June 15, 1943. C. A. HORN 2,321,600

METHOD OF MAKING MOLDED STEMS

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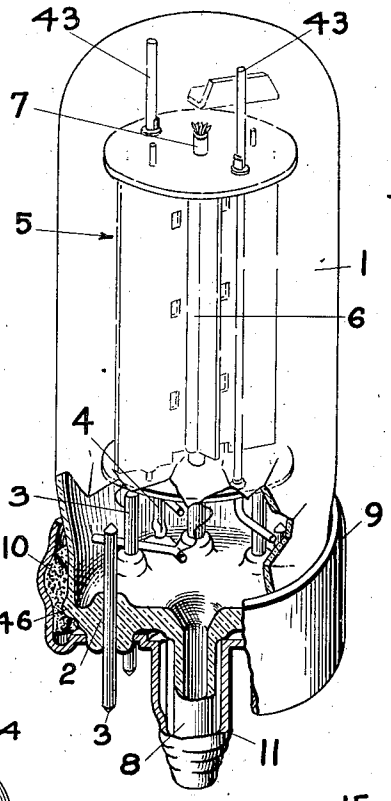


FIG. 1.

FIG. 3.

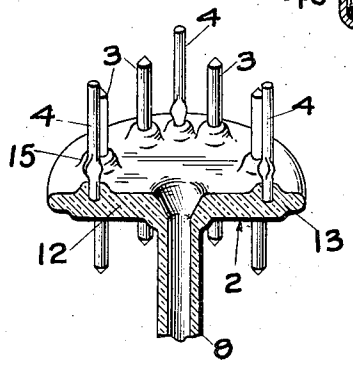


FIG. 4.

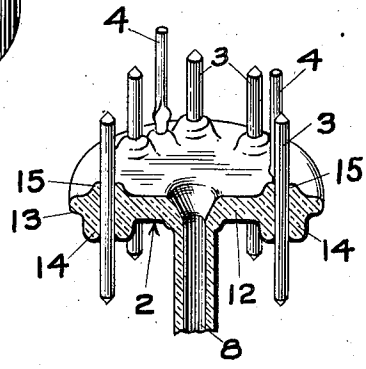
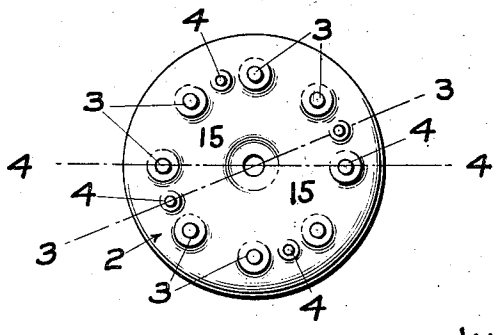


FIG. 2.



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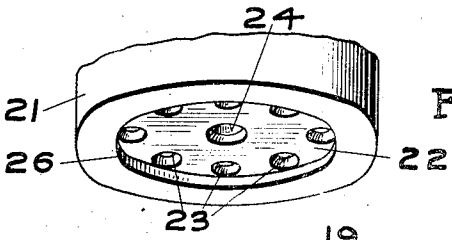


FIG. 5.

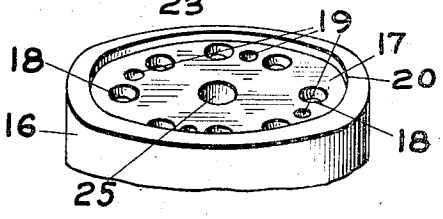


FIG. 6.

FIG. 7.

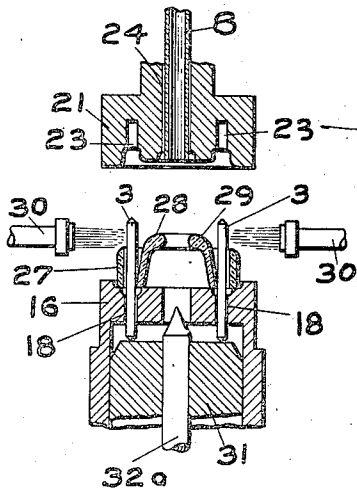


FIG. 8.

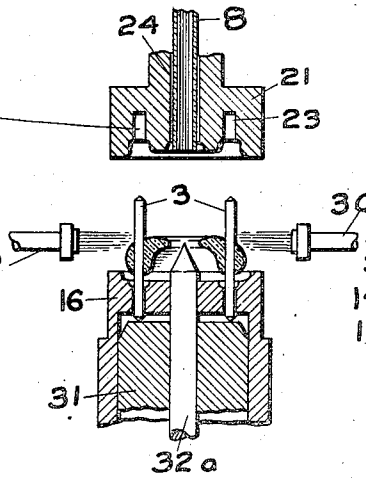
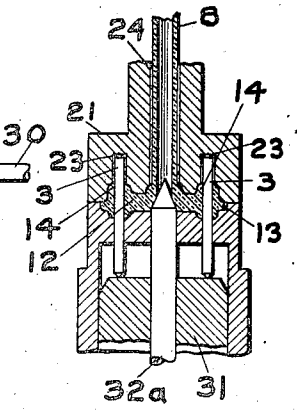


FIG. 9.



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METHOD OF MAKING MOLDED STEMS

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FIG. 10.

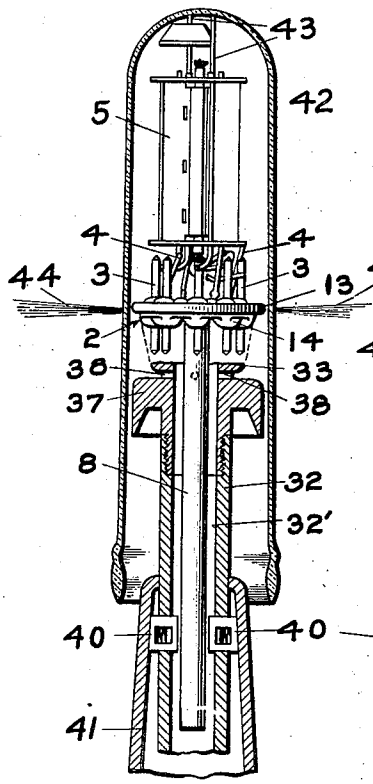


FIG. 11.

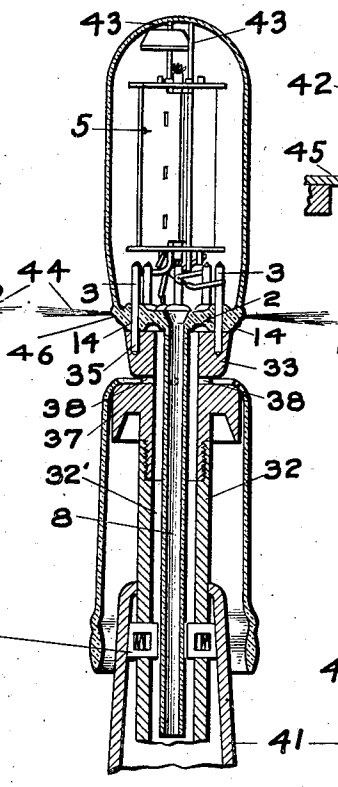


FIG. 12.

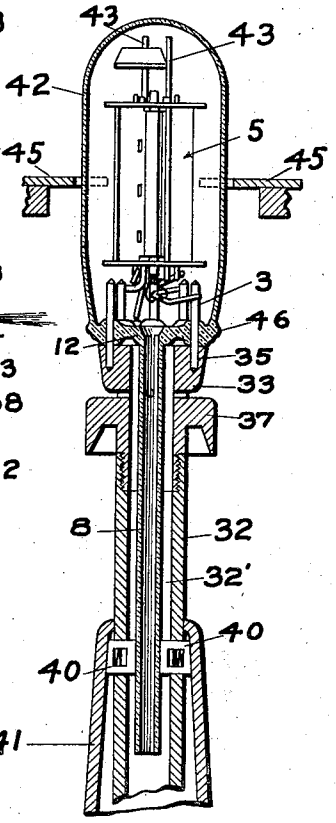


FIG. 13.

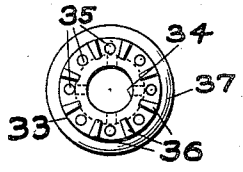
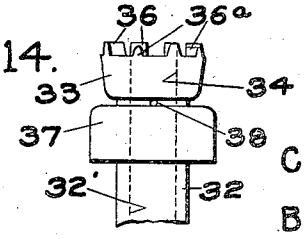


FIG. 14.



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UNITED STATES PATENT OFFICE

2,321,600

METHOD OF MAKING MOLDED STEMS

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Original application February 24, 1939, Serial No. 258,263. Divided and this application April 25, 1939, Serial No. 269,871

5 Claims. (Cl. 49—78)

This invention relates to electrical discharge devices comprising sealed envelopes, such as electron discharge devices and the like, and more particularly to a novel stem and a novel method of making such a stem. This application is a division of my co-pending application, Serial No. 258,263, filed February 24, 1939.

Attempts have been made to produce electron discharge tubes with glass envelopes in which the stem serves as the tube base itself, and which carries lead-in conductors which also serve as the external contact pins. Difficulties have been encountered in constructing a stem which readily could be sealed to the envelope.

An object of this invention is to devise a stem of the foregoing type which can be sealed to an enveloped in a simple, inexpensive and reliable manner.

Another object is to devise such a stem which is inexpensive to manufacture.

A further object is to devise a novel method of making such a stem.

The foregoing and other objects of this invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawings, wherein:

Fig. 1 is a perspective view, partly broken away, of an electron discharge tube incorporating my novel stem;

Fig. 2 is a top view of a stem made in accordance with the present invention;

Fig. 3 is a section taken along line 3—3 of Fig. 2;

Fig. 4 is a section taken along line 4—4 of Fig. 2;

Fig. 5 is a perspective view of the top press block of a machine for molding my novel stem;

Fig. 6 is a perspective view of the bottom press block of such a machine, said figure being placed in juxtaposition to Fig. 5 in order to show their relative operating positions;

Figs. 7, 8 and 9 show essential parts of the machine for molding my novel stem and the successive steps in forming such a stem;

Figs. 10, 11 and 12 show the successive steps in the sealing of the envelope to the stem;

Fig. 13 is a top view of the mount block used in the apparatus of Figs. 10 to 12; and

Fig. 14 is a side view of said mount block.

The tube as illustrated in Fig. 1 consists of a glass envelope 1 having a bottom wall consisting of a stem or base 2. A plurality of lead-in rods 3 are sealed through said stem 2. These lead-in rods are made of some metal which readily seals to the glass of said stem, and may conveniently be made of chrome iron. The lead-in rods 3 are disposed in a circle concentric with the center of the stem 2. These lead-in rods are also rigid so that in the completed form of the tube they serve as the external contact pins adapted to be inserted into a cooperating tube socket. If desired a number of dummy support wires 4 may likewise be sealed into the upper surface of the stem 2. These dummy support wires do not extend through the stem, and therefore need not form an air-tight seal therewith. For this purpose these dummy support wires may be made of a metal which does not make a perfect seal with the glass. They may conveniently be formed of nickel. The usual type of mount 5 is supported by the lead-in rods 3 and the dummy support wires 4. The mount 5 may consist of a plurality of electrodes, for example, an anode 6 surrounding a cathode 7. In order to enable the tube to be exhausted, the stem 2 is provided at its central portion with an exhaust opening communicating with an exhaust tube 8. The bottom of the tube is surrounded by a guard shell 9 held in place on the tube by means of a ring of cement 10. The guard shell 9 is provided with a central tubular member 11 which surrounds and protects the portion of the exhaust tube remaining on the completed tube. The guard shell 9 is provided with sufficiently large openings around each of the lead-in rods 3 so that electrical contact between the shell 9 and the rods 3 is effectively prevented.

The tube, as illustrated in Fig. 1, is adapted to be inserted in a suitable tube socket, the tubular member 11 cooperating with some suitable locking arrangement, and the pins 3 cooperating with suitable contact members in said socket, whereby the proper electrical connections may be made to the electrode elements within the envelope 1.

A tube of the foregoing type presents certain difficulties and requirements if such an arrangement is to be commercially successful. Since the lead-in rods 3 serve as the external contact members for the tube, they must be kept parallel and maintained accurately in their predetermined circular relationship in order that such tubes may fit interchangeably in standard sockets provided therefor. The glass of the stem must not extend too far up or down along the lead-in rods 3. Glass extending down along the lead-in rod 3 might well interfere with the proper insertion of the tube into its socket. Glass extending along said rod 3 in either direction to an excessive degree produces a tendency for cracks to occur at

the lead-in rods. Another requirement is that the stem 2 may be easily sealed to the envelope 1 by the usual type of sealing-in machine. A further requirement is that during this sealing-in process, the main body of the stem 2 carrying the lead-in rods 3 shall not be subjected to any distortion which might tend to upset the requisite positional accuracy of said lead-in rods. Stems made in accordance with my present invention satisfy each of these requirements, and produce a tube which satisfies all of the objects of my invention as stated above.

My novel stem consists of a substantially flat disk of glass having a central thickened portion 12 into which the lead-in rods 3 and the dummy support wires 4 are sealed. This thickened portion must be sufficiently strong to withstand atmospheric pressure exerted on its lower flat surface upon completion of the tube. It must also be thick enough to firmly and definitely support the lead-in rods 3 and the dummy wires 4 without cracking. It also must be sufficiently massive so that during the sealing of the stem to the envelope 1, it is not heated sufficiently to soften to any appreciable extent. I have found that the thickness of this central portion in a particular instance conveniently may be between .080 and .095 of an inch. However, thicknesses as low as .060 might be feasible in some instances. Surrounding the thickened portion 12 is a thinned edge 13. The top of this edge 13 is preferably disposed in the same plane as the top of 12, for reasons which will be explained below. This thinned edge 13 must have a thickness sufficiently less than that of the central portion 12, so that during the sealing-in process it can soften sufficiently to seal readily to the glass envelope 1 without producing any appreciable softening of the central portion 12. I have found that the thickness of the edge 13 conveniently may be made about half of the thickness of the central portion 12. In a particular instance I have used .045 to .055 as a thickness of said edge. In the particular examples which I have cited, the thickness of the wall of the glass envelope 1 was between .030 and .050 of an inch. The stem 2 is preferably formed with a lower boss 14 around each lead-in rod 3, and a smaller upper boss 15 around each of said lead-in rods. The bosses 14 project through the openings in the guard shell 9, and thus maintain said guard shell in its proper position as well as insure against electrical contact between said guard shell and the lead-in rods.

In Figs. 5 and 6 I have shown certain essential features of the machine for molding the novel stem described above. In Fig. 6 there is shown the lower press block 16 which is provided with a central circular depression 17 which forms the lower press mold. The face of the lower press mold is provided with a plurality of holes 18 adapted to receive the rods 3. Said lower press mold is also provided with a plurality of holes 19 which are adapted to receive the dummy support wires 4. The surfaces of the lower press mold around each of the holes 18 and 19 are recessed in order to provide boss-forming surfaces. Around the circular depression 17 is provided a raised edge 20 which forms a stop beyond which the molten glass during the molding operation cannot flow. This edge, therefore, determines the maximum diameter of the edge 13 of the stem. In Fig. 5 is shown the upper press block 21 likewise provided with a central circular depression 22 which forms the upper press mold. This upper press mold is provided with holes 23 only for the rods 3, since as previously indicated the dummy support wires 4 do not extend through the stem 2. The upper press mold likewise is recessed around each opening 23 in order to provide boss-forming surfaces. The upper press mold is provided with a central hole 24 for the purpose of receiving the exhaust tube 8, while the lower press mold is provided with a central opening 25 through which an exhaust port-forming mandrel may project. The upper press block 21 is also provided with a raised edge 26 surrounding the upper press mold depression 22. This raised edge 26 is of smaller diameter than the raised edge 20, and determines the diameter of the central thickened portion 12 of the stem. These differences in diameter likewise form the thinned edge 13 as will be evident from the following description of the mode of manufacture of said stem.

Figs. 7, 8 and 9 show the relative operative positions of the upper and lower press blocks 16 and 21. The lower press block 16 is mounted to rotate in a fixed plane, while the upper press block is suitably mounted to reciprocate in a vertical line above the lower press block. The upper block 21 is also mounted to rotate in synchronism with said lower press block.

The glass for the stem is supplied in the form of two glass rings or collars 27 and 28, which as shown are set upon the lower press block 16, respectively, inside and outside of the circle of holes 18 and 19. The lead-in rods 3 are then threaded into the openings 18, and the dummy support wires 4 are threaded into the holes 19. The inner glass ring is formed, as shown, with the top portion 29 thereof turned in so as to provide a substantial amount of glass already positioned toward the central portion of the stem. This arrangement facilitates the uniform distribution of glass throughout the extent of the stem, and also prevents the melting and sticking of glass onto the rods 3 above the maximum desired height. This latter tends to occur when straight glass rings of the requisite size are used. The turned-in shape of the inner glass ring 28 also facilitates the guiding or threading of the rods 3 and wires 4 into their respective holes 18 and 19. The exhaust tube 8 is also inserted into the opening 24 so as to be in a position to be sealed to the stem.

Heat may be conveniently applied to the glass from gas burners 30 positioned to play on the upper rims of the glass rings. As the glass collars soften, their upper edges flow together and around the lead-in rods and wires to form a plastic mass which adheres to the wires, as shown, for example, in Fig. 8. To sufficiently soften the glass and minimize the tendency of said glass to stick to the lower press mold 16, the lead-in rods 3 and the adherent mass of glass are then raised above the lower press mold 16, as shown in Fig. 8. For this purpose a plunger 31, provided below the lower press block 16, is raised, pushing the lead-in rods and glass upwardly into the direct path of the gas flames. After the mass of glass has become sufficiently plastic, the upper press block is lowered, and with the downward movement of said press block, the molten glass is molded between the two blocks 21 and 16 to form the requisite shape of stem as previously described. The holes 23 in the upper press block 21 are made of limited depth so that, during the above molding operation, they come into contact with the upper ends of the lead-in rods 3. During said

molding operation, the plunger 31 is retracted in synchronism with the downward movement of the upper press block 21. This results in the lead-in rods 3 being pushed through the mass of plastic glass. This motion insures an exact limitation of the degree to which the glass extends along the lead-in rods 3 to form the bosses 14. The resulting form of said bosses, therefore, is usually slightly recessed around the rods 3, as shown more clearly in Fig. 4. This particular step insures a remarkable uniformity of the size and position of said bosses 14. During the foregoing molding operation, the exhaust tube 8, the lower end of which previously has been softened by the application of a gas flame thereto, is brought into contact with the central portion of the plastic mass so as to be sealed thereto. To maintain the opening through the exhaust tube, a mandrel 32a is provided which is raised, as shown in Fig. 9, to confine the molten glass exteriorly of the inner wall of the exhaust tube. The upper press block 21 is then retracted and the completed stem is permitted to cool on the lower press block 16. This permits said stem to free itself from said lower press block, and also insures an accurate alignment of the various elements of the completed stem. The completed stem is then removed from the machine.

After the stem has been completed, the mount 5 is assembled on the lead-in rods 3 and dummy support wires 4. The envelope 1 is then sealed to the stem around the mount, as illustrated in Figs. 10 to 14, inclusive. In these figures there is shown an individual sealing head unit of an envelope sealing machine. As shown, this unit includes a hollow rotatable member 32 carrying a mount block 33 at its upper end. This mount block 33 is partly broken away in Fig. 10. The rotatable member 32 is provided with a central bore 32' through which air is adapted to be blown. The mount block 33 is likewise provided with a central bore 34 communicating with the bore 32'. The mount block 33 is likewise provided with a series of holes 35 which are adapted to receive the pins 3 of a stem. A series of lugs 36 is provided on the mount block 33 between each two holes 35. These lugs are spaced sufficiently far apart so that the bosses 14 of a stem may be received between each pair of lugs 36. Every other lug, as indicated at 36a, is made shorter than the adjacent lug so that when a stem is supported upon said mount block and air is blown through the bore 32', passages are left so that air may flow freely over the bottom face of the stem 2 for a purpose which will be described below. The mount block 33 is provided at the lower portion thereof with an annular shoulder 37. Immediately above said annular shoulder is provided a series of bores 38 which pass from the bore 34 to the exterior of the mount block. The lower portion of the rotatable member 32 is provided with a pair of clutch jaws 40—40 which are normally spring-biased outwardly. A tapered sleeve 41 surrounds the rotatable member 32 and is adapted when moved downwardly to force the clamping jaws 40—40 inwardly.

In order to seal the glass envelope to the stem 2, the stem 2 carrying the mount 5 is inserted on the sealing-in head by inserting the exhaust tube 8 into the bores 34 and 32'. The rods 3 of the stem 2 are received into the holes 35 and the bottoms of the bosses 14 rest upon the face of the block intermediate the lugs 36. Some support also is afforded by the upper edge of each alternate lug 36 engaging the glass of the stem intermediate the bosses 14. The clutch jaws 40 being in their outward position, the exhaust tube 8 is free to slide between them so that variations in length, due to temperature expansion, may readily occur. A cylindrical glass envelope 42 is then applied over the stem and mount as indicated in Fig. 10. This envelope is conveniently positioned by resting against a pair of standards 43 formed as part of the mount 5. Heat is applied by means of suitable gas flames 44 adjacent the thinned edge 13 of the stem 2. This brings about a softening of the glass at this point, causing a gradual constriction toward the stem until contact is made with the thinned edge 13 and fusion of the wall of the envelope 42 and said thinned edge 13 occurs. This constriction is aided by the pressure of the gas flame directed toward the axis of the rotating sleeve in the head unit. In a subsequent position the gas flames are directed to a point slightly below the thinned edge 13, the heat produced being sufficient to cause a melting of the glass. The weight of the lower skirt of the glass envelope 42 tends to cause a separation at the thinned edge 13. In order to assist this separation, air is blown up through the bore 32'. The previous softening of the glass has caused sufficient constriction thereof so as to contact the annular shoulder 37, thus producing a closed pocket between said annular shoulder and the stem 2. The air coming up through the bore 32' and passing through the bores 38 causes an air pressure within this pocket which bursts the plastic glass bubble thus formed and produces the desired separation at the thinned edge 13. The gas flames are continued for a short time around the thinned edge so as to produce a uniform rounding of the glass at the point 46. The sealing-in head then moves out of the region of the gas flames and air is continued to be blown through the bore 32' for a short period. This air passes up through the bore 34 and out through the spaces left by the short lugs 36a as well as other intervening spaces between the stem 2 and the mount block 33. This air, which is relatively cool, cools the body of the stem 2 so as to insure that said body is solid and rigid during the subsequent pull-down operation. This prevents any distortion of the main body of the stem and dislocation of the lead-in rods 3 during said pull-down.

As shown in Fig. 12, a pair of clamping jaws 45 move inwardly and engage the envelope 42 while the tapered sleeve 41 is moved downwardly to force the clutch jaws 40 into clamping engagement with the exhaust tube 8. Relative motion is then produced between the clutch arms 45 and the rotatable member 32 so that the stem 2 is pulled down with respect to the envelope 42. This pull-down produces the requisite working and rounding of the glass at the sealing-in point which is the usual purpose of such a pull-down. Due, however, to the fact that the main body of the stem 2 is rigid and the rods 3 are firmly received in the holes 35, no distortion of said stem or dislocation of the rods 3 takes place during such pull-down. The envelope is now ready for exhaustion which takes place through the exhaust tube 8, after which operation the exhaust tube is sealed off and the guard shell 9 applied as indicated in Fig. 1.

I have found that tubes made in accordance with my invention produce satisfactory seals which have very little tendency to crack at the sealing-in point 46. This is due partly to various aspects of the invention pointed out above in-

volving the thickened central portion 12 and thinned edge 13 of the stem 2. I have found that if the internal surface of the envelope adjacent the sealing-in point 46 (see Fig. 1) is kept free of all sharp bends and a smooth and rounded contour preserved, substantially all tendency to crack at this point will be eliminated. By forming the stem 2 with the thinned edge 13 in the same plane as the upper surface of said stem, this elimination of sharp bends and the preservation of a smooth contour is readily obtained, since due to the particular construction which I have described, when the edge 13 is made plastic during the sealing-in process, the wall of the envelope will fuse to this thinned edge 13 and form a continuation thereof. During the pull-down operation, the thinned edge 13 will have some slight tendency to be bent upwardly, thus producing a smooth transition curve from the thinned edge 13 to the interior walls of the envelope. Since the edge 13 is originally formed as a continuation of the upper surface of the stem 2, this smooth transition will be carried down without break or interruption onto the upper surface of said stem 2, as indicated most clearly in Fig. 1. Even if said edge 13 were not formed in this way, the requisite sealing might still be accomplished with proper precautions. Thus considerable advantage is still obtained from the thinned edge 13 irrespective of its relationship with respect to either surface of the stem 2.

Of course it is to be understood that this invention is not limited to the particular details as described above as many equivalents will suggest themselves to those skilled in the art. For example, in some instances it may be desired to utilize this invention in tubes having the conventional base with additional contacting prongs. Various other changes will suggest themselves to those skilled in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. The method of forming a glass seal which comprises forming a relatively thick substantially flat glass wall member with a relatively thin glass sealing lip projecting from said wall member, and a plurality of lead-in conductors sealed into said wall member, heating the side wall of a glass envelope and said sealing lip to sealing plasticity without appreciably plasticizing said wall member, sealing the outer perimeter only of said sealing lip to the inner plasticized wall of said envelope, cooling said flat wall member while said lip is heated to insure rigidity of said wall member, and producing a pull-down between said flat wall member and said envelope.

2. The method of forming a glass seal which comprises forming a relatively thick substantially flat glass wall member with a relatively thin glass sealing lip projecting from said wall member, and a plurality of lead-in conductors sealed into said wall member, heating the side wall of a glass envelope and said sealing lip to sealing plasticity without appreciably plasticizing said wall member, sealing the outer perimeter only of said sealing lip to the inner plasticized wall of said envelope, cooling said flat wall member while said lip is heated to insure rigidity of said wall member by blowing cool air thereon, and producing a pull-down between said flat wall member and said envelope.

3. The method of forming a glass seal which comprises forming a relatively thick substantially flat glass wall member with a relatively thin glass sealing lip projecting from said wall member, and a plurality of lead-in conductors sealed into said wall member, the top surface of said sealing lip lying in substantially the same plane as the top surface of said wall member, heating the side wall of a glass envelope and said sealing lip to sealing plasticity without appreciably plasticizing said wall member, sealing the outer perimeter only of said sealing edge to the inner plasticized wall of said envelope, cooling said flat wall member while said lip is heated to insure rigidity of said wall member, and producing a pull-down between said flat wall member and said envelope.

4. The method of forming a glass seal which comprises forming a stem with a plurality of lead-in conductors sealed into a wall member, and a glass sealing edge projecting from said wall member, placing an open-ended glass envelope over said stem, sealing said sealing edge to the inner wall of said envelope, bringing the lower side wall of said envelope below said stem into engagement with an annular shoulder to form a pocket between said stem and said shoulder, softening the envelope wall below said stem, and blowing air into said pocket to sever the glass of said envelope below said stem from the rest of the structure.

5. The method of forming a glass seal which comprises forming a relatively thick substantially flat glass wall member with a relatively thin glass sealing edge projecting from said wall member, and a plurality of lead-in conductors sealed into said wall member, placing an open-ended glass envelope over said wall member, sealing said sealing edge to the inner wall of said envelope, bringing the lower side wall of said envelope below said wall member into engagement with an annular shoulder to form a pocket between said stem and said shoulder, softening the envelope wall below said stem, and blowing air into said pocket to sever the glass of said envelope below said stem from the rest of the structure.

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