June 22, 1954 H. D. FRASER 2,682,009

SEAL AND METHOD OF FABRICATION

Filed Dec. 31, 1952

2 Sheets-Sheet 1

Fig. 1.

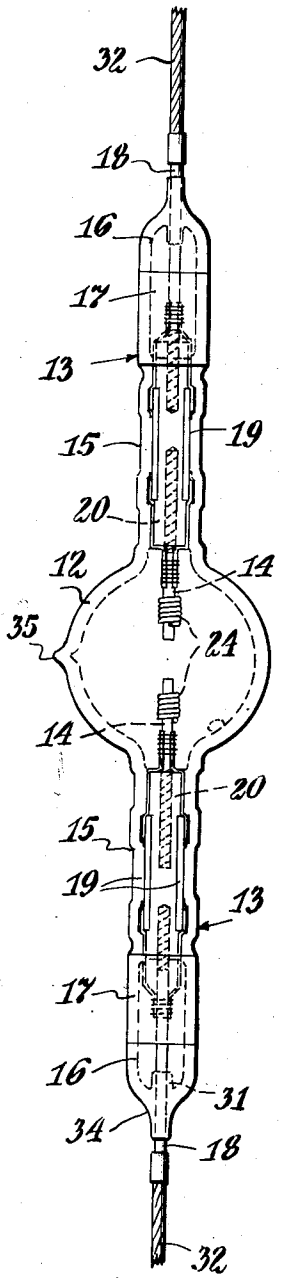


Fig. 2.

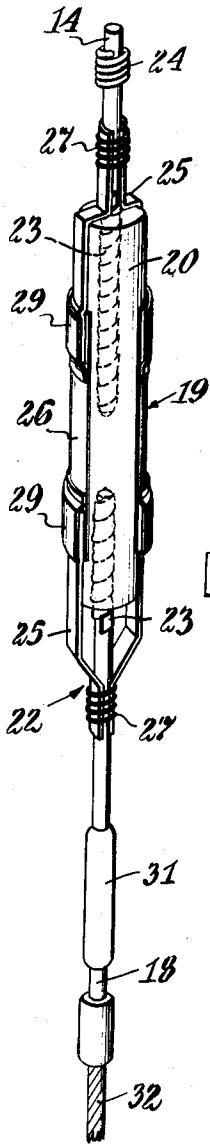


Fig. 11.

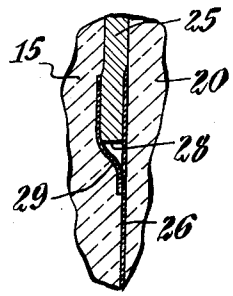
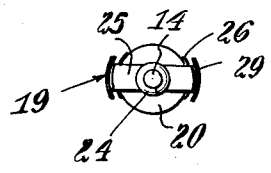


Fig. 4.

Fig. 3.



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2 Sheets-Sheet 2

Fig. 5.

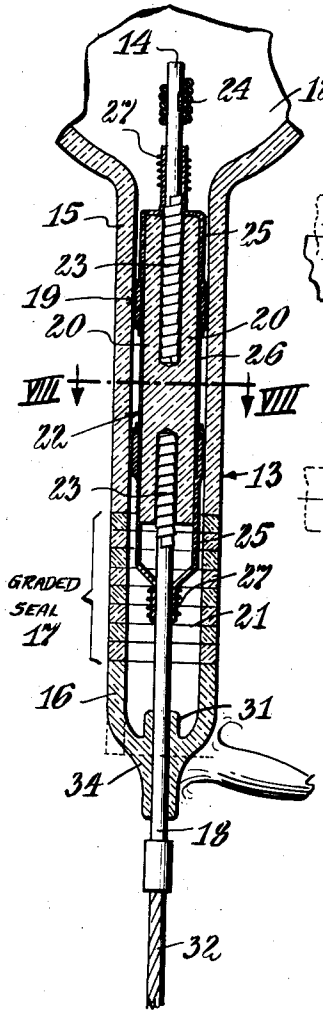


Fig. 6.

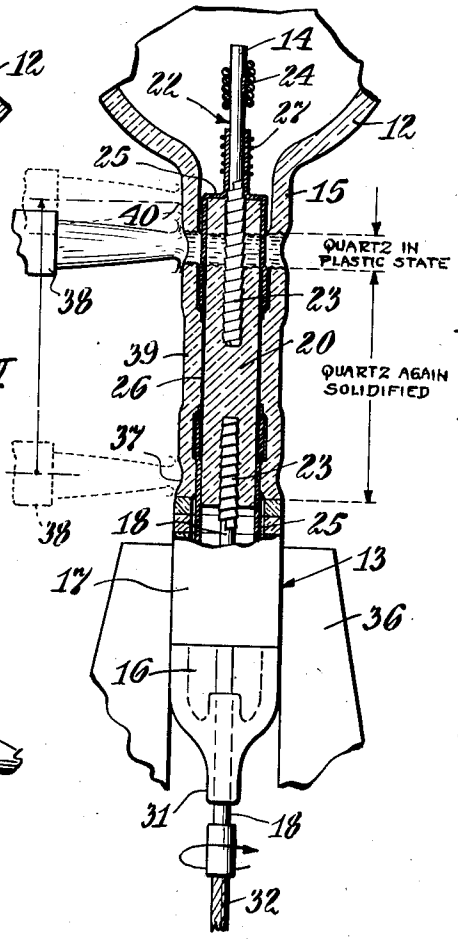


Fig. 7.

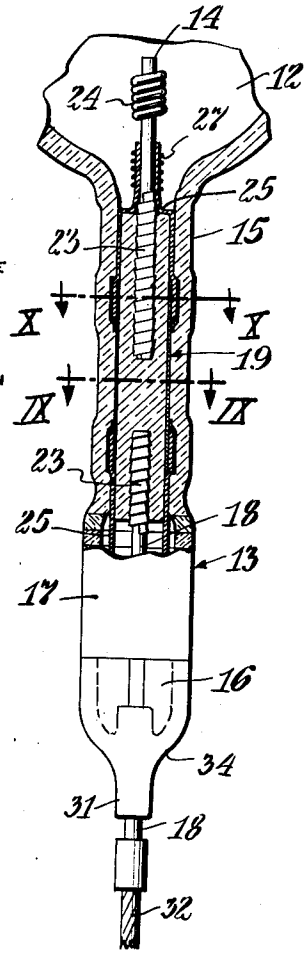


Fig. 8.

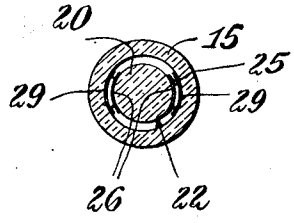


Fig. 9.

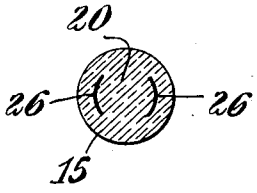
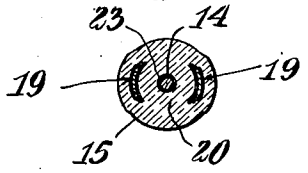


Fig. 10.



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Patented June 22, 1954

2,682,009

UNITED STATES PATENT OFFICE

2,682,009

SEAL AND METHOD OF FABRICATION

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Application December 31, 1952, Serial No. 328,936

2 Claims. (Cl. 313—220)

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My invention relates to seals and, more particularly, to seals for quartz short arc mercury lamps or other quartz lamps which draw high currents and which require conductors of high current carrying capacity, and to the method of making the seal wherein the electrodes of these lamps are maintained in alignment during the sealing operation.

The industry has been faced with the problem of finding a satisfactory seal and in the past, the higher current quartz short arc mercury lamps and other related lamps have been practically impossible to make, except by carefully controlled laboratory methods because of the great difficulty in making a satisfactory seal and in maintaining the lamp electrodes in proper alignment during fabrication of the seal. In addition, whenever relatively higher currents were required, as in the case of short arc mercury lamps of over 500 watts capacity, the thin ribbon conductors would tend to oxidize, thus shortening the useful life of the lamp.

Therefore the principal object of my invention is to provide a seal for a higher current quartz short arc mercury lamp in which the jointure of the ribbon conductors to the lead-in conductors and the ribbon conductors themselves are not subject to oxidation and in which the necessary seals may be made on a production line basis, instead of a complicated, hand-made basis.

A further object of my invention is to provide a method of making the seal wherein the electrodes of the lamp are maintained in proper alignment during the sealing operation.

Still another object of my invention is to provide an electrode assembly for use in the sealing operation which electrode assembly consists of a quartz retaining body with an electrode and a lead-in conductor inserted therein, the inserted portion of the electrode being of considerable length to facilitate the maintenance of the electrode alignment during the sealing operation.

Yet another object of my invention is to provide a ribbon coil around the inserted portions of the electrode and the lead-in conductor, which ribbon serves as a cushion to prevent the quartz from cracking.

An additional object of my invention is to incorporate a graded seal into my sealing arrangement in order to prevent oxidation of the ribbon conductors, especially at their jointure with the lead-in conductors.

Yet another object of my invention is to provide a flap of thin ribbon over the ledge occurring at the jointure of the heavy and the thin ribbons.

The above objects, and other objects which will become apparent as the description proceeds, are achieved by using an electrode assembly comprising a quartz retaining body carrying the electrodes and lead-in conductors in conjunction with a graded seal in fabricating my seal for higher current quartz short arc mercury lamps. Oxidation of the ribbon conductors is prevented by enclosing these conductors in an oxygen-free atmosphere.

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The description of the present invention will be better understood by reference to the drawings which illustrate a preferred embodiment of my invention and in which:

Fig. 1 is a front elevational view of a preferable embodiment of a quartz short arc mercury vapor lamp embodying my seal showing the envelope and two arms with the completed seal;

Fig. 2 is a perspective view of the electrode assembly which is used as a part of my seal and in fabricating my seal, including the lead-in conductor, electrode, and ribbon conductors which electrically connect the lead-in conductor and electrode;

Fig. 3 is a top plan view of the electrode assembly;

Fig. 4 is a front elevational view, partly in section, of a quartz bulb and arms, prior to fabrication of the lamp;

Fig. 5 is a fragmentary longitudinal cross-sectional view of one arm, as shown in Fig. 1, which shows an initial step in fabricating my seal;

Fig. 6 is a fragmentary cross-sectional view of an arm, as shown in Fig. 1, showing a latter stage of fabrication of my seal;

Fig. 7 is a fragmentary cross-sectional view of one arm as shown in Fig. 1, showing the fabricated seal;

Fig. 8 is a cross-sectional view taken along the lines VIII—VIII of Fig. 5 in the direction of the arrows;

Fig. 9 is a cross-sectional view taken along the lines IX—IX of Fig. 7 in the direction of the arrows;

Fig. 10 is a cross-sectional view taken along the lines X—X of Fig. 7, in the direction of the arrows;

Fig. 11 is a fragmentary cross-sectional view of the jointure of the ribbons which electrically connect the electrodes and the lead-in conductors.

The short arc mercury lamp, as illustrated in the drawings, is generally comprised of a substantially spherical vitreous envelope 12, preferably quartz, having two oppositely disposed arms 13 extending outwardly therefrom. Supported within the arms 13 and extending into the lamp envelope are electrodes 14. The arms 13 each comprise three sections, the inner section 15 fused to the quartz envelope being comprised of a glass, preferably quartz, having a low co-

efficient of thermal expansion in order to enable sealing to the quartz envelope. The outer section 16 of the arm 13 is comprised of a glass of relatively high coefficient of thermal expansion, and the intermediate section joining the inner and outer sections is comprised of a graded seal 17. The graded seal 17 consists of a series of glasses running in succession from a low thermal coefficient of expansion glass at its inner end, to match the inner section 15 of the arm 13, to a high thermal coefficient of expansion glass to match the glass of outer section 16. The high coefficient of expansion glass enables a lead-in conductor 18 to be sealed therethrough to provide electrical connection for the electrodes 14. The electrodes 14 and the lead-in conductors 18 are electrically connected by ribbon conductors 19. Fused inside the inner section 15 of the arm 13 is a vitreous retaining body 20, of a low coefficient of expansion glass and readily fusible to said arm, preferably quartz, which becomes an integral part of the inner section 15 on being fused thereby forming an hermetic seal for the lamp envelope 12 and a chamber 21 in the outer end of the arm 13.

The retaining body 20, the electrode 14, lead-in conductor 18, and ribbon conductors 19 constitute an electrode assembly 22, as shown in Fig. 2. The electrode assembly 22 is of such size as to fit snugly into arms 15.

Each electrode 14 and lead-in conductor 18 is supported by and extends into the vitreous retaining body 20. That portion of the electrode 14 which is inserted into the retaining body 20 is of sufficient length to facilitate fabrication of my seal as is hereinafter explained. The portion of each electrode 14 and lead-in conductor 18 which is inserted into the retaining body 20 is wound with a thin ribbon 23 consisting of molybdenum or other suitable material. The purpose of this ribbon 23 is to provide a cushion so that when the seal of my invention is effected, the retaining body 20 of the electrode assembly 22 will not crack. The electrode 14 is preferably comprised of tungsten and may be provided with a coil 24 at its inner end containing a small amount of thorium to facilitate the starting of the lamp, as is common in the art.

The ribbon conductors 19 are preferably comprised of two end sections 25 and an intermediate section 26. The end sections 25 of ribbon conductors 19 are of a heavy type ribbon and are comprised of molybdenum or other suitable material and are preferably of approximately .004'' thickness, although this may vary. The intermediate section 26 of ribbon conductors 19 is of a thin type ribbon and is comprised of molybdenum or other suitable material and is preferably of approximately .0006'' thickness. It has been found that this thickness of .0006'' represents a practical, usable thickness of conductor, if a good hermetic seal is to be maintained between the retaining body 20 and the inner portion 15 of the arms 13. However, this thickness of .0006'' may be increased or decreased, if desired. The inner end section 25 of the conductor 19 is secured to the electrode 14 within the lamp envelope 12 by wires 27 wrapped around and welded to the electrode 14. The outer end section 25 of the conductor 19 is similarly secured to the lead-in conductor 18 within the chamber 21 by wires 27 and by welding.

The end sections 25 and intermediate sections 26 of conductor 19 are welded together forming a ledge 28. Over the ledge 28 is welded a thin flap of molybdenum 29 or other suitable material of a thickness equivalent to the intermediate section 26 of conductor 19. This is illustrated in Fig. 11. It has been found that cracks will form in the low thermal expansion glass, if it is fused onto a ledge of greater than .001'' depth. Since in the disclosed embodiment of my invention the ledge 28 formed by the jointure of the intermediate section 26 and end sections 25 of conductors 19 is over .003'', the flap 29 is used to gradually reduce the gradient and act as a cushion, as shown in Fig. 11, and thus prevent the formation of cracks in the low thermal expansion glass at the ledge 28. The thin intermediate section 26 of conductor 19 cannot be satisfactorily welded or secured to the electrode 14 or the lead-in conductor 18 because the jointure would not withstand the shocks of service due to the fragile character of this very thin ribbon. Thus the heavy type ribbon end sections 25 are required for this jointure, since they will much better withstand the shocks of service. However, the heavy type ribbon end sections 25 have too great a thickness to allow a satisfactory hermetic seal to be effected between the inner portion 15 of the arm 13 and the retaining body 20 of the electrode assembly 22. Thus both the thin and heavy type ribbon sections 25 and 26 are necessary in the preferred embodiment of my invention. The number of ribbon type conductors 19 may vary according to the current at which the lamp is desired to operate.

To facilitate fusing the lead-in conductor 18 to the outer section 16 of the arms 13, a glass bead 31 is slipped over the lead-in conductor 18, as is common in the art. A flexible lead 32 may be attached to the lead-in conductor 18, if desired.

In fabricating my seal, the electrode assemblies 22 are slipped into the arms 13. In the preferable embodiment of my lamp, the two electrode assemblies 22 and the arms 13 are identical. The tips of the electrodes 14 are positioned and then aligned with respect to one another and the envelope 12 is firmly grasped in a chuck. Heat is then applied to the outer section 16 of arm 13 to fuse the outer section 16 of the glass bead 31 on lead-in conductor 18 to make an air-tight seal 34 at the outer end of the arm 13, as shown in Fig. 5. Fig. 8 shows a cross-sectional view of Fig. 5 taken at XIII—XIII in the direction of the arrows and illustrates the air gap which exists between the electrode assembly 22 and the inner surface of the inner section 15 of the arm 13 in this stage of fabrication. The envelope 12 and the arms 13 are then evacuated through an exhaust tubulation 35. An inert gas may be now inserted into the envelope 12 and arms 13, if desired, or the vacuum may be maintained.

The partially assembled lamp is then grasped by a chuck 36 at the outer section 16 and graded seal section 17 of the arm 13. This is illustrated in Fig. 6. Either both ends of the lamp may be simultaneously grasped or the assembly may be grasped at one end by a chuck 36, as shown in Fig. 6 and by another chuck, not shown, at the envelope 12.

The assembly is then rotated and heat applied to the inner portion 15 of arm 13 at a point 37 near the graded seal 18, as shown in Fig. 6. This causes the inner portion 15 of the arms 13 to fuse to the retaining body 20 of the elec-

trode assembly 22 at the point of heat. The heat may be supplied by the gas jet 38, as is common in the art.

The gas jet 38 is moved slowly toward the envelope 12 from point 37 at a rate sufficient to allow the glass under the flame to become plastic and fuse, the inner portion 15 of the arm 13 sinking down onto the retaining body 20 of the electrode assembly 22. It is obvious that when heat is applied at point 37 the electrodes 14 are held rigidly in alignment with respect to one another by the chucks which hold the arms firm, or in the alternative by a chuck 36 holding one arm and another chuck, not shown, holding the envelope 12. As the glass becomes plastic under the flame, this electrode alignment is always maintained by the chucks, as there is always unheated and solidified glass between one chuck and the electrodes, since only one arm at a time is fused and sealed.

As the gas jet 38 is moved upward toward the point 39 at approximately the midpoint of inner section 15 of arm 13, as shown in Fig. 6, the glass surrounding the furthest inserted portion of electrode 14 becomes plastic. Were the electrode 14 not inserted a sufficient amount into the retaining body 20, the plastic glass would allow the electrode being heated to move with respect to the other electrode. However, the inserted portion of electrode 14 is of sufficient length so that some part of the inserted portion of electrode 14 is always surrounded by solidified glass, thus restraining any movement of one electrode 14 with respect to the other electrode.

The heating is then continued up to a point 40 at approximately the inner end of retaining body 20, as shown in Fig. 6, at which time one arm has been fused and sealed, the glass of the inner section 15 of the arm 13 sinking onto the retaining body 20 of the electrode assembly 22. The same procedure is then followed on the other arm. Care must be taken not to seal too closely to the point where the graded seal 17 is fused to the inner section 15 of the arm 13. Likewise, care must be taken not to seal too closely to the envelope 12.

The envelope is now given a final exhaust through exhaust tubulation 35 and the necessary amount of mercury and an inert ionizable gas such as argon is inserted into the envelope, as is common in the art. The exhaust tubulation 35 is then tipped off, as shown in Fig. 1.

Fig. 7 represents an assembly of my seal after the seal has been completed and Figs. 9 and 10 illustrate how the glass of inner section 15 of arm 13 has been sunk down over the conductors 19 and the retaining body 20.

When fabrication of my seal is completed, the chamber 21 is substantially oxygen free, so that when ribbon conductors 19 are heated due to heavy currents or due to heat conducted from envelope 12, there will be no oxidation of the ribbon conductors 19. In order to maintain the oxygen-free atmosphere of the chamber 21, graded seal 17 is necessary to complete the hermetic seal 34 about the lead-in conductor 18. Thus, it is obvious from the foregoing that my seal has been fabricated with no misalignment of the electrodes and with a high coefficient of thermal expansion glass to conductor seal 34, which seal will not admit air to the oxygen-free chamber 21 when the seal 34 is heated by the conduction of heavy currents or by heat from the lamp.

While I have described a specific embodiment

of my invention, it will be understood that modifications may be made within the spirit and scope of my invention.

I claim:

1. A seal for a short arc mercury lamp comprising a quartz envelope having an arm connected thereto, said arm being comprised of a quartz cylinder having an inner and an outer end, a glass tube having a higher coefficient of thermal expansion than said quartz, a tubular graded seal connecting one end of said higher coefficient of expansion glass tube to the outer end of said quartz cylinder, said quartz cylinder being connected at the inner end to said envelope, an electrode part of which is inserted into the inner end of said quartz cylinder, the end of said electrode opposite said inserted part projecting into said envelope, a lead-in conductor part of which is inserted into the outer end of said quartz cylinder, the other end of said higher coefficient of expansion glass tube being fused around said lead-in conductor to form an hermetic seal, a chamber enclosed by the outer end of said quartz cylinder, said graded seal, said higher coefficient of expansion glass tube, and said hermetically sealed lead-in conductor, said chamber having a substantially oxygen-free atmosphere, said envelope having a substantially oxygen-free atmosphere, a ribbon conductor electrically connecting said lead-in conductor and said electrode, and said ribbon conductor being totally enclosed within said chamber, said quartz cylinder and said envelope.

2. A short arc mercury lamp comprising a quartz envelope having two outwardly extending arms connected thereto, each arm being comprised of a quartz cylinder having an inner and an outer end, a glass tube having a higher coefficient of thermal expansion than said quartz, a tubular graded seal connecting one end of said higher coefficient of expansion glass tube to the outer end of said quartz cylinder, said quartz cylinder being connected at the inner end to said envelope, an electrode part of which is inserted into the inner end of said quartz cylinder, the end of said electrode opposite said inserted part projecting into said envelope, a lead-in conductor part of which is inserted into the outer end of said higher coefficient of expansion glass tube being fused around said lead-in conductor to form an hermetic seal, a chamber enclosed by the outer end of said quartz cylinder, said graded seal, said higher coefficient of expansion glass tube, and said hermeticaly sealed lead-in conductor, said chamber having a substantially oxygen-free atmosphere, said envelope having a substantially oxygen-free atmosphere, ribbon conductors electrically connecting said lead-in conductors and said electrodes in each arm, and said ribbon conductors being totally enclosed within said chamber, said quartz cylinder and said envelope.

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