Nov. 5, 1940. H. L. THORSON 2,220,741

SEAL FOR LEAD-IN CONDUCTORS

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Fig. 1.

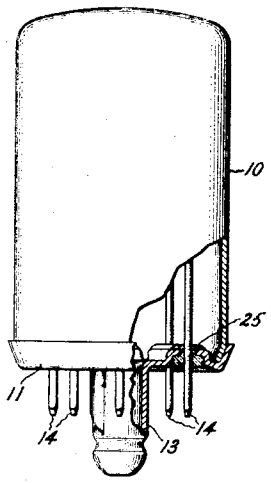

Fig. 2.

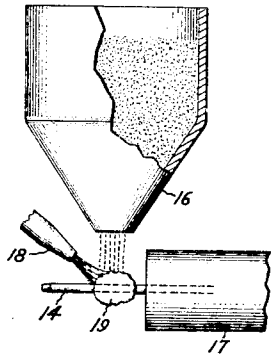

Fig. 3.

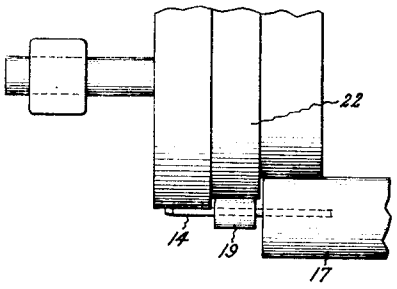

Fig. 8.

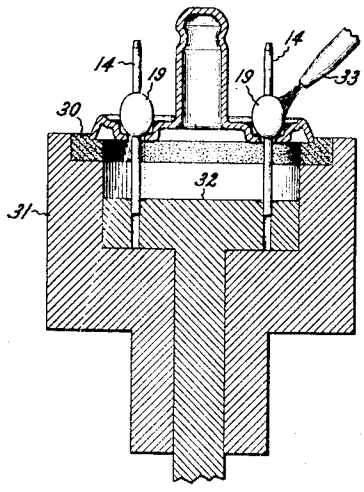

Fig. 4.

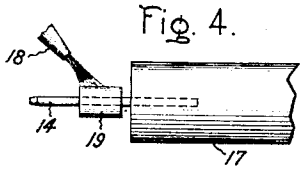

Fig. 5.

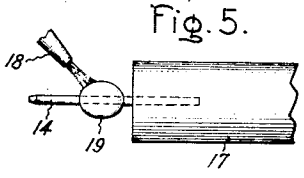

Fig. 6.

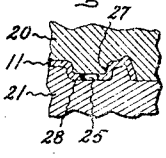

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Fig. 7.

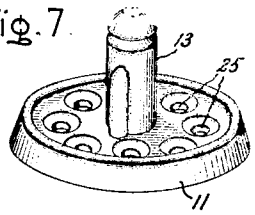


Fig. 11.

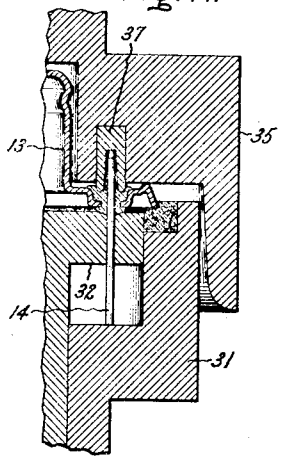


Fig. 9.

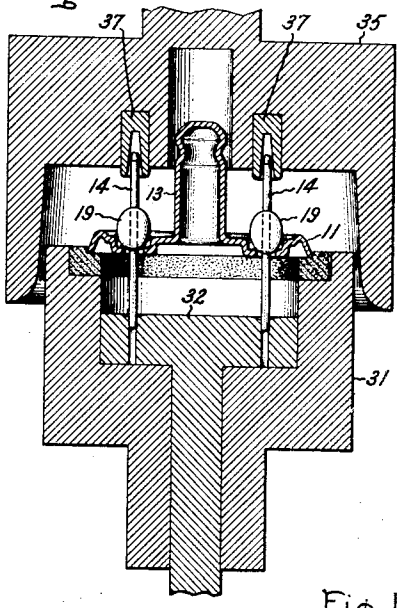


Fig. 12.

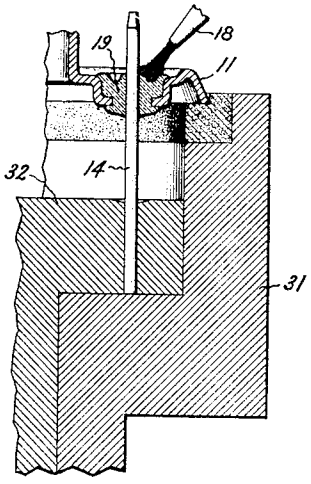


Fig. 13.

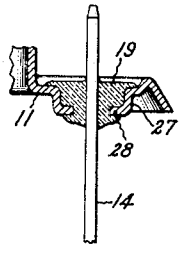


Fig. 10.

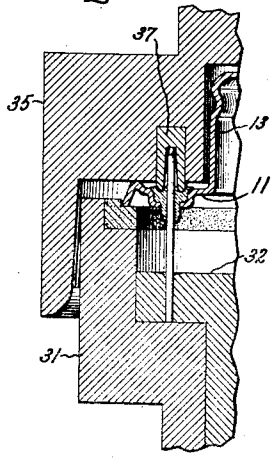
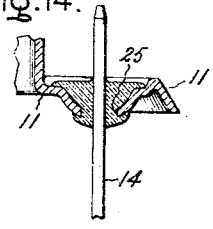


Fig. 14.



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His Attorney.

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UNITED STATES PATENT OFFICE

2,220,741

SEAL FOR LEAD-IN CONDUCTORS

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Application April 7, 1939, Serial No. 266,569

5 Claims. (Cl. 250—27.5)

The present invention relates to an improved method and means for sealing a lead-in conductor through a metallic wall member. While not limited thereto, the invention is especially applicable in connection with metal enclosed electrical discharge devices, such as metal vacuum tubes.

It is a primary object of the invention to provide a simplified lead-in construction which is characterzied by a high degree of mechanical strength.

It is a further object to provide a method of fabricating seals of the character described above which is easily practiced under the conditions of mass manufacture.

The features which I desire to protect herein are pointed out in the appended claims. The invention itself, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the drawings, in which Fig. 1 represents a metal vacuum tube suitably embodying the invention; Figs. 2, 3, 4, and 5 illustrate the principal steps in the process of preparing an individual lead-in conductor for incorporation in the tube; Fig. 6 shows a step in the process of forming a header member to be used for closing one end of the tube; Fig. 7 shows a header in completed form; Figs. 8, 9, 10, 11 and 12 show various steps in combining a lead-in conductor with the header structure; Fig. 13 shows a typical seal of my invention in its finished condition; and Fig. 14 shows an alternative embodiment.

Referring particularly to Fig. 1 there is shown a metal enclosed vacuum tube of a novel form which is described and claimed in James E. Beggs' application Serial No. 266,558, filed April 7, 1939. This comprises a cylindrical shell 10 which is closed at its lower end by means of a circular header 11 peripherally joined to the shell as by soldering thereto. The header is provided with a protuberance 13 which serves as a guide for locating the tube in an appropriate socket (not shown). For energizing the enclosed electrode structure (not shown) there are provided relatively rigid lead-in conductors 14 which project through various openings 25 punched or otherwise formed in the header. These conductors are shaped at their outer extremities to serve as contact pins for insertion in a cooperating socket and are inwardly connected to the electrode structure. Each lead-in conductor is supported in insulatingly spaced relation to the header by means of a mass of fusible vitreous material which also constitutes a seal for the associated header opening.

It is preferred, for reasons of economy to form the header itself of iron, or, more specifically, of cold-rolled or deep-drawing steel. In order that this may be done without rendering the creation of vacuum-tight seals extremely difficult it is necessary that the lead-in conductors be constituted of a material having substantially the same thermal expansion characteristics as iron. On the other hand, where, as in the arrangement of Fig. 1, it is desired to have the externally projecting portions of the conductors serve as contact terminals for engagement with a socket, it is advisable that these comprise a relatively non-oxidizable metal. Both of these conditions are fulfilled by forming the conductors of an alloy which consists essentially of from 70% to 80% nickel with the remainder iron. (This latter feature is the invention of A. W. Hull and is more fully described and claimed in his application Serial No. 266,603, filed April 7, 1939.)

In fabricating a tube of the type shown in Fig. 1 and more particularly the lead-in seals therefor, it is convenient as a preliminary step to form a bead of fusible vitreous material on each of the individual leads. For sealing with a header and lead-in conductors of the composition described above, it is advantageous to employ a lead glass whose theoretical oxide composition consists approximately of 45% SiO_2, 12% K_2O, 6% Na_2O, 32% PbO and 5% CaF_2. Other suitable materials are described in application Serial No. 266,604, filed April 7, 1939, in the name of A. W. Hull and Louis Navias.

The beading of the lead-in conductor is preferably accomplished by the method described and claimed in my prior application Serial No. 210,781, filed May 28, 1938. As explained therein, glass or other vitreous material in granular form may be deposited on the conductor by rotating and heating the same while permitting particles of glass to impinge thereon. The essentials of the method are illustrated in Fig. 2 of the drawings wherein there is shown a rotating jig 17 supporting an individual conductor 14. A flame projected onto the conductor by means of a nozzle 18 serves to maintain it at approximately the fusion temperature of glass. With these conditions established, ground glass of approximate fineness is slowly fed to the heated portion of the conductor from a hopper 16. By virtue of the continuous rotation of the conductor the glass is caused to accumulate thereon in the form of a bead-like mass as indicated at 19. In order to improve the adherence of the glass to the conductor, the latter may be given a preliminary coating of copper, deposited, for example, by electrolysis.

When the vitreous material employed consists of a lead glass such as I have mentioned above, the accretion which takes place on the conductor 14 is apt to be in the form of a rather loose or flocculent mass of non-compacted particles. In order to bring the glass into a desired form it is

expedient to shape it mechanically as for instance, by an apparatus such as is illustrated in Fig. 3.

In the arrangement shown there is provided a stepped roller 22 which provides separate bearing surfaces for the conductor 14, the mass of vitreous material 19, and for the rotating jig 17. By rotating the jig with the various surfaces in contact, the glass may be brought to a desired condition of compactness. The cylindrical form which results from this procedure may be changed by the application of heat (Fig. 4) so as to cause the bead to assume the more or less spherical form shown in Fig. 5.

The header with which the beaded lead-in conductors are to be combined is performed in the manner indicated in Fig. 6. As shown, the header 11 (illustrated only in part) is placed between a pair of opposed die members 20, 21 which are urged together with sufficient force to bend the header metal in the desired fashion. In accordance with my present invention, each header opening 25 is caused to lie at the bottom of a shallow depression which is bounded by a peripheral wall portion 27 extending transversely to the principal plane of the header and a flattened floor portion 28 which is substantially parallel to the plane of the header. This latter portion provides a lip which surrounds the associated opening and serves a purpose which will be explained more fully in the following.

As is readily apparent, Fig. 6 shows only a fragmentary portion of the header structure. A completed header is shown in perspective in Fig. 7. When the header has been brought to the form indicated, it may advantageously be given a thin coating of copper to increase its ability to be wet by glass or other vitreous sealing agents.

As a first step in the actual fabrication of the lead-in seals, the completed header is positioned in a suitable jig as indicated in Fig. 8. In this figure it will be noted that the header is supported in inverted position with its periphery in engagement with an annular member 30. This member, which is in turn supported by a circular carriage 31, preferably is constructed of an insulating material such as lava. By this means it is possible to minimize conductive heat loss from the header.

Subsequent to positioning the header in the manner specified, a plurality of beaded lead-in conductors 14 are arranged in the various openings of the header in such fashion as to bring the glass beads 19 into proximity to the header openings. (These beads should be of larger diameter than the openings so as to be incapable of passing through them.) The conductors are held in the proper position by virtue of their entry into small openings formed in a metal plunger 32, positioned as shown. The function of the plunger, which is movable in a vertical direction, will be explained more fully in the following.

After the various elements are assembled in the relationship shown in Fig. 8, they are next heated, as by gas jets one of which is shown at 33, to a temperature corresponding to the fusion temperature of glass, say on the order of 700° C. In order to facilitate the heating operation and to insure even heating, the entire structure shown in Fig. 8 may be arranged to rotate unitarily about its central vertical axis.

Subsequent to the foregoing, the carriage 31 is brought into cooperating relationship with a second plunger 35 which is illustrated in Fig. 9. This plunger is movable in a vertical direction and consists of a metallic base part having a series of apertured protuberant members 37 which correspond in number and position to the lead-in conductors 14. The members 37 preferably consist of a hardened corrosion-resisting metal, such as Monel metal or nickel.

Immediately after bringing the carriage 31 and the plunger 35 into the relationship illustrated in Fig. 9, the plunger is moved downwardly to the position shown in Fig. 10 so that the lips of the protuberant elements 37 engage the softened glass of the beads 19. The resultant downward motion of the conductors 14, as impelled by the plunger 35, taken in connection with the pressure exerted on the glass by the members 37 is effective to force or extrude a portion of each bead through the adjacent header opening and to spread or mold the remainder into engagement with the upper surface of the header. (See Fig. 10.)

Next, without withdrawing the plunger 35, the plunger 32 is moved upwardly as shown in Fig. 11 to bring its surface into engagement with the downwardly extending portions of the glass beads. As a result of this motion and of the pressure thereby exerted, the said portions are caused to flow outwardly into engagement with the under surfaces of the flattened lips which surround the respective header openings. Due to the countersunk shape of the plunger 32 at the region of its engagement with each portion of glass, the latter is molded into the form of a tapered mound having the lead-in conductor passing through its apex.

As a result of the operations so far described the sealing glass is caused to assume a shape substantially as shown in Fig. 12 wherein it appears to be characterized by numerous irregularities. By withdrawing the plungers and applying further heat, the glass is caused to flow sufficiently to assume the smooth contour shown in Fig. 13. In this figure, which represents the finished condition of the seal after cooling, it will be seen that a portion of the glass evenly fills the shallow depression surrounding the opening 25. The remaining portion constitutes a rounded mound adhering to the lower side of the floor of the depression.

Seals having the form described in the foregoing are found to be uniformly characterized by a degree of mechanical strength sufficient to avoid cracking by strains imposed on them as a result of the use of the externally projecting conductors as contact pins. This is due in part to the reinforcing action of the lateral wall portion of the preformed depression and to the fact that the use of a preformed depression surrounding the lead-in conductor makes it readily possible to regulate the depth of the glass. It is also considered to be due in further part to the presence of the lip 28 which provides a sealing surface parallel or approximately parallel to the principal plane of the header. As a result of the latter factor much of the strain set up due to expansion or other movements of the parts is tangential to the sealing plane. It is known that this is a condition conducive to good mechanical strength and avoidance of cracking.

From the electrical standpoint it is a further advantage of the seal described that its form assures long electrical leakage paths on both sides of the header. It is, therefore, possible to use relatively small openings through the header without creating a danger of electrical breakdown. The use of openings of small diameter

is of considerable value in avoiding the occurrence of any but tangential strains such as are referred to in the preceding paragraph as being conducive to maximum seal strength.

The precise configuration shown in Fig. 13 is not essential to the purposes of the invention and in Fig. 14 there is shown one possible modification thereof. In this case the depression provided in the header is of generally hemispherical contour rather than of cylindrical shape as in Fig. 13. It will be seen, however, that it conforms in essential particulars to the previously described arrangement in providing a peripheral portion which extends transversely to the principal plane of the header and a lip portion surrounding the opening 25 in a plane which is generally parallel to the header.

It will be understood that all the procedural steps which have been outlined in the foregoing may be carried out on a step-by-step machine of known type, wherein the various operations are accomplished sequentially at successive stations. After the header and lead-in conductors are assembled in permanent relation in the manner specified, the header may be joined to the remaining structure of the discharge envelope by any appropriate means. In accordance with one method with which I am familiar this is done by cleaning and tinning the header and thereafter soldering it to the envelope body.

I have described the steps of my improved method as being carried out in a certain order. It will be realized, however, that this order may be modified in numerous respects without affecting the results obtained. I, therefore, aim in the appended claims to cover all such variations of either the procedure or product as fall within the true spirit and scope of the foregoing disclosure.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of sealing a lead-in conductor through a metal wall member, which method comprises providing on said conductor a bead-like mass of fusible vitreous material, forming in said wall member an opening of smaller diameter than the said bead-like mass but of larger diameter than the lead-in conductor, passing the conductor through the opening to bring the vitreous material into close proximity thereto, heating the said mass to its fusion temperature and maintaining compressive contact between the fused mass and the boundaries of the opening, thereby to force a portion of the vitreous material through the opening and to force another portion thereof into extensive surface engagement with the lip of the opening on one side of the wall member, and thereafter molding the said first-named portion of the vitreous material into extensive surface engagement with the lip of the opening on the other side of the wall member, whereby the parts produce a sealed joint between the engaging metal and vitreous surfaces.

2. The combination which includes a metal wall member provided with a shallow generally circular depression therein formed by deformation of the wall, the part of the wall member bounding said depression including a peripheral portion which extends transversely to the principal plane of the wall member and a floor portion which is substantially parallel to such plane, an opening formed in said floor portion, an electrical conductor positioned in said opening, and a mass of fusible insulating material substantially filling said depression and sealed to said floor portion in extensive surface engagement therewith on both sides of the said wall member, said insulating material serving to support the said conductor from the wall member.

3. In an electrical discharge device, an envelope which comprises a metal wall having a circular depression therein provided by deformation of the wall, the part of the wall bounding the depression including a peripheral portion which extends transversely to the principal plane of the wall and a second portion which extends generally parallel to such plane, although offset therefrom, an opening formed in said second portion, a metal conductor projecting through said opening and shaped at its outer end to serve as a contact pin, electrode structure enclosed by said envelope and connected to the conductor, a mass of fusible vitreous material filling the said depression and insulatingly supporting the conductor on one side of the wall, and an additional mass of vitreous material extending through said opening and supporting the conductor on the other side of the wall, said additional vitreous material being sealed in extensive surface contact to the said second portion of the wall bounding the depression.

4. In an electrical discharge device, an envelope enclosing electrode structure, a metal header closing one end of the envelope and having a plurality of circular depressions therein provided by deformation of the header, the part of the header bounding each depression including a peripheral portion which extends transversely to the principal plane of the header and a second portion which extends generally parallel to the plane of the header, there being an opening provided in the said second portion of each depression, metal conductors respectively positioned in the various openings, such conductors being shaped at their outer extremities to serve as contact pins and being inwardly connected to the said electrode structure, separate masses of fusible vitreous material filling each of the said depressions and furnishing support to the various lead-in conductors on one side of the header, and additional masses of vitreous material extending through the openings around said conductors and sealed to said header in extensive surface contact therewith on the side of the header opposite said depressions.

5. The method of sealing a lead-in conductor through a metal wall member which method comprises forming in the wall member a shallow depression having a central opening therein, providing on said conductor a bead-like mass of fusible vitreous material of greater diameter than the said opening, passing the conductor through the opening to position the said mass of vitreous material in the said depression, heating the said vitreous material to fusion temperature and maintaining compressive contact between such material and the boundaries of the said opening to extrude a portion of the material through the opening, and molding the unextruded portion of the material into the space defining the said depression and the extruded portion thereof into extensive surface engagement with the lip of the opening on the side of the wall member opposite the depression.

HARRY L. THORSON.