between the two flanges **19** of said member.

Between the ring and the reentrant groove **18** of the trough is an annular channel element **20** having approximately the same coefficient of expansion as the glass of bowl **13**. Said channel element **20** is preferably the above-mentioned alloy referred to under the trademark "Kovar" and the glass of the bowl is the borosilicate glass likewise identified above. The intervening thickness of the material forming the trough **18** is

thin enough to readily respond to expansion and contraction of the "Kovar" and the glass, and is sealed to both. Since the glass is sealed to the copper trough and the flanges of the bridge are sealed to the copper ring, a vacuumtight closure is effected between the ring and glass. Consequential upon being subjected to the external atmospheric pressure, the bowl tends to seat at its rim edge toward the flat face of the ring. The channel element thickness limits approach of the reentrant portion **18** of the bridge member toward the face of the ring. Greater radial expansion, due to heat in the ring transmitted from the anode by conduction, or otherwise, is readily accommodated by the "Kovar" channel element **20** sliding on the face of the ring and by flexure of the bridge flanges.

If so desired, the ring may be provided as shown in Fig. 2 with an annular projection or rib **21** between the outer flange **19** of the bridge and said "Kovar" channel element and so positioned that as the copper ring contracts to normal condition after an expansion thereof said projection will engage the channel element and automatically slide it back to concentric relation to the ring in event it did not of itself return to that relation.

Again, if so desired, the space enclosed by the bridge and area of the ring thereunder may have pipe connections **22** thereto for circulation of a fluid coolant in said space.

We claim:

1. An electron discharge device having a radial metallic surface and a cylindrical glass member requiring vacuumtight seal therebetween, a flexible metallic bridging element having opposite flanges and with said flanges sealed to and projecting from the said metallic surface, an intermediate portion of said bridging element traversing the end of and sealed to said glass member, and an element interposed in juxtaposition to the said intermediate portion of said bridging element between said flanges and making contact with said metallic surface.

2. An electron discharge device having a radial metallic surface and a cylindrical glass member requiring vacuumtight seal therebetween, a flexible metallic bridging element having opposite flanges and with said flanges sealed to and projecting from the said metallic surface, an intermediate portion of said bridging element traversing the end of and sealed to said glass member and an element interposed in juxtaposition to the said intermediate portion of said bridging element and making slidable contact with said metallic surface, said element and glass member having substantially the same coefficient of expansion.

3. An electron discharge device having a radial metallic surface and a cylindrical glass member requiring vacuumtight seal therebetween, a flexible metallic bridging element having opposite flanges and with said flanges sealed to and projecting from the said metallic surface, an intermediate portion of said bridging element traversing the end of and sealed to said glass member, and an element interposed in juxtaposition to the said intermediate portion of said bridging element and making contact with said metallic surface, said element and glass member having substantially the same coefficient of expansion.

4. An electron discharge device having a metallic surface transverse to a central axis and a cylindrical glass member coaxial thereto, a flexible metallic bridge over an annular part of said metallic surface and sealed thereto at the annular peripheries of said bridge, and an element between said bridge and said surface maintaining distance of said bridge thereat from said surface, and said glass member being sealed to said bridge in opposition to said element.

5. An electron discharge device having a metallic surface transverse to a central axis and a cylindrical glass member coaxial thereto, a flexible metallic bridge over an annular part of said metallic surface and sealed thereto at the annular peripheries of said bridge, and an element between said bridge and said surface maintaining distance of said bridge thereat from said surface, said element having slidable engagement with said surface and said glass member being sealed to said bridge in opposition to said element.

6. An electron discharge device having a metallic surface transverse to a central axis and a cylindrical glass member coaxial thereto, a reentrant annular bridge having flanges sealed to the said surface and with the reentrant portion in proximity to said surface between said flanges and sealed to said glass member, a channel element on said reentrant portion interposed between said portion and said surface and slidable on said surface, and a positioning projection next an edge of said element and fixed with respect to said surface for actuation of said element and bridge to normal concentric location on said surface.

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