

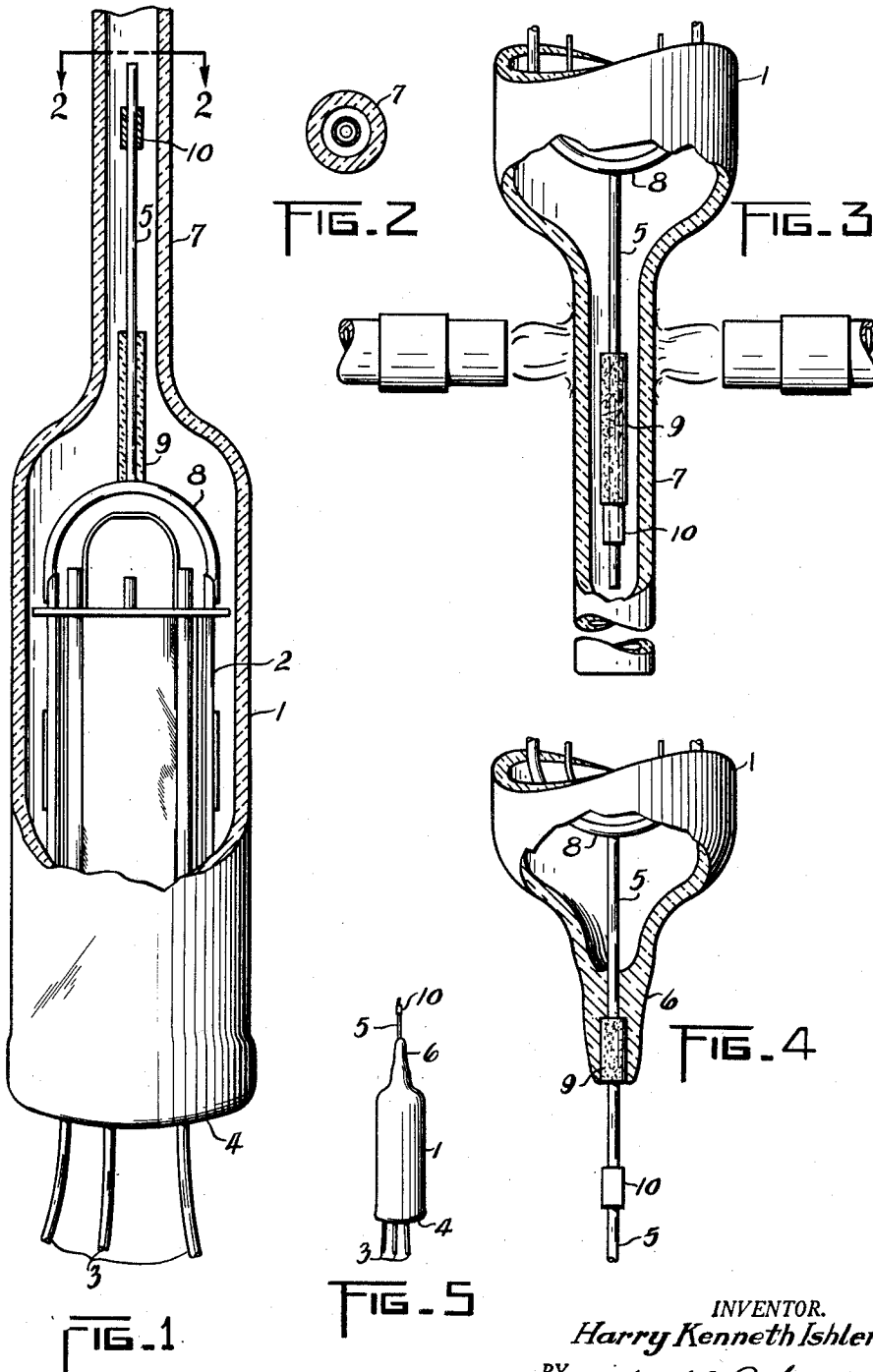
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LEAD WIRE CONSTRUCTION AND METHOD OF SEALING

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LEAD WIRE CONSTRUCTION AND METHOD
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The present invention relates to hermetically sealed devices having conductors sealed through the envelope thereof. More particularly the invention is directed to a method of sealing metal-to-glass, and also the form of seal resulting from practicing the method.

In vacuum-tight devices, such as electron tubes and the like, it has always been a problem to seal satisfactorily the lead-in wire through the envelope during the manufacture of the device. This problem is complicated by the type of the device, the character of sealing-in wire required, the form of the seal made, etc. Presses and headers containing a plurality of leads are commonly fabricated before the general assembly of the device, as for example an electron tube, and the sealing operation in the fabrication of such parts is relatively simple. On the other hand, individual lead-in wires are customarily sealed separately through some particular portion of the envelope of the device, as for example they may be brought out through the side or top, and terminate in a tip formed externally during the sealing operation. The failure of tip seals is relatively high because the tip, generally pointed, is inherently weak. Mechanical strains, such as may be produced by bending the lead-in wire in handling or installing the tube, frequently crack the tip with the result that the vacuum of the tube is broken, thereby rendering the tube defective.

Another source of sealing-in shrinkage in the production of vacuum-tight devices is the burning or melting of lead-in wires during the sealing operation. The art requires the use of high-speed automatic machinery and in performing various operations, such as exhaust and sealing-off, time is the essence. It is therefore a practical requirement that tip seals be made rapidly which necessitates the use of relatively intense heat to melt quickly the glass or material of the envelope. Under these conditions the lead-in wire heats rapidly and may burn or melt before the seal is formed. Various expedients have been proposed to overcome this difficulty. For example, using a lead-in wire of larger diameter than would otherwise be desired; also using special sealing-in conductors requiring special glasses. These expedients introduce complications and have not been a satisfactory solution to the problem.

Among the objects of the invention are: to provide a method and means whereby the lead-in wire is protected from injury that may be caused by excessive heat applied during the seal-

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ing-in of the lead through the envelope of a vacuum-tight device; to avoid the formation of a seal having a pointed tip which renders the seal inherently fragile; to strengthen the tip of that type seal; to relieve mechanical strains at the exit of the lead-in wire from the envelope of the device, which strains may be produced by manipulation of the lead-in wire; to provide a sealing-in construction which permits the formation of a seal between the envelope material and a leading-in wire, and simultaneously the formation of a tight joint or union between protective means for the leading-in wire, the lead and protective means being brought out through the tip; and other novel features of construction which will become apparent as the description proceeds.

Referring to the drawings:

Fig. 1 is a side elevation, partly in section, of an electron tube embodying the seal construction contemplated by the present invention;

Fig. 2 is a sectional view along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary side elevation, partly in section, of the top portion of the tube shown in exhaust and sealing position;

Fig. 4 shows the structure of Fig. 3 at the completion of the exhaust and sealing operation; and

Fig. 5 is a side elevation of a full-size completed electron tube.

The invention is shown embodied in an electron tube of the miniature type in order to afford a complete understanding of the various structural features contemplated, and also the method of practicing the invention, although it will be appreciated that such a device is used for purposes of illustration only. Referring to Fig. 1 it will be seen that the tube may comprise an elongated tubular envelope 1, enclosing an electron assembly indicated generally by the numeral 2. The assembly 2 may comprise a conventional arrangement of electrodes, support members and lead-in wires, such as for example a central cathode surrounded by a plurality of grids and an anode, which elements are supported between mica discs. Connection to the electrodes of the assembly are made principally by lead-in wire 3 sealed through a header 4, which is prefabricated as a unit and closes the bottom of the envelope of the tube.

According to present day construction of miniature tubes they do not have a base in the usual sense of the term, but rather connections to the associated apparatus are made directly to

the leading-in wires of the tube. Another characteristic feature of conventional miniature tubes is the absence of leading-in wires brought out through the side or top of the tube envelope, although this is common practice in the manufacture of relatively large vacuum-tight devices. The principal reason why this practice has not been extended to the construction of miniature tubes is because a seal made with the side or top of the envelope, results in the formation of a pointed tip and this point is inherently fragile unless protected by the usual cap provided in the case of relatively large tubes. Furthermore, where a cap is provided for the tip of the seal, the lead-in wire is connected to the cap which then becomes a terminal for connecting the tube in the circuit.

It has not been found practical to adopt this practice to the manufacture of miniature tubes for the reasons just explained, as well as for other reasons obvious to those skilled in the art. Therefore, as stated above, among the objects of the invention it is proposed to provide a seal having a reinforced tip which construction may be utilized in the production of miniature tubes.

The sealing-in construction contemplated by the invention for making connection to an electrode, particularly through the top of the tube, comprises a sub-assembly including a sealing-in conductor or lead-in wire 5 having a surrounding sheath or sleeve 9 slidably mounted thereon. The sleeve 9 consists of an elongated tubular body of non-conducting and preferably friable material, such as ceramic, which sleeve closely fits the lead-in wire 5 but provides enough clearance to be actuated by gravity as presently explained. As shown in Figs. 1 and 4, one end of the lead-in wire 5 is connected, as by welding, to a loop 8, which in turn is connected to the anode of the electrode assembly 2, while the other end of the wire 5 extends into an exhaust tube 7, which latter is eventually consolidated into a seal having a tip 6.

When the tube is in an upright position, as shown in Fig. 1, the ceramic sleeve or sheath 9 slides by force of gravity to the bottom of the lead-in conductor 5 and rests against the loop 8. When the tube is in this position the header 4 may be sealed to the envelope 1. For exhausting and sealing-off purposes the position of the tube is inverted (see Figs. 3 and 4) and connection with the exhaust pumps is made by means of exhaust tube 7. With the tube in the position shown in Fig. 3, the air may be pumped out through the exhaust tube 7, the parts may be heated to drive out absorbed gases, the cathode may be activated by raising its temperature, and any other required steps may be performed, this process usually being carried out on automatic machinery.

At the completion of the exhaust process, the seal to lead wire 5 is made by melting the exhaust tube so that the material thereof, forced inward by the external air pressure, flows around the lead wire 5, simultaneously sealing the lead and closing the envelope, as presently explained.

The sealing fires (schematically illustrated) are applied opposite the sleeve 9, which being of ceramic, prevents the lead wire 5 from overheating and melting during the sealing operation. By preventing excessive heating of the lead-in wire 5 it is possible to employ a lead wire of smaller diameter than otherwise would be possible. This has advantages obvious to workers of the art. The length of the ceramic sleeve 9 and the loca-

tion of a stop or support 10, which may take the form of a short sleeve or a flattened surface on the lead wire 5, are so chosen that the ceramic sleeve 9 is properly positioned with respect to the point at which the sealing fires are applied.

Further advantages of the use of a ceramic sleeve arise from the way in which the seal is formed, as shown in Fig. 4. The material of the exhaust tube flows around the wire 5 and also around the ceramic sleeve 9 so that the ceramic sleeve is embedded in the seal and becomes a part of the tip, the exhaust tube material making a close joint with the sleeve as well as sealing to the lead wire.

After the seal has been formed, a portion of the tip, with the adjoining embedded section of the sleeve 9, is cut away or broken off at its pointed end, leaving the completed tube as shown in Fig. 5. This may be done with a pair of pliers or by automatic means, and is feasible because both the material of the envelope and the sleeve are friable, i. e., one is glass and the other ceramic.

The lead-in wire 5 thus emerges from the envelope via the sealed-in portion of the sleeve 9, which portion forms a union with the seal and/or tip, and the lead-in wire 5 is not in contact with the tip at the point of emergence therefrom. Consequently, since the sleeve has an appreciably larger diameter than the lead wire, the bending of the lead wire, which is likely to occur during handling or installing of the tube, is not likely to crack the seal, especially the tip, thus avoiding or materially reducing a source of shrinkage by air leaking into the device. The breakage of tip seals is a serious shrinkage factor, and therefore, any construction or technique which will materially reduce this form of shrinkage is an important advancement in the industry.

It will be clear to those skilled in the art that in the practice of the invention many modifications may be made from the embodiment described and illustrated. It is not necessary, for example, to exhaust the air from the device through an exhaust tube surrounding a lead-in wire; in accordance with general practice there would be no exhaust operation in the making of side seals. The support sleeve 9 may be composed of a wide variety of satisfactory materials. Additionally, the ceramic sleeve 9 may be replaced by a suitable coating applied to the lead wire 5; for example, a coating of aluminum oxide deposited on the lead by electrophoresis has been used. This variation is possible because the coating serves primarily as a protection to the lead-in wire and is not relied upon for making the seal between the envelope and the sealing-in conductor.

Therefore, although I have shown and described a particular embodiment of my invention, I do not desire to be limited thereto, and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

What I claim is:

1. An electrical device comprising an envelope having a glass wall, a friable, heat-shielding sleeve, and a flexible conductor extending through said wall and said sleeve, said glass wall being sealed to said conductor and to said sleeve, and said sleeve extending to the exterior of said envelope.

2. An electron discharge device comprising an envelope having a wall of glass enclosing part of the length of a flexible conductor in a cavity of progressively reduced cross-section, said cavity

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terminating where the conductor is sealed to the glass, and an outwardly adjacent friable sleeve surrounding said conductor and sealed in the glass, said conductor extending beyond the end of said sleeve.

3. An electron discharge device comprising an envelope having a wall of glass enclosing part of the length of a conductor within a cavity of progressively reduced cross-section, said cavity terminating where the conductor is sealed to the glass, and an outwardly adjacent sleeve loosely surrounding said conductor and sealed in the glass.

4. In the manufacture of electron discharge devices, the method of completing the envelope comprising the steps of arranging an electrode conductor having a fixed stop and a friable loosely surrounding heat-shielding sleeve extending along part of its length within an exhaust tubulation extending from the incomplete envelope, fusing the exhaust tubulation while vertical and with the sleeve resting on the stop to form glass seals to the conductor and the sleeve, and parting the exhaust tubulation and sleeve to expose the external part of the conductor free of adhered glass.

5. A hermetically sealed device including an envelope and a conductor sealed through said envelope, the seal comprising a union of the envelope material with the conductor and a friable protective sleeve surrounding the conductor, said sleeve having one end imbedded in the seal at the side of the seal to the exterior of the envelope and said conductor extending from said sleeve.

6. An electron discharge device having an envelope including a glass wall, said envelope having a seal-off tip and a conductor sealed through

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said tip and extending to the exterior of the envelope, the thickness of glass about said conductor diminishing toward the end of the tip and a friable sleeve surrounding the portion of said conductor which is imbedded in the end of said tip.

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