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ELECTRON TUBE SEAL STRUCTURE

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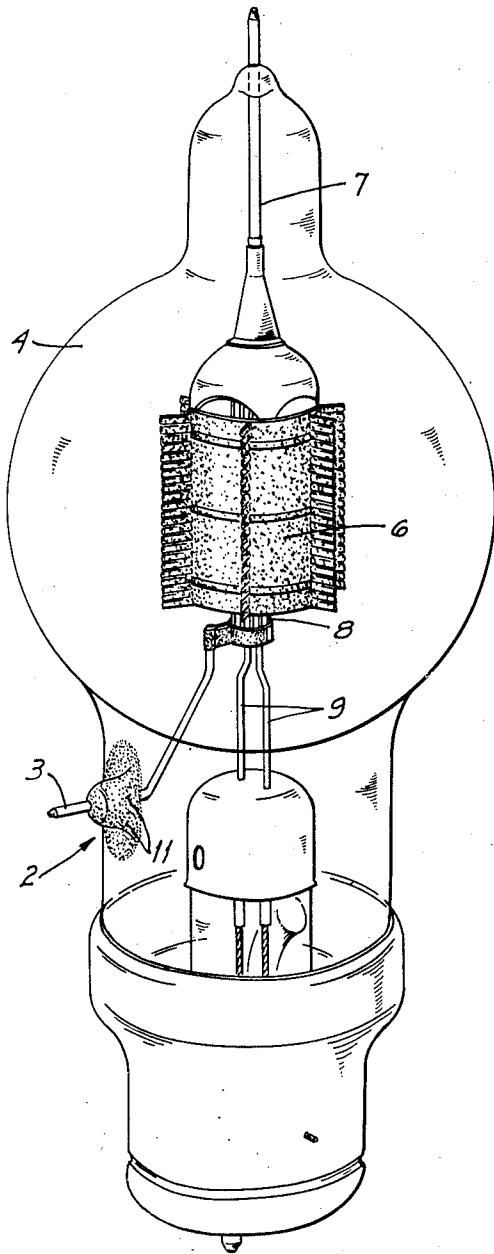


Fig. 1

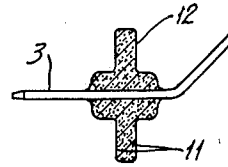


Fig. 2

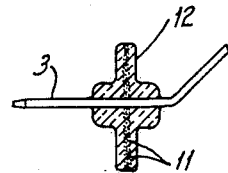


Fig. 3

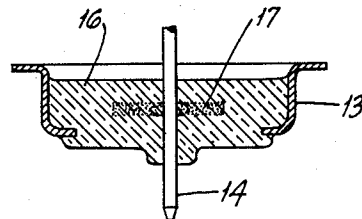


Fig. 4

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ELECTRON TUBE SEAL STRUCTURE

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3 Claims. (Cl. 313—318)

1

Our invention relates to electron tubes, and more particularly to the glass-to-metal seals at the lead-in conductors of such tubes.

In vacuum tubes having a glass wall through which a metal lead is sealed, there is a serious problem of glass cracking at the seal. Frequently these cracks do not develop until after a tube has been in operation for a period of time, but once a crack occurs the tube is no longer vacuum tight and is therefore inoperable, which accounts for many tube failures in radio transmitters and the like.

The usual practice in tube making is to form a glass-to-metal seal at the lead-in conductor which may be a tungsten rod, the glass used being one having a coefficient of expansion matching that of the metal lead. Ordinarily the metal lead is first oxidized since a metallic oxide layer produces a better bond between the glass and metal. In the case of envelopes made of preformed glass blanks, the practice is to seal a glass bead to the lead and then seal the bead to the glass envelope wall. In another type of envelope structure where the glass wall is cast, using powdered glass moulding techniques, the leads are sealed directly in place when the glass wall is cast.

In either case the likelihood of cracks developing at the seals is a problem. The reason for these seal failures is not thoroughly understood, there probably being several contributory causes such as voltage gradients, electron bombardment and thermal conditions. There is also evidence that electrolysis occurs in the glass which results in a deterioration of the glass and/or metallic oxide adjacent the seal; and it further appears that, with negative grid type tubes, the cracking problem is worst at the grid seals which operate at a negative potential with respect to the anode.

A number of devices have been suggested for protecting the glass at the seals, some involving metal caps such as shown by the patent to Heintz, No. 1,970,750 and others involving protective metallic coatings such as described in patents to Foulke, No. 1,832,009, and to Wagener, No. 2,329,019. These devices are applied over the glass surfaces after the seals have been made, and although applied superficially, are more or less helpful in alleviating the cracking troubles.

The broad object of our invention is to provide a more effective and dependable solution to the seal cracking problem.

Another object is to provide a protected seal structure which will withstand extremely adverse operating conditions without failure, whereby the tube will give better performance, operate at higher ratings, and provide longer tube life.

Still another object is to provide a seal structure in which the protective means is incorporated as an integral part of the glass at the seal.

Further objects include the provision of an im-

2

proved seal of the character described which is easy to make in mass production, and in which the parts of the seal are maintained visible for inspection.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of our invention. It is to be understood that we do not limit ourselves to this disclosure of species of our invention, as we may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawings:

Figure 1 is a side elevational view of a glass envelope type of electron tube embodying our improved seal structure at the grid lead.

Figure 2 is a vertical sectional view showing a bead on the grid lead prior to sealing to the envelope wall; and

Figure 3 is a similar view illustrating an alternate construction.

Figure 4 is a vertical sectional view of a modified type of envelope and seal structure, incorporating our improvements.

In terms of broad inclusion, an electron tube embodying our invention comprises an envelope having a glass wall, an electrode in the envelope, and a metal lead for the electrode extending through and sealed to the wall, the glass surrounding the lead being impregnated with metallic powder. In our preferred seal structure the metallic powder is concentrated in the central regions of the glass and extends radially of the lead.

In greater detail, and referring to the drawings, Figure 1 illustrates our improved seal structure 2 incorporated at the grid lead 3 of a conventional triode type vacuum tube having a glass envelope 4. In this all-glass style of tube envelope construction, the main body of the envelope is usually made of a preformed glass blank. Other parts of the tube include an anode 6 supported on a lead 7, a grid 8 supported on the lead 3, and a suitable cathode such as a filament supported on the leads 9. The leads for the various electrodes are preferably of a refractory metal such as tungsten, and the glass employed is selected to match the expansion characteristics of the metal as is common practice.

In our improved seal structure, as illustrated at the grid seal 2, the glass surrounding the lead 3 is impregnated with a metallic powder 11 to provide a region about the lead in which the glass itself is metallized. The metal of the powder is preferably the same as that of the lead, namely, if a tungsten lead is used the impregnating powder is also of tungsten. The usual procedure of first beading the lead and then sealing the bead to the envelope is followed in the practice of our invention, the metallic powder 11 being incorpo-

rated in a flanged glass bead 12 as shown in Figure 2.

Bead 12 is preferably cast about lead 3, using powdered glass in a graphite mould which is heated in a suitable furnace to fuse the glass, the lead 3 being first oxidized to insure the desired glass-to-metal seal. In one form of our invention the metallic particles 11 are uniformly distributed throughout the bead, as shown in Figure 2. This is accomplished by mixing the metal powder uniformly with the glass powder, which mixture is then placed in the mould and heated to melt the glass. The metal powder is preferably quite fine, and a sufficient quantity is incorporated to provide an electrical conducting path in the glass. The only precaution to observe in this connection is to avoid adding too much metal powder, as an excess tends to make the glass porous and might produce an air leak through the envelope wall. After removal from the mould the beaded lead is sealed to the tube envelope in the usual manner, the impregnated bead thus providing the metallized glass wall portions surrounding the lead 3 shown in Figure 1.

The modified structure illustrated in Figure 3 is ordinarily preferred because it avoids any possibility of a porous wall. In this case the metallic powder 11 is concentrated in a disk-like zone lying in the central regions of the glass and extending radially of the lead. This structure is made by first placing a layer of glass powder in the bottom of the mold, then a layer comprising a mixture of glass and metal powders, and finally another layer of glass powder. The mold is then heated to the melting point of the glass which fuses the mass, including the central metallized glass zone, into a solid body. Since the outer glass layers insure vacuum tight surfaces, the central zone may have quite a high concentration of metal. For example, we have used for the central zone a mixture containing one part by weight of tungsten powder to five parts by weight of glass powder with good results, the powdered glass employed being preferably finely divided to provide a homogeneous mixture. As shown in Figure 2, the central metallized layer makes contact with the bead 3. In either case a bead is provided which is vitreous in character yet provides an electrical conducting path radiating outwardly from the lead within the glass wall. The flanged bead 12 is made sufficiently large in diameter, say an inch or so for a medium size transmitting type tube, so that the internal glass conducting path extends for a considerable distance out away from the lead 3.

We have operated tubes of the type shown in Figure 1 with our improved seal structure alongside similar tubes of conventional seal construction, and found that the improved tubes did not develop grid seal cracks under conditions which caused the conventional seals to crack at frequent intervals. We also found that tubes with our improved metallized glass seals would withstand adverse operating conditions such as higher ambient temperatures, and would operate successfully when exceeding the normal tube ratings, without seal failures.

While the precise causes of seal cracking are not fully understood we have found that our metallized glass seals provide a practical solution to the problem. It is believed that the provision

of an electrical conducting path within the glass itself, which path radiates outwardly from the lead within the glass body in the region of the seal, is the important feature contributing toward the improved results. Another desirable attribute of our seal construction is that the protective means is not applied as an external device but rather is incorporated as an integral part of the glass envelope. In our construction the glass at the seal is visible for inspection at all times.

Figure 4 shows our improvements embodied in another type of tube envelope construction. In some tubes a part of the envelope may be of metal such as the ring-shaped piece 13, which ring is brazed or sealed to another part of the envelope. When an electrode lead 14 is brought out through such a ring it is common to cast the entire glass wall section 16 in a graphite mould, using powdered glass moulding techniques. In this case we form a metallized disk-shaped area 17 surrounding the lead 14, the procedure being to partially fill the mould with powdered glass, then pour in a mixture of metal and glass powders to occupy the area 17, and then complete the filling of the mould with powdered glass. After the mould has been fired to fuse the glass the entire unit, including the sealed-in lead 14 and ring member 13, is ready for further tube assembly upon removal from the mould.

We claim:

1. An electron tube comprising an envelope having a glass wall, an electrode in the envelope, and a metal lead for the electrode extending through and sealed to said wall, the glass surrounding the lead being impregnated with metallic powder, said impregnated glass extending radially of the lead for an appreciable distance to provide a disk-like metallized glass protective shield in the envelope wall surrounding the lead.

2. An electron tube comprising an envelope having a glass wall, an electrode in the envelope, and a metal lead for the electrode extending through and sealed to said wall, the glass surrounding the lead being impregnated with metallic powder, said powder being concentrated in the central regions of the glass and extending radially from the lead for an appreciable distance to provide a disk-like metallized glass protective shield in the envelope wall surrounding the lead.

3. An electron tube comprising an envelope having a glass wall, electrodes in the envelope including a grid, a metal lead for the grid extending through and sealed to said wall, the glass surrounding the lead being impregnated with metallic powder, said impregnated glass extending radially of the lead for an appreciable distance to provide a disk-like metallized glass protective shield in the envelope wall surrounding the lead.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
335,160	Thomson	Feb. 2, 1886
485,478	Pollard	Nov. 1, 1892