July 30, 1968 W. R. STUART 3,394,451

METAL-TO-CERAMIC SEAL FOR HIGH VOLTAGE ELECTRON TUBES AND METHODS OF FABRICATION

Filed July 28, 1965

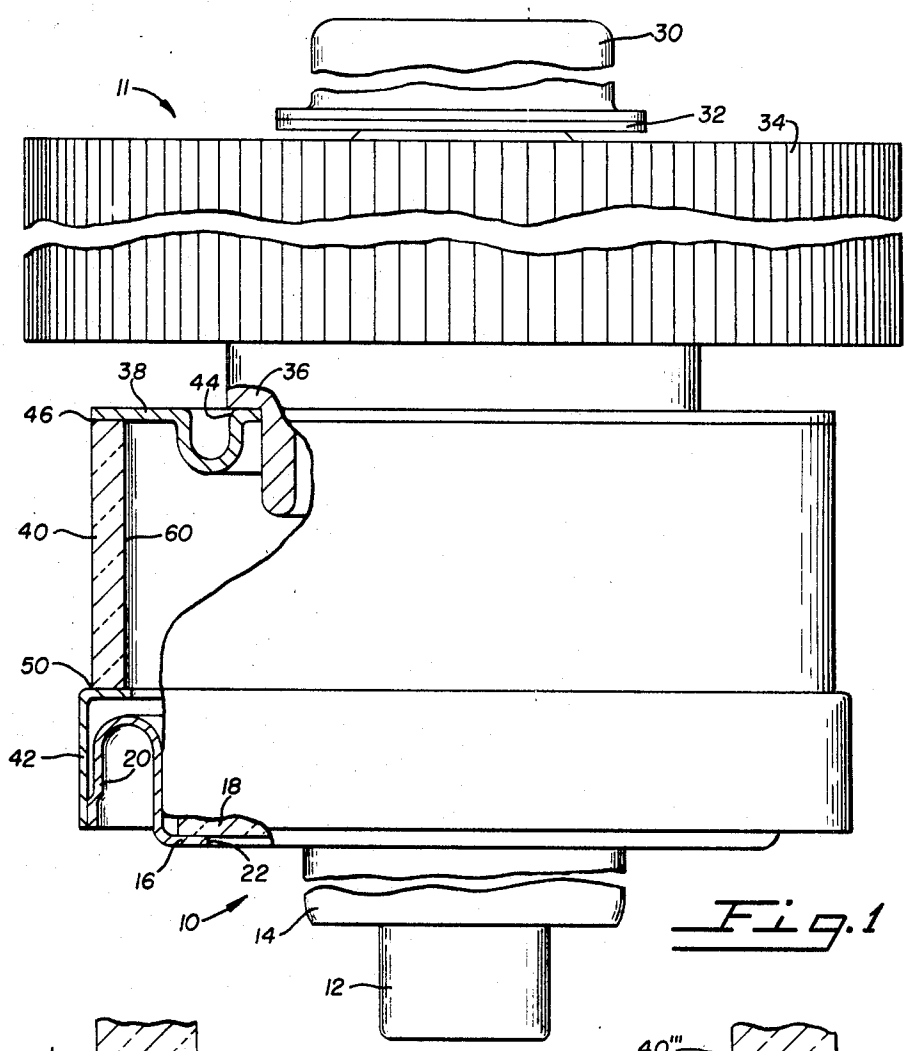
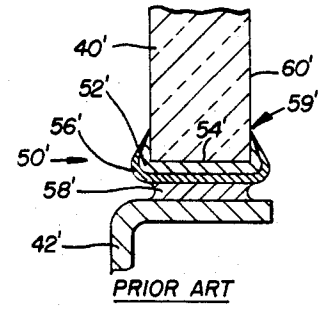


Fig. 1



PRIOR ART

Fig. 2

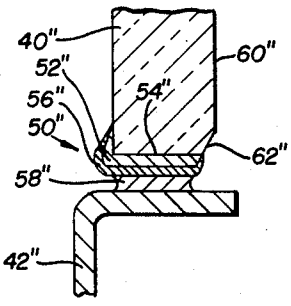


Fig. 3

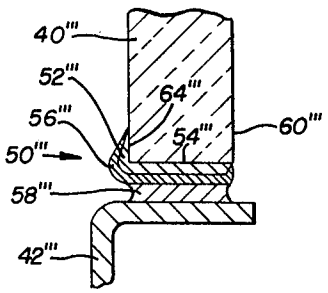


Fig. 4

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United States Patent Office 3,394,451 Patented July 30, 1968

3,394,451

METAL-TO-CERAMIC SEAL FOR HIGH VOLTAGE ELECTRON TUBES AND METHODS OF FABRICATION

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Filed July 28, 1965, Ser. No. 475,527
8 Claims. (Cl. 29—473.1)

ABSTRACT OF THE DISCLOSURE

Method of producing a vacuum-tight seal between a ceramic body and a metal body in an electron tube. A selected seal area on the ceramic is first metallized. The metal body is next brazed to the ceramic body at the seal area. Metallizing adjacent the seal area is then mechanically removed to inhibit electric discharge from the seal.

This invention relates to vacuum-tight metal-to-ceramic seal structures and more specifically to vacuum-tight metal-to-ceramic structures designed to minimize undesirable effects of high voltage applied thereto.

It has been found that in certain vacuum-tight metal-to-ceramic structures, which include a ceramic member sealed between two metal elements, a threshold voltage condition between the two metal elements can be reached whereby an apparent electric discharge is generated which fans out from point sources of ceramic metalizing material deposited along the interior, or vacuum side, of the ceramic member. This metalizing material is deposited when the ceramic member is being metalized in preparation for making a metal-to-ceramic braze seal.

In the particular case investigated involving a small tetrode (250-watt plate dissipation) the electric discharge occurred from apparent point sources adjacent the screen grid-ceramic seal and fanned out across the ceramic cylinder towards the tube's anode. The electric discharge, resulting from a low impedance anode-to-screen grid path, caused excessive plate current to flow. A fast blowing fuse in the anode circuit would blow out whenever the discharge occurred. It has been found that this phenomena may be eliminated by removing the metalizing material at the internal negative potential end of the ceramic cylinder.

One process found completely effective is to grind a bevel onto the inside metalized area of what will be the negative potential end of the ceramic cylinder of the tetrode prior to brazing the metal-to-ceramic seal. This beveling is done after the metalizing has been completely processed on the ceramic and the operation removes both the non-desired metalizing material and the ceramic underbase immediately therebelow. This grinding operation, however, was found to be expensive for normal high volume manufacturing processes. Another, less expensive, process has been found for removing the non-desired metalized material from the interior of the ceramic cylinder whereby said non-desired metalizing material is removed by an air-driven abrasive, or "sand-blasting," prior to firing of said metalizing. This process does not necessarily remove any ceramic underbase.

An object of this invention is to provide a metal-to-ceramic seal which is specifically adapted for high voltage application.

This and other objects are accomplished in accordance with the present invention, by specially processing the ceramic portion of a composite metal-to-ceramic seal prior to assembly.

This invention as well as other objects, features, and advantages thereof, will readily be apparent from consideration of the following detailed description relating to the annexed drawing in which:

FIGURE 1 illustrates, in partial cross-section, an electron tube incorporating a metal-to-ceramic seal;

FIGURE 2 is a detailed drawing, not to scale, of the prior art design of the subject seal, the drawing shows exaggerated metallizing, plating and braze material layers;

FIGURE 3 is a detailed drawing, not to scale, of the subject seal incorporating the beveling removal process of the subject incention, the drawing shows exaggerated metalizing, plating and braze material layers; and

FIGURE 4 is a detailed drawing, not to scale, of the subject seal incorporating the "sand-blasting" removal process of the subject invention, the drawing shows exaggerated metalizing, plating and braze material layers.

Referring now to the drawings, wherein like reference characters represent like or corresponding parts throughout the several views, there is illustrated in FIGURE 1 an electron tube comprised of a header section **10** and an anode section **11**.

The header section **10** of the tube is basically a series of concentric cylindrical structures with, shown externally only in FIGURE 1, an outer filament contact **12** and a control grid contact **14** and, shown in partial cross-section, a header ceramic support flange **16**, header ceramic **18** and header assembly sealing flange **20**. The header assembly sealing flange **20** is actually an arcuate extension of the header ceramic support flange **16**. The header ceramic support flange **16** is hermetically sealed to the header ceramic **18** with a metal-to-ceramic seal **22**.

The anode section **11** of the tube is also basically a series of concentric cylindrical structures with, shown externally only in FIGURE 1, a tubulation cap **30**, a tubulation cap flange **32**, and a composite cooling fin structure **34**, and shown in partial cross-section, an anode core **36**, an anode core sealing flange **38**, a ceramic cylinder **40** and a screen grid contact flange **42**. The anode core **36** is brazed **44** to the anode core sealing flange **38**. The anode core sealing flange **38** is hermetically sealed to the ceramic cylinder **40** with a metal-to-ceramic seal **46**. The ceramic cylinder **40** is hermetically sealed to the screen grid contact flange **42** with a hermetic metal-to-ceramic seal **50** incorporating an embodiment of the invention.

FIGURE 2 is a detailed non-scale cross-sectional drawing of the prior art metal-to-ceramic seal **50'**. In the manufacture of seal **50'** metalizing material **52'** is painted, or otherwise deposited, on the end face **54'** of the ceramic cylinder **40'**. Some of the metalizing material **52'** runs, or is otherwise deposited, onto the ceramic surfaces adjacent the end face **54'**. The metalizing material **52'** is then sinter-fired and plated with a secondary metal **56'** such as copper or nickel. The secondary metal **56'** is next sinter-fired. A hermetic braze joint is then made between the sinter-fired plating **56'** and the screen grid contact flange **42'** with a layer of braze material **58'** therebetween.

In particularly high voltage applications involving the prior art metal-to-ceramic seal (FIGURE 2), the apparent electric discharge occurs within the electron tube in the general area **59'** where the metalizing material **52'** extends around the end face **54'** and along the inside surface **60'** of the ceramic cylinder **40'**. The electric discharge appears to emit from very small point sources of metalizing material **52'** and fan out across the inside surface **60'** of the ceramic cylinder **40'** in the direction generally away from the screen grid contact flange **42'**.

FIGURE 3 is a detailed non-scale cross-sectional drawing of an improved metal-to-ceramic seal **50''** wherein the metalizing material **52''** is applied on the end face **54''** of the cylinder **40''** and sinter-fired as in the prior

art. However, prior to plating 56'' of the sinter-fired metalizing material 52'', the inside, or vacuum side 60'' of the end face of the ceramic cylinder is ground off 62'' as well as any covering of metalizing material thereon. The remaining sinter-fired metalizing material 52'' is then plated with a secondary metal 56'' and the secondary metal 56'' is then, too, sinter-fired. A hermetic braze joint is then formed between the sinter-fired plating 56'' and the screen grid contact flange 42'', with a layer of braze material 58'' therebetween. A hermetic metal-to-ceramic seal 50'' is thus formed.

FIGURE 4 is a detailed non-scale cross-section drawing of another improved metal-to-ceramic seal 50''' wherein the mealizing material 52''' is applied on the end of face 54''' of the ceramic cylinder 40''' as in the prior art. However, prior to sinter-firing of the metalizing material 52''', the inside, or vacuum side 60''', of the end face 54''' of the ceramic cylinder 40''' is sand-blasted whereby all metalizing material deposited thereon is removed. The remaining metalizing material 52''' on both the end face 54''' and the adjacent outside wall 64''' of the ceramic cylinder 40''' is sinter-fired and plated with a secondary metal 56'''. The secondary metal 56''' is then sinter-fired. A hermetic braze joint is then formed between the sinter-fired plating 56''' and the screen grid contact flange 42''' with a layer of braze material 58''' therebetween. A hermetic metal-to-ceramic seal 50''' is thus formed.

In the two methods described for fabricating metal-to-ceramic seals wherein the metalizing material 52 is mechanically removed from the inside surface 60 of the ceramic cylinder 40, the step for removing the metalizing material 52 was specifically noted. These removal steps, however, are not critical in sequence and may be performed, in either case, at any time prior to sealing (with the braze material 58) of the sintered metallic plating 56 and the screen grid contact flange 42. It is easier, however, in the sand-blasting operation to remove the metalizing material 52'' prior to sintering as a softer "sand" may be used.

Chemical removal (mixture of hydrofluoric and nitric acid solutions) of the undesired metalizing material 52 was considered, prior to adoption of the mechanical removal procedures, but was found to be unsatisfactory as the process was slow, dangerous to the technician doing the work, difficult to control the actual area cleaned, and detrimental to the strength of the ceramic in that the glassy phase is weakened.

In any fabricating of the improved metal-to-ceramic seal, all metalizing material on the interior surface of the ceramic cylinder must be removed or the aforementioned apparent electric discharge will not be eliminated. Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than specifically described.

I claim:

1. In the method of producing a vacuum-tight seal between a ceramic body and a metal body in an electron tube comprising the steps of metalizing a selected seal area on said ceramic body and brazing said ceramic body to said metal body at said seal area, the additional step of mechanically removing all metalizing from said ceramic body adjacent said seal area.

2. The combination in claim 1 wherein said mechanical removal of all metalizing from said ceramic body adjacent said seal area is accomplished by sand-blasting.

3. The combination in claim 1 wherein said mechanical removal of all metalizing from said ceramic body adjacent said seal area is accomplished by grinding of the ceramic surface.

4. The method of producing a metal-to-ceramic hermetic seal in an electron tube comprising: depositing metalizing compound on a selected area of said ceramic, allowing said metalizing compound to dry, mechanically removing all of said metalizing compound deposited adjacent said selected area, sinter-firing said metalizing compound, depositing a secondary metal layer on said metalizing compound, sinter-firing said secondary metal layer, and brazing said secondary metal layer to said metal of said metal-to-ceramic seal.

5. The combination in claim 4 wherein said mechanical removal of said metalizing compound deposited adjacent said selected area is accomplished by sand-blasting.

6. The combination in claim 4 wherein said mechanical removal of said metalizing compound deposited adjacent said selected area is accomplished by grinding of the ceramic surface.

7. The combination in claim 4 wherein said secondary metal layer on said metalizing compound is copper.

8. The combination in claim 4 wherein said secondary metal layer on said metalizing compound is nickel.

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