May 10, 1966 J. WILSON ETAL 3,250,941

DISCHARGE LAMP MANUFACTURE

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Fig. 1.

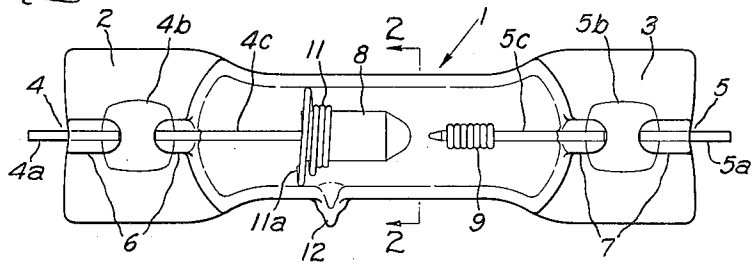


Fig. 3a.

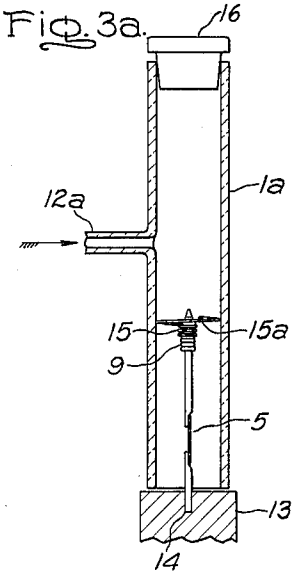


Fig. 3b.

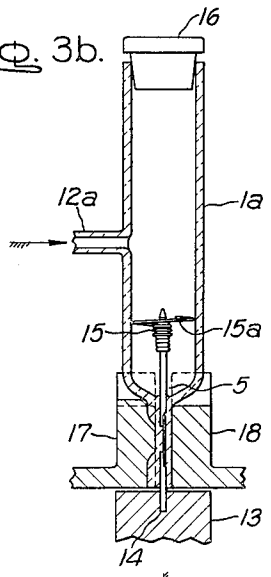


Fig. 4a.

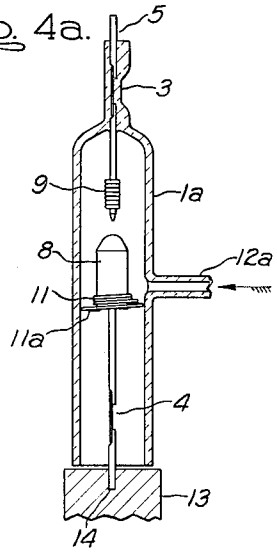


Fig. 4b.

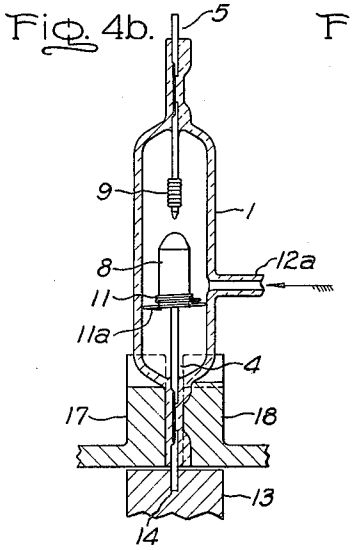


Fig. 5.

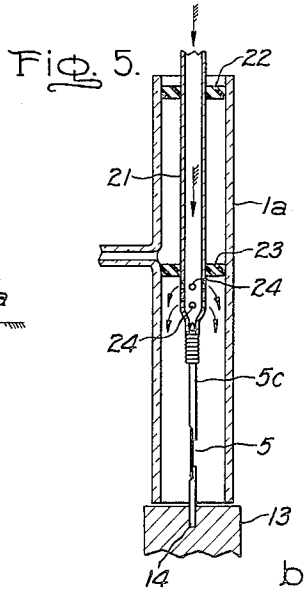
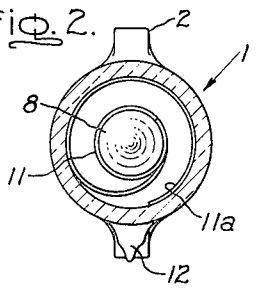


Fig. 2.



Inventors:
John Wilson
Clarence G. Cook
by Ernest W. Legner
Their Attorney

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Fig. 6a.

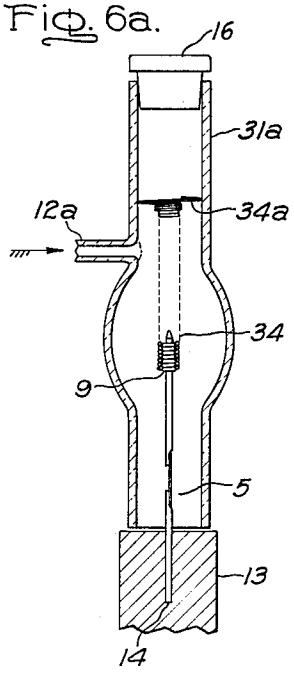
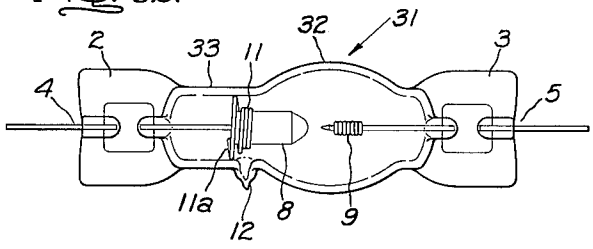


Fig. 6b.



Inventors:
John Wilson
Clarence G. Cook
by Ernest W. Legree
Their Attorney

United States Patent Office 3,250,941
Patented May 10, 1966

3,250,941

DISCHARGE LAMP MANUFACTURE

John Wilson, Mayfield Heights, and Clarence G. Cook, Cleveland Heights, Ohio, assignors to General Electric Company, a corporation of New York

Filed Mar. 1, 1963, Ser. No. 262,009
3 Claims. (Cl. 313—244)

This invention relates to a lamp structure and to a method of manufacture for accurately positioning the electrodes and achieving a precise interelectrode gap or spacing. The invention is particularly useful in connection with short arc or compact source lamps utilizing pinch seals in quartz arc tubes.

An example of a compact source lamp is a high-pressure xenon arc lamp wherein the arc is electrode stabilized between electrodes whose distance apart is less than the distance between the electrode tips and the envelope wall. In such a lamp, accurate alignment and spacing of the electrodes is imperative because otherwise the arc may run off to one side of the anode for instance, causing inefficient light output and arc instability. Also accurate positioning of the electrodes is necessary in order for the lamp to be suitable for use in an optical system which requires a small and precisely placed light source.

Pinch-sealing is the preferred practice in sealing electrode inleads into quartz arc tubes. In pinch sealing, the electrodes within the arc tube are supported on the inner ends of inlead wires of refractory metal such as tungsten or molybdenum, and a thin foliated or foil-like portion is provided between the inner and outer sections of the inlead which is hermetically sealed through the quartz. The sealing is done by pressing or pinching the ends of the arc tube in a heat-softened condition between a pair of opposed jaws which are moved in a direction perpendicular to the plane of the foil portions to press or pinch the quartz flat about them. Such pinch-sealing is described and claimed in Patent 2,965,698, Gottschalk and, being fast and amenable to mechanized operation, has largely supplanted older forms of sealing such as vacuum sealing or graded seals. However, pinch sealing has the disadvantage that as ordinarily practiced it cannot maintain accurate alignment of the electrode-foil assemblies. This is readily understood inasmuch as at the instant when the pinching jaws close on the plastic quartz, the electrode is supported entirely by a thin foil which has insufficient rigidity to withstand any lateral stress.

The objects of the invention are to provide an improved lamp construction and a method of manufacture which maintains electrode alignment in pinch-sealing the inleads.

In copending application Serial No. 228,605 filed October 5, 1962, now Patent No. 3,151,922, of Kenneth S. Preschel and Clifford F. O'Neil, entitled "Discharge Lamp and Method of Making the Same" and assigned to the same assignee as the present invention, there is disclosed and claimed a method for maintaining electrode alignment and spacing during pinch-sealing which involves making the two electrodes as a rigid assembly connected by a knock-out portion. After sealing, the knock-out portion is tapped out with a rod inserted through the exhaust tube. This method is not entirely suitable on direct current lamps in which generally the anode has a much larger mass than the cathode. In addition it requires that the lamp envelope have an exhaust tube at the center of the bulb and in line with the interelectrode gap; the subsequent tipping-off of the exhaust tube leaves an optical defect at a critical place which may not be acceptable for certain optical systems. Therefore, another object of the invention is to provide a lamp construction and method of manufacture which avoids the foregoing drawbacks.

Briefly, in accordance with our invention, electrode alignment during pinch-sealing of the first inlead to be sealed in may be maintained through an internal support bearing against the wall in a tubular region of the envelope, or by supporting the electrode directly through the open end of the arc tube opposite from that being pinched. During pinch-sealing of the second inlead, electrode alignment is maintained by providing an auxiliary electrode support such as a wire coil fastened to the electrode proper or to its shank and engaging the envelope wall in a tubular region which is not heated to plasticity during the pinch-sealing. The wire coil or support is located at such a place that it does not interfere with the optics of the lamp and is merely left in place in the completed lamp. Preferably the more massive anode electrode is sealed in last and the coil stays in its shadow relative to the arc; also the coil provides additional support to the heavier anode as a safeguard during handling or in abusive service.

Further objects and advantages of the invention will appear from the following description of a preferred embodiment to be read in conjunction with the accompanying drawings wherein like reference symbols denote corresponding parts throughout the several views.

In the drawings:

FIG. 1 illustrates a compact source lamp embodying the invention.

FIG. 2 is a cross section along line 2—2 of FIG. 1 illustrating particularly the wire coil support.

FIGS. 3*a* and 3*b* illustrate successive stages in pinch-sealing the first electrode into the lamp.

FIGS. 4*a* and 4*b* illustrate successive stages in pinch-sealing the second electrode into the lamp.

FIG. 5 illustrates an alternative arrangement for supporting the first electrode at pinch-sealing.

FIG. 6*a* illustrates the first stage in pinch-sealing a modified form of lamp and FIG. 6*b* illustrates the finished lamp.

Referring to the drawings and more particularly to FIGS. 1 and 2, the illustrated compact source lamp comprises a generally tubular envelope **1** which suitably is made of quartz or quartz-like glass. The ends of the tube are sealed by full diameter pinch-seals **2**, **3** through which pass respectively inleads **4**, **5**. Each inlead comprises an outside terminal portion indicated **4***a*, **5***a*, suitably of tungsten wire; a thin intermediate foil portion with feathered edges indicated **4***b*, **5***b*; and an inner electrode supporting portion indicated **4***c*, **5***c*, likewise suitably of tungsten wire. The intermediate foil portions **4***b*, **5***b* are preferably of molybdenum with the edges feathered down either by rolling or by chemical etching. The hermetic seals to the quartz are made at the foil portions. The outer and inner wire portions of the inleads are welded to the foil portions, and the quartz of the pinch-seal is thickened or relieved over the welds, as indicated at **6**, **7** for greater mechanical strength.

The anode **8** is a bullet-shaped tungsten body mounted on inner lead portion **4***c* and having a generally conical rounded nose. The illustrated cathode **9** is formed by wrapping a tungsten wire coil around the front end of inner lead portions **5***c* and may be activated by alkaline earth interoxides including barium as a coating and as a filling in the interstices of the coil. Inasmuch as the anode is more massive and heavier than the cathode, the pinch-seal of the cathode inlead is preferably made first and the auxiliary support which remains in the arc tube is used in pinch-sealing the anode inlead. As illustrated, it consists of a springy wire coil **11** having several smaller turns wrapped tightly around the anode body and a single expanded turn **11***a* which bears against the tubular envelope wall, thus resiliently interengaging the anode and the wall. Preferably the expanded turn is located to

the rear so as to be completely in the shadow of the arc occurring between the electrode tips. The lamp is exhausted and provided with a suitable ionizable filling, such as xenon at a pressure of a fraction of an atmosphere to several atmospheres, through an exhaust tube which leaves a tip **12** in the envelope wall after tipping off. The exhaust tip is quite removed from the vicinity of the interelectrode gap where the arc occurs and so does not cause an objectionable optical defect.

In the preferred method of manufacturing the lamp, the cathode electrode is pinch-sealed in first. As illustrated in FIG. 3*a*, a straight-bore quartz tube **1** having a lateral exhaust tube **12***a* is supported vertically with its lower edge just clearing the face of a vertical spindle **13**. The means for holding the quartz tube have not been illustrated but they may consist of pivotable jaws on a vertically slidable head which is raised or lowered to adjust the clearance between the lower edge of the quartz tube and the spindle **13**; suitable apparatus of this kind is described in Patent 2,965,698, Gottschalk. The outer terminal portion of electrode inlead assembly **5** is accommodated in a cavity at **14** in the face of the spindle so that the assembly extends up vertically into the quartz tube. A wire coil **15** is wrapped around the cathode coil **9** and has an expanded diameter turn **15***a* which bears resiliently against the inside wall of the quartz tube. Although the foil portion **5***b* does not have enough stiffness to resist bending against lateral pressure, it will support the cathode assembly and will not collapse so long as the wire coil **15** maintains the axial alignment of the cathode.

The upper end of the quartz tube is closed by a suitable stopper such as a transite plug **16** and nitrogen is fed into the arc tube through exhaust tube **12***a* during the pinch-sealing operation in order to protect the electrode assembly from oxidation. The lower end of the tube is heated to a brilliant white heat by suitable burners feeding mixed jets of hydrogen and oxygen. As the quartz becomes plastic, it begins to neck down by surface tension and at this instant the burners are withdrawn and pinching jaws **17, 18** are actuated to press together the quartz walls of the tube about the inlead, as illustrated in FIG. 3*b*. The faces of the jaws are suitably shaped to provide the desired cross section to the pinch seal including the reliefs **6, 7** about the wire portions. The expanded turn **15***a* bears against the tube wall above the region which is softened by heat. During the pinching operation, the foil may readily become distorted and of course it could not of itself maintain the electrode in alignment. However, in accordance with the invention, the electrode alignment is maintained by the wire coil **15** and as the jaws **17, 18** come together, the foil is straightened out and this restores the electrodes to its proper axial position. After cooling below oxidation temperature, the plug **16** is removed and the wire coil **15** is disengaged from the electrode and removed.

The next step consists in sealing in the anode inlead assembly. The quartz tube is reversed, the cathode end which has been pinch-sealed being now held uppermost and the lower edge of the tube just clearing spindle **13** as illustrated in FIG. 4*a*. The anode inlead assembly **4** is positioned with the outer terminal portion **4***a* in the cavity **14** in the spindle and with wire coil **11** maintaining the alignment of the anode body within the quartz tube. As before, nitrogen is supplied through exhaust tube **12***a* in order to prevent oxidation, the lower end of the quartz tube is heated to plasticity and the jaws **17, 18** then close to collapse the quartz walls together about the inlead and form the pinch-seal. The wire coil **11** is left in place but since it is situated at the outer end of the anode well back from the nose, it does not interfere with the arc nor with the optical system in which the lamp is used.

FIG. 5 illustrates a variant in the method of the invention which may be used in pinch-sealing the first electrode inlead assembly, preferably the cathode for the reasons previously stated. The cathode is maintained in alignment within the quartz tube by means of a metal tube **21** which extends down through the open end of the quartz tube and engages the tip of the inner cathode wire **5***c*. The metal tube **21** is held in position by a suitable jig (not illustrated in the drawing) and spacers or centering discs **22, 23**, suitably of transite, to assure more accurate alignment and centering of the metal tube **21** within the quartz tube. Nitrogen to prevent oxidation of the electrode assembly may be supplied through the metal tube **21** and issues through the apertures **24** below the lower centering disc **23** which also serves as a stopper. The nitrogen flow is indicated by the arrows. The pinch-seal is formed in the same manner as described heretofore by heating the lower end of the quartz tube to plasticity and causing the jaws **17, 18** to close together. The pinch-sealing of the anode electrode inlead assembly is then performed in the same manner as previously described.

FIGS. 6*a* and 6*b* illustrate another form of compact source lamp embodying the invention but differing in that the quartz envelope **31** is provided with a spherical or bulbous portion **32** centered generally about the interelectrode gap between the nose of the anode **8** and the tip of the cathode **9**. This bulb configuration has been found desirable with compact source xenon lamps having a cold filling pressure of several atmospheres in order to prevent arcing from the tip of the cathode, along the quartz wall, and over to the expanded turn **11***a* of the support coil around the anodes. The bulbous portion lengthens the discharge path along the wall and prevents this from happening. The lamp is intended to be mounted within a sealed reflector along the optical axis and, for this reason, it is desired to make it as short compact as possible. Therefore, a tubular portion **33** is provided in the lamp envelope at the anode end only, substantially none being provided at the cathode end. With such an envelope configuration, it is no longer practical to utilize the wire coil **15** of FIG. 3*a* or the centering disc **23** of FIG. 5 for maintaining alignment of the cathode at pinch-sealing.

According to another feature of the invention, alignment of the cathode is maintained through the use of an axially elongated temporary coil support **34**. As illustrated in FIG. 6*a*, coil **34** is screwed over the cathode coil **9** and extends clear through the bulbous part of the envelope up to the tubular portion where an expanded diameter turn **34***a* bears against the envelope wall. The pinch seal is then formed in the same manner as described heretofore by heating the end of the quartz tube to plasticity and causing the jaws **17, 18** to close together. Coil support **34** is then removed and pinch sealing of the anode electrode inlead assembly performed in the usual manner, resulting in the lamp illustrated in FIG. 6*b* wherein the anode inlead assembly extends through the tubular portion of the envelope and the arc gap is substantially centered in the bulbous portion. The coil support **11** is located at the rear end of the anode body and the expanded turn **11***a* bears against the tubular portion **33** of the envelope wall. The entire support is located in the shadow of the arc and so does not interfere with the optics of the lamp. The lamp or arc tube is mounted in a reflector to extend along the optical axis with the shorter cathode end towards the reflector.

While a wire coil has been described and illustrated as the preferred means for maintaining the alignment of the electrodes, it will be appreciated that other forms of supporting devices may be used. The electrode itself may be provided with portions which engage the wall of the quartz tube in an area where it does not become heated to plasticity, in order to maintain the desired alignment. The invention is of course most useful with compact source or short arc gap lamps but it may find application in any lamp manufacture wherein it is necessary to

maintain alignment and precise positioning of the internal electrode structure.

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

1. A compact source lamp comprising a vitreous envelope having a tubular portion, pinch seals at opposite ends of the envelope through which extend inleads each including a foil portion hermetically sealed through the pinch seal and a rod-like portion projecting into the envelope, electrodes having their outer ends attached to the inner ends of said rod-like portions and defining a short interelectrode gap, the foil portion associated with at least one of said electrodes being insufficiently rigid to support the electrode vertically, and at least one support member comprising a wire coiled around said one electrode at its outer end and having an expanded turn bearing against the wall of said vitreous envelope at said tubular portion.

2. A compact source lamp comprising a tubular quartz envelope, pinch seals at opposite ends of the envelope through which extend inleads each including a foil portion hermetically sealed through the pinch seal and a rod-like portion projecting into the envelope, a cathode and a relatively massive bullet-shaped anode having their outer ends attached to the inner ends of said rod-like portions and defining between them a short interelectrode gap, the foil portion associated with said anode being insufficiently rigid to support the anode vertically, and a support member formed of a wire coiled tightly around the outer end of the anode and having an expanded turn bearing against the wall of said envelope.

3. A compact source lamp comprising a quartz envelope having a bulb portion and a tubular portion, pinch seals at opposite ends of the envelope through which extend inleads each including a foil portion hermetically sealed through the pinch seal and a rod-like portion projecting into the envelope, a cathode and a relatively massive bullet-shaped anode having their outer ends attached to the inner ends of said rod-like portions and defining between them a short interelectrode gap located within said bulb portion, the anode inlead extending through said tubular portion, the foil portion associated with said anode being insufficiently rigid to support the anode vertically, and a support member formed of wire coiled tightly around the outer end of the anode and having an expanded turn bearing against the wall of said envelope at said tubular portion.

References Cited by the Examiner

UNITED STATES PATENTS

2,765,420	10/1956	Martt	313—184
2,864,025	12/1958	Foote et al.	313—279
2,876,377	3/1959	Retzer et al.	313—184
2,935,783	5/1960	Hergenrother et al.	29—25.16
3,068,548	12/1962	McCullough et al.	29—25.16
3,113,234	12/1963	Schlegel	313—184
3,132,278	5/1964	Collins et al.	313—279 X
3,168,668	2/1965	Rexer	313—184

GEORGE N. WESTBY, *Primary Examiner.*

D. E. SRAGOW, R. JUDD, *Assistant Examiners.*