Nov. 22, 1938. A. A. THOMAS 2,137,424

ELECTRON TUBE

Filed Oct. 20, 1936

Fig. 1

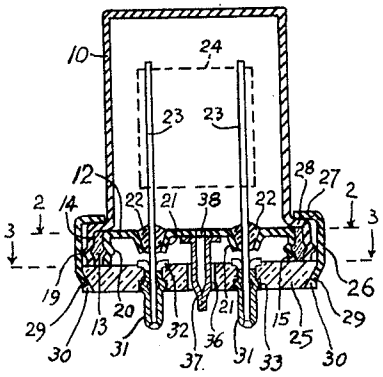


Fig. 5

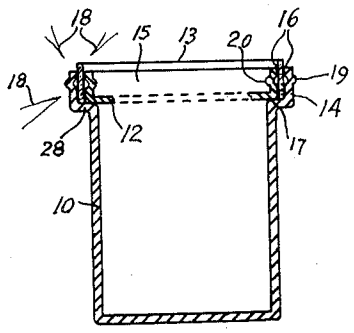


Fig. 2

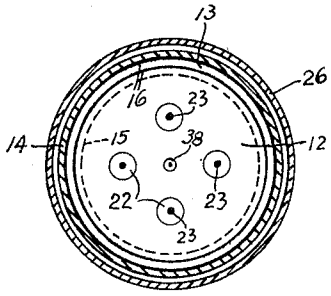


Fig. 3

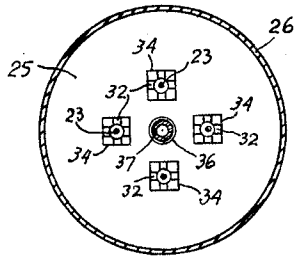


Fig. 4

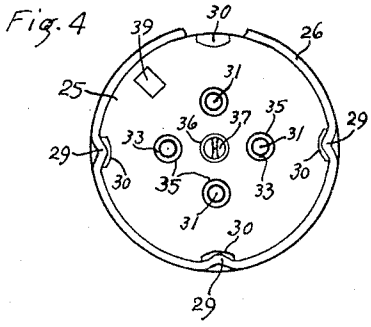
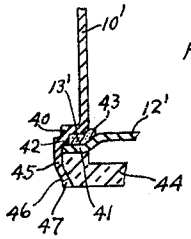


Fig. 6



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2,137,424

ELECTRON TUBE

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Application October 20, 1936, Serial No. 106,503

13 Claims. (Cl. 250—27.5)

My invention relates to electron discharge devices and its object is to produce an all-metal tube embodying certain features of novelty whereby the manufacturing cost is lowered and the useful life of the tube prolonged as compared with prior devices of that kind. This metal tube is particularly adapted for use in radio apparatus, but my invention is not limited to that field.

One characteristic feature of my all-metal tube is a glass seal between the metal shell and the metal base disk of the envelope, whereby a perfect gas-tight weld is obtained between the metal parts. In prior radio tubes of this type, the metal shell and metal base are directly welded together, but this welding operation requires the most careful handling and it is difficult to obtain a weld free from burning and one in which the metal parts are in complete contact uniformly all around. In the use of those prior metal tubes there have been complaints of leakage at the weld. This drawback is eliminated in my tube by uniting the metal shell and metal base disk into an integral gas-tight envelope by a sealing ring of glass, which is easily fused in place and produces a strong weld certain to be leak-proof in every instance.

Another novel feature of my invention resides in the insulating mounting of the lead-in wires in the metal base of the envelope. In prior metal tubes the metal base disk has a number of holes (one for each wire) and around each hole is welded an alloy eyelet to which a small glass cylinder is fused, each cylinder carrying a lead-in wire. In my tube I dispense with those separate sealing eyelets by forming the sheet metal base of the envelope with integral cup-shaped projections which are filled each with a glass seal, and the lead-in wires pass through these glass seals in such length of contact as to be rigidly supported.

The foregoing and other novel features and practical advantages of my invention will be understood from a description of the accompanying drawing, in which—

Fig. 1 is a vertical section of an all-metal electron tube embodying my invention;

Figs. 2 and 3 are sections on lines 2—2 and 3—3 of Fig. 1;

Fig. 4 is a bottom view of Fig. 1;

Fig. 5 illustrates the position of certain parts during the sealing operation; and

Fig. 6 is a fragmentary section of a modification.

The evacuated envelope of the tube consists of a cylindrical metal shell or cup 10 and a metal disk 12, these two parts being integrally united in a vacuum-tight joint by a sealing ring 13 of glass. The sheet metal parts 10 and 12 may be of steel, nickel, aluminum, duralumin, alloys of iron and nickel, and other metals found suitable for the purpose. To obtain a strong seal over a sufficiently wide contact area, I provide the metal shell 10 with an integral flange 14 and the metal disk 12 with an integral flange 15, these flanges being spaced to form an annular recess 16 which is filled by the fused glass of ring 13.

Fig. 5 illustrates a simple way of fusing the glass sealing ring 13 in place: The shell 10 is held upside down on a suitable support (not shown) and the disk 12 is placed over the shell, the edge of the disk resting on shoulder 17 of the shell. Then the glass ring 13 (cut from a long tube) is placed in the recess 16, and is progressively heated, together with flanges 14—15, by gas jets 18 properly arranged, until the glass melts and fills the recess 16, whereby the fused glass and the adjacent hot metal surfaces become welded together in a permanent gas-tight seal. As in all glass sealing operations, the assembled parts 10 and 12 are slowly rotated to insure uniform heating of the glass and the adjacent metal to the proper temperature.

The cross-sectional shape of the annular sealing space 16 is preferably different from the normal rectangular cross-section of the glass ring 13 so as to provide a seal that also locks the parts together in a mechanical way. Thus, by forming opposite beads 19 and 20 on flanges 14 and 15, I provide an enlargement in the annular recess 16. When that enlargement is filled with glass from ring 13, the resultant seal positively locks the shell 10 and disk 12 against axial displacement aside from the adhesion of the glass to the metal. The cross-sectional area of ring 13 is so chosen with respect to the volume of recess 16 that the fused glass fills the recess practically to the limit.

Attention is called to the depth or axial length of the glass seal 13 as determined by the length of flanges 14—15. This wide contact between the glass and the metal assures not only a vacuum-tight seal but one that is mechanically strong to withstand even rough and careless handling of the tube. It is not necessary that the contact between the edge of disk 12 and the shoulder 17 of shell 10 be a perfect fit, for the fused glass 13 seals up any irregularities in that contact. No special skill or care is required to make the

glass seal 13 uniformly perfect for all tubes. Except for an attendant to insert the glass rings 13, the sealing can be done by automatic machinery.

The metal surfaces in contact with the glass seal 13 should have practically the same coefficient of expansion as the glass, so that the vacuum-tight union between the glass and metal parts is not affected by changes of temperature. Either the metal itself of which the shell 10 and the disk 12 are composed has the same expansion coefficient as the glass seal, or the glass-contacting surfaces of flanges 14—15 are lined with such a metal. For example, the seal 13 may consist of a borosilicate glass (such as Pyrex) having a coefficient of expansion less than 0.000004, and the sheet metal parts 10 and 12 may be of an iron-nickel alloy with substantially the same expansion coefficient. A commercially known alloy of approximately 63% iron and 37% nickel (called Invar) has an expansion coefficient so low as to be practically negligible, and this alloy (or one like it) may be used for making the shell 10 and disk 12. Ordinarily these two parts will be made of sheet steel, which is cheap and strong, and is furthermore magnetic, so that the steel envelope also acts as an electromagnetic shield for the electrodes inside.

The sheet metal disk 12 is formed with integral nipples 21 which provide cup-shaped recesses or craters filled with sealing glass 22. These nipples may extend either up or down from the disk and are preferably conical or convergent toward the outer end so as to hold the glass seals 22 more easily in position during the sealing operation. That is to say, the restricted end openings of nipples 21 keep the plastic glass of seals 22 from dropping out. The glass seals 22 support the lead-in wires or rods 23 in a strong vacuum-tight joint and at the same time insulate them from the metal of disk 12. As seen in Fig. 1, the axial depth of the glass seals 22 provides wide contacts thereof with disk 12 and wires 23, so that the latter are rigidly sealed in the disk and safely insulated. The coefficient of expansion of the glass in seals 22 should be practically the same as that of the lead-in wires 23 and the inner surface of nipples 21, as previously explained for seal 13 and the metal parts 14—15.

A suitable electrode assembly 24 is supported in the tube either directly on the lead-in wires 23 or independently thereof by separate members, according to well known practice. I have not considered it necessary to show or describe the structural details of the electrode assembly 24, since any practical arrangement and construction of electrodes may be used, depending upon the intended function of the tube. Thus, for radio reception the electrodes in the tube would be a cathode, an anode, and one or more control grids. It will therefore be understood that the dotted outline 24 in Fig. 1 represents any suitable construction and arrangement of electrodes.

A base disk 25 of molded insulating material (such as glass, porcelain, or a condensation product) is attached to the metal shell 10 by means of a sheet metal collar 26, which has an inturned top rim 27 engaging an annular shoulder 28 on the shell. The bottom edge of collar 26 has portions 29 indented into bevelled notches 30 in base 25, whereby the latter is firmly held within the collar against the annular glass-metal rim formed by the adjacent ends of parts 13—14—15. To mount the insulating base 25 on the tube, the metal collar 26 is slipped over the shell 10 (or the latter is dropped inverted through the collar) until the rim 27 engages the shoulder 28. The base disk 25 is then placed within the collar against the bottom edge of the sealed members 10—12, and then the portions 29 of collar 26 are peened into the notches 30 of disk 25. The bevelled surfaces of these notches cause the disk 25 and the rim 27 of collar 26 to be drawn together by the peening operation, so that both the disk and the collar are held tightly in place. This method of attaching the base 25 to the tube is very simple and dispenses with the use of cement. The rim 27 may be soldered or otherwise attached to shoulder 28.

Before the base disk 25 is attached to the tube, it receives the contact pins 31, of which four are shown by way of example, but the number of pins will depend upon the number of elements in the electrode assembly 24. The metal contact pins 31 pass through holes in the disk 25 and are secured thereto by top tabs 32 and intermediate beads 33 formed integral on the pins. These pins are hollow or tubular and the beads 33 are readily formed by radially expanding the tubular wall of the pin, so that the beads are integral hollow enlargements of pins 31, which are made of suitable conducting metal. The tabs 32 (I have shown four on each pin for example) are bent out flat over the top of disk 25, which may have square or angular recesses 34 to receive the tabs and prevent turning of the pins, although this detail is not essential. The beads 33 fit tight in recesses 35 on the underside of disk 25 and limit the inward axial movement of pins 31. First, these pins are pushed through the holes in disk 25 as far as the beads 33 will let them go, then the tabs 32 are bent over in pressure contact with the top surface of the disk. In this way the contact pins 31 are rigidly clamped to the base disk 25 without the aid of an adhesive, the disk being sufficiently thick to hold the pins steady.

The contact pins 31 are preferably hollow to receive the lead-in wires 23 in good electrical connection. A hole 36 in the center of disk 25 receives the exhaust tubulation 37 (which may be metal) depending from the disk 12, to which the tubulation is welded over the exhaust hole 38 of the disk. A lug 39 (integral or separately attached) on the bottom of disk 25 is so positioned as to enter a slot on the socket of the tube to assure the proper mounting of the latter for operation. The lug or pin 39 extends axially from disk 25 and may be of any suitable shape, it being shown rectangular in cross-section in the bottom view of Fig. 4.

In Fig. 6 the shell 10' and disk 12' (both of sheet metal) are integrally united by a glass sealing ring 13' which fills the annular recess between the flange 40 of shell 10' and the flange 41 of disk 12'. The edge of this disk abuts against the shoulder 42 of shell 10' and this engagement definitely determines the width of the sealing space between the flanges 40—41. The normal thickness of the glass ring 13' is preferably somewhat greater than the axial depth of the recess between flanges 40—41, so that the plastic mass of the ring is pressed against said flanges in complete vacuum-tight contact therewith when the flange 41 strikes the shoulder 42 during the sealing operation. Any excess of the plastic glass is squeezed out of the annular sealing space, as indicated at 43. A base 44 of molded insulating material is held rigidly against the underside of flange 41 by the rim 45 of

shell 10', this rim having portions 46 peened into slots 47 of the base. Otherwise, what has been said about the materials and the expansion coefficients of parts 10, 12 and 13 in Figs. 1–5 applies fully to the corresponding parts 10'—12'—13' in Fig. 6. It is also to be assumed that the disk 12', like disk 12, carries the necessary lead-in wires, and that the base member 44 carries the usual contact pins, as shown in Fig. 1.

It is hardly necessary to add that the drawings were not made with the mathematical accuracy required in shop drawings, and I have purposely exaggerated the relative dimensions of the parts for clearness.

Although I have shown and described certain specific constructions, I want it understood that my invention is not limited to the details set forth, for various changes and modifications may be resorted to without departing from the invention as defined in the appended claims.

I claim as my invention:

1. An electron tube having a gas-tight envelope consisting of a metal shell and a metal disk integrally united by a glass seal, said metal shell and disc having integral portions in abutting contact with each other along a circular line at one edge of said glass seal, and an electrode assembly in said envelope.

2. An electron tube comprising a metal shell provided with a flange, a metal disk also having a flange, said flanges being spaced to form an annular recess, said metal shell having an integral shoulder at one end of said recess, one end of the flange on said disc abutting against said shoulder, a sealing ring of glass filling said recess and fused to said flanges, whereby said shell and disk constitute a gas-tight metal envelope, and an electrode assembly in said envelope.

3. An electron tube having a gas-tight envelope consisting of a metal shell and a metal disk integrally united by a glass seal, cooperating means on the united glass and metal surfaces for mechanically locking the shell and disk together against axial displacement, said locking means being in addition to the adhesion of the united surfaces, and an electrode assembly in said envelope.

4. An electron tube comprising a sheet metal shell which terminates in an integral shoulder and a cylindrical flange, a sheet metal disk terminating in a cylindrical flange, said flanges being in nested spaced relation and arranged so that the flange on the disc is in abutting contact with said shoulder to provide an annular recess which is closed at one end, a ring of glass in said recess and fused to said flanges, whereby said shell and disk constitute a gas-tight metal envelope, and an electrode assembly in said envelope.

5. An electron tube comprising a metal shell provided with a flange, a metal disk also provided with a flange, said flanges being spaced to form an annular recess, a sealing ring of glass filling said recess and fused to said flanges, whereby said shell and disk constitute a gas-tight metal envelope, said shell having a circular shoulder engaged by said disk and closing one end of the glass-filled recess, said shoulder also acting as an abutment to hold the disk in predetermined axial relation to the shell, and an electrode assembly in said envelope.

6. An electron tube comprising a sheet metal shell which terminates in a cylindrical flange, a sheet metal disk also terminating in a cylindrical flange, said flanges being spaced to provide an annular recess, a ring of glass filling said recess and fused to said flanges, whereby said shell and disk constitute a gas-tight metal envelope, cooperating means on said metal flanges and glass sealing ring for mechanically locking said shell and disk together against axial displacement, said locking means being in addition to the adhesion between the glass and metal parts, and an electrode assembly in said envelope.

7. An electron tube comprising a metal shell provided with a flange, a metal disk also having a flange, said flanges being spaced to form an annular recess, sealing glass in said recess fused to said flanges, whereby said shell and disk constitute a gas-tight metal envelope, an electrode assembly in said envelope, insulated lead-in wires passing through said metal disk and connected to said electrode assembly, a second disk of insulating material carrying contact pins which are connected to said wires, and means for securing said second disk to the metal shell, said second disk abutting against at least one of said flanges to limit its inward axial movement.

8. An electron tube having an envelope formed by a metal shell and a metal disk welded together in a gas-tight joint, insulated lead-in wires passing through said disk, an electrode assembly in said envelope connected to said wires, a metal collar mounted on said shell, said collar being separate from the shell and disk, a base disk of insulating material within said collar, engaging means on said collar and base disk for attaching the latter rigidly to the collar, and contact pins carried by said base disk and connected to said lead-in wires.

9. An electron tube having an envelope formed by a metal shell and a metal disk welded together in a gas-tight joint, insulated lead-in wires passing through said disk, an electrode assembly in said envelope connected to said wires, said shell having an outer annular shoulder, a metal collar having a rim engaging said shoulder, a base disk of insulating material arranged within said collar and having peripheral notches, said collar having portions indented into said notches to clamp the base disk to the shell, and contact pins carried by said base disk and connected to the lead-in wires.

10. An electron tube having an envelope containing an electrode assembly, a base disk of insulating material attached to said envelope, said disk having a plurality of holes, a tubular contact pin mounted in each hole, cooperating mechanical means on said disk and pins for positively locking each pin to the disk, said locking means including a hollow bead formed integral on each pin as a radial expansion of its tubular wall, said integral hollow beads abutting against the disk, and means for connecting said pins to the electrode assembly.

11. An electron tube having an envelope containing an electrode assembly, a base disk of insulating material attached to said envelope, said disk having a plurality of holes, a tubular contact pin mounted in each hole, a hollow integral bead on each pin adapted to abut against the disk and limit the axial movement of the pin into its hole, each bead being a hollow radial expansion of the tubular wall of the pin, flanged means on the inner end of each pin engaging the disk, whereby each pin is locked in its hole by said bead and flanged means, and means for connecting said contact pins to said electrode assembly.

12. In the manufacture of all-metal electron tubes, the method of sealing a sheet metal disk to a sheet metal shell, which comprises supporting the shell in inverted position, placing the disk centrally on the shell so as to leave an annular groove between the nested parts, placing a glass ring in said groove, and fusing the glass ring, which substantially fills the groove and unites the metal shell and disk in a strong gas-tight weld.

13. In the manufacture of all-metal electron tubes, the method of sealing a sheet metal disk to a sheet metal shell, which comprises providing the shell and disk with circular flanges, supporting the shell and disk in nested relation so that the flanges form an annular groove, placing a glass ring in said groove, fusing the glass ring, which substantially fills the groove, and causing the fused mass of the ring to assume a configuration which mechanically locks the shell and disk together against axial displacement in addition to the adhesion of the glass and metal surfaces, whereby the fused glass ring unites the metal shell and disk in a strong gas-tight weld.

ADOLPH A. THOMAS.