Sept. 12, 1967 J. WILSON 3,341,731

REFLECTOR ARC LAMP WITH ARC TUBE SUPPORT COMPRISING ARC TUBE INLEAD CONNECTORS FASTENED TO THE OUTER END OF FERRULES SEALED IN THE OUTER ENVELOPE

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Fig. 1.

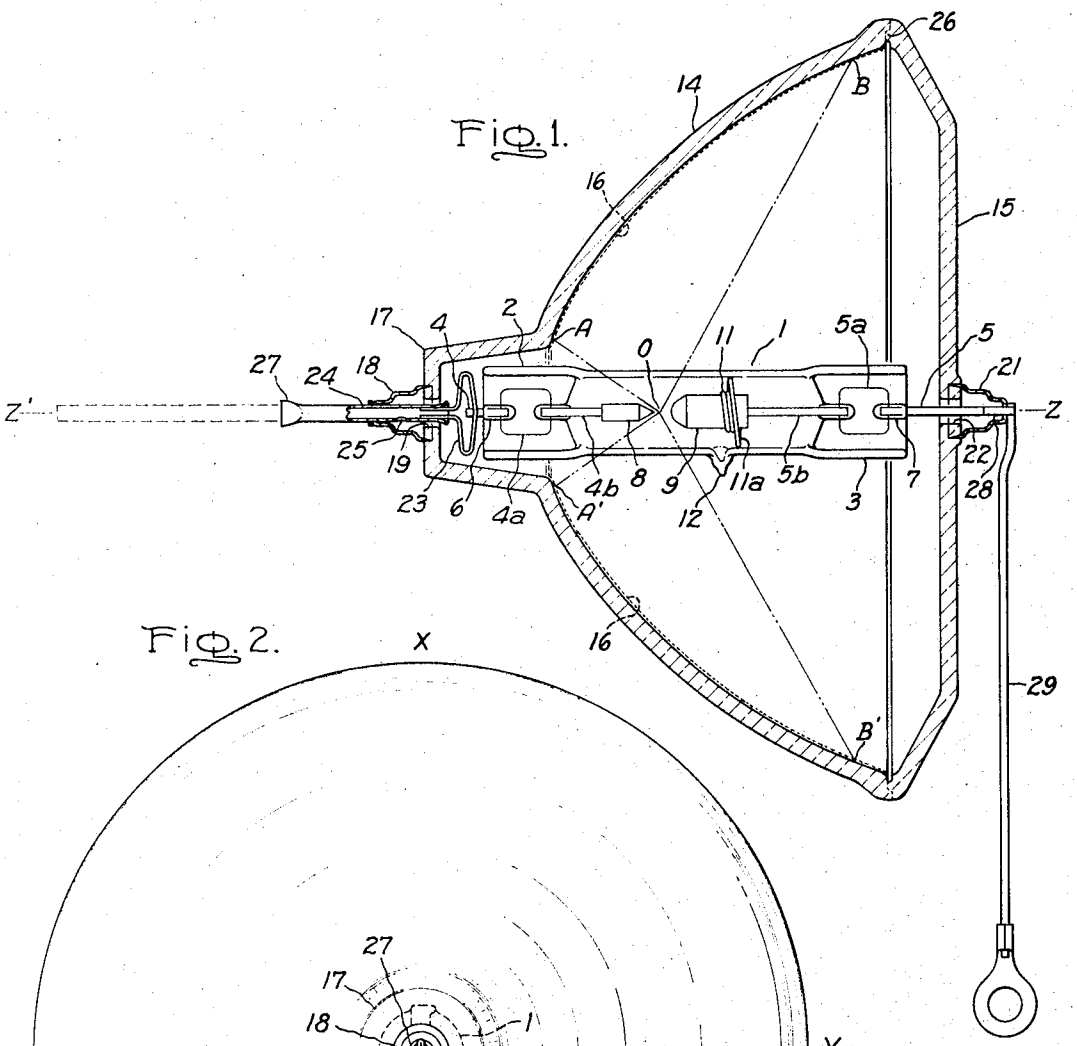


Fig. 2.

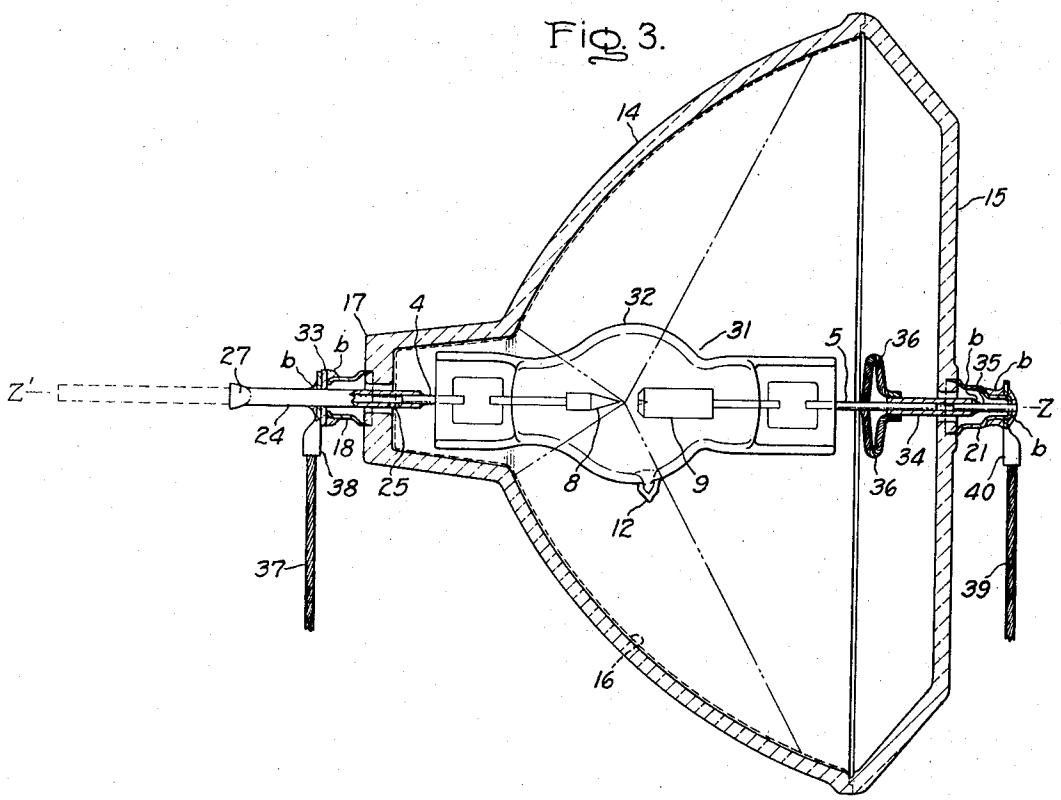
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Fig. 3.



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REFLECTOR ARC LAMP WITH ARC TUBE SUPPORT COMPRISING ARC TUBE INLEAD CONNECTORS FASTENED TO THE OUTER END OF FERRULES SEALED IN THE OUTER ENVELOPE

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10 Claims. (Cl. 313—113)

This invention relates to a high pressure gas arc lamp of a reflector type wherein the arc tube is mounted in a sealed vitreous reflector. The invention is more particularly concerned with the mounting arrangement for the arc tube and with the means for positioning the arc gap at the focus of the reflector. The present application is a continuation-in-part of my copending application Ser. No. 336,187, filed Jan. 7, 1964, similarly titled and now abandoned.

Reflector type discharge lamps as known up to the present have usually been rather large in physical dimensions and have not been required to meet stringent specifications in respect of focusing accuracy or performance. For the usual lighting applications, this creates no problem. The present invention however is concerned with a gas arc, specifically xenon, reflector lamp intended for use as the light source in projection systems and is subject to severe specification requirements in respect of maximum size and accuracy of focus.

An object of the invention is to provide a new and improved reflector type arc lamp featuring a mounting arrangement for the arc tube within the vitreous reflector permitting small size in the components while achieving accuracy of focal adjustment, eliminating the possibility of arc-over between support wires or inleads to the arc tube, substantially avoiding or reducing the shadows cast by support wires, and able to withstand repeated temperature cycling. Another object is to provide a convenient method of assembling and focusing such lamp.

In order to have the arc tube accurately focused in the reflector envelope, its inleads are fixed after focusing, one through the reflector and the other through the front cover glass or lens, and provide the entire support for the arc tube. In a preferred embodiment wherein the arc tube is of quartz and contains xenon, the reflector is provided with a rearwardly projecting neck portion in which the cathode pinch seal of the arc tube is accommodated. A ferrule is sealed to the end wall of the neck portion and another ferrule is sealed in the center of the lens, both ferrules being located substantially on the optical axis and providing passageways into the reflector envelope. After the arc tube has been accurately focused, its inleads are attached by brazing to the ferrules at their outer extremities which are accessible from the outside. This arrangement provides a compact design which permits accurate focusing, and avoids the shadow which an internal support wire extending alongside the arc tube would create.

For further objects and advantages and for a better understanding of the invention, attention is now directed to the following description of a preferred embodiment to be read in conjunction with the accompanying drawing. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

FIG. 1 is a sectional side view of a reflector xenon arc lamp embodying the invention.

FIG. 2 is a view of the same lamp looking at the back of the reflector.

FIG. 3 is a sectional side view of a similar lamp embodying a preferred form of the invention for withstanding temperature cycling.

Referring to FIGS. 1 and 2 of the drawings, the illustrated lamp comprises an internal generally tubular arc

tube 1 made of quartz and having its ends sealed by confined pinch seals 2, 3 through which pass respectively composite inleads 4, 5. In addition to the externally projecting terminal portion, each inlead includes a thin intermediate foil portion indicated 4*a*, 5*a* and an inner electrode supporting portion indicated 4*b*, 5*b*. The intermediate foil portions 4*a*, 5*a* are preferably of molybdenum with the edges feathered down and make the hermetic seals to the quartz. The outer wire portions of molybdenum and the inner wire portions of tungsten are welded to the foil portions; the quartz of the pinch seals is thickened or relieved over the welds, as indicated at 6, 7, for greater mechanical strength.

The cathode 8 is a thoriated tungsten cylindrical body having a conical nose mounted on inlead portion 4*b*. The anode 9 is a larger cylindrical body of tungsten having a rounded nose and mounted on inlead portion 5*b*. The arc tube may be made according to the teachings of copending application Ser. No. 262,009, filed Mar. 1, 1963, of myself jointly with Clarence G. Cook, entitled Discharge Lamp Manufacture, and assigned to the same assignee as the present invention. As described therein, in order to maintain electrode alignment during pinch-sealing, the cathode inlead is sealed in first and alignment of the cathode is maintained by means of an internal support which engages the cathode and bears against the wall of the envelope. The support is then removed and during pinch-sealing of the anode inlead, alignment is maintained by 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 envelope wall. This coil is left in place in the sealed arc tube and, as illustrated, is prefearbly located towards the rear of the anode body in order 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 arc tube is mounted with its axis coinciding substantially with the optical axis of a concave vitreous reflector 14 which, in combination with a cover glass or lens 15 peripherally sealed thereto, forms a closed container or jacket for the arc tube. Cover glass 15 is ordinarily referred to as a lens, even though in the present instance it has no optical function and consists of plain glass. At least over the surface of revolution formed by revolving the angle AOB about the Z axis, the reflector is elliptical with one focus of the ellipse located at the point O. The surface of revolution AB–A'B' is coated with a light-reflective coating 16, either a metallic mirror film or a multiple layer optical coating which focuses the light to the other or second focal point of the ellipse. By way of example, the second focus may be located a distance of approximately 10" in front of lens 15. When a multiple layer optical coating is used, it may be one comprising a plurality of interference films which, by proper combination of film thicknesses and of high and low refractive index film materials, reflect visible light while transmitting heat or infrared radiation. Such films are known and are characterized by a lustrous or metallic reflection in the visible range of the spectrum followed by a relatively great transparency in the infrared. By using such an optical coating, the heat projected to the second focus of the elliptical reflector is greatly reduced without appreciable reduction in useful light.

The quantity of light which a reflector collects and redirects is dependent upon the solid angle which the reflecting surface subtends at the focus, in this case the integrated solid angle made by revolving angle AOB about the Z axis. For a large subtended angle, it is necessary to make the distance between the vertex of the ellipse and

the focus as small as possible. The vertex is the point where the curved elliptical surface BAA'B' if continued would intersect the Z axis. However, the arc tube cannot be reduced in physical size below a certain point and it must be mounted along the axis of the reflector with its brightest spot at the focus O. The brightest spot, which is also known as the cathode hot spot, is a point at about ⅓ the distance from the cathode tip to the anode tip.

A relatively large arc tube is accommodated within a reflector of comparatively small size by providing on the reflector a rearward protuberance or neck portion **17** in the region of the vertex to accommodate the cathode pinch seal **2** of the arc tube. At the center of the end wall of the neck, a metal thimble or ferrule **18** is fusion-sealed in place by embedding its feathered edge in the glass. Ferrule **18** surrounds an aperature **19** in the end wall of the neck on the Z axis; a similar ferrule **21** is provided in the center of lens **15** surrounding an axial aperture **22**. The arc tube is mounted in the reflector with the cathode inlead connector extended out into reflector ferrule **18** and the anode inlead connector extended out into lens ferrule **21**. The cathode inlead **4** is welded to the center of a bow-shaped connector lead **23** whose ends are brazed together into a copper tube **24** which extends through aperture **19** and reflector ferrule **18** and is brazed to the latter. Connector lead **23** by reason of its shape and of its small diameter allows for expansion of the arc tube during operation of the lamp. Copper tube **24** is provided with a side hole at **25** and is used to pass nitrogen into the reflector during sealing of lens **15** to reflector **14**. The reflector and lens have a mating ridge and groove shown at **26** to facilitate seating of the parts prior to heat-sealing. Tube **24** also serves as an exhaust tube for evacuating the sealed bulb and filling it with nitrogen at about ½ atmosphere. Tube **24** is then pinched off at **27** by a cold weld and thereafter it serves as the electrical lead to the cathode end of the lamp.

A short length of alloy wire **28** is welded to anode inlead **5** and brazed to lens ferrule **21**. Outer lead **29** extending in a radial direction along lens **15** is brazed to lens ferrule **21**. By having the anode outer lead outside the reflector, the need for an internal support wire extending alongside the arc tube within the reflector is eliminated and the shadowing effect which results from its presence is avoided. Outer lead **29** does not create a shadow in the ordinary sense of the word but merely obstructs some of the light which otherwise would go to the second focus. Since the amount of light which outer lead **29** obstructs is in proportion to the area of the lead relative to the area of lens **15**, the amount involved is insignificant.

Among other advantages, the mounting arrangement in accordance with the invention holds the arc tube much more securely than would conventional twin support wires passing out through the base or neck of the reflector. When a high voltage pulse is required for starting the arc tube, there is no danger of arc-over between leads. The arc is not attracted to one side by the magnetic field created by current in a support wire extending alongside the arc tube and in proximity to it. Such magnetic deflection becomes more serious at higher currents and when the arc tube is operated in a horizontal position.

One method for mounting the arc tube within the reflector and assembling the cover to the reflector is as follows. The bow-shaped connector lead **23** is silver-brazed to copper tube **24** at its double end and is welded to cathode inlead **4** at the midpoint of the bow. A short length of alloy wire **28** is welded to the end of the anode inlead **5**. All welding is done in such a manner that the external leads of the arc tube lie along its longitudinal axis passing through the cathode tip. By so doing, the cathode tip is located about at the optical axis of the reflector when are arc tube is mounted in place. Minimum adjustment is then required to bring the cathode hot spot into focus in the XY plane of the reflector. An oversized hole in the reflector ferrule **18** allows the arc tube to be moved in the XY plane. Final focusing of the lamp is done by moving the arc tube along the Z axis, that is along the reflector axis. Focusing is done by operating the lamp in a jig and adjusting the arc tube for maximum brightness at the second focus of the elliptical reflector, brightness being measured by a photocell located at the second focus.

After completion of the focusing, copper tube **24** is brazed to reflector ferrule **18**, a copper washer being used to reduce the opening between the tubing and the hole through the ferrule at brazing. The arc tube and the reflector are now permanently fastened together and henceforth care must be exerted not to jar the assembly and alter the adjustment. The lens **15** is next sealed to the reflector, nitrogen being passed into the reflector during sealing to prevent oxidation of the lamp leads and also to prevent the lens or cover from collapsing due to the heat of the sealing fires. Alloy wire **28** which is welded to the anode inlead **5** and outer lead **29** is then silver-brazed to lens ferrule **21**. Finally, the envelope is exhausted to remove any contaminants and filled with nitrogen at one-half atmosphere pressure; copper tube **24** is then pinched off at **27** by means of a cold weld.

In the improved lamp construction illustrated in FIG. **3**, arc tube **31** is generally similar to arc tube **1** of FIG. 1 and like reference numerals denote corresponding parts. The arc tube has an expanded bulbous portion **32** to allow higher loading without over-heating and softening the quartz. Alignment and spacing of the electrodes may be achieved in the manner described in application Ser. No. 512,943, filed Dec. 10, 1965, of Klaus Gottschalk jointly with myself, entitled Compact Source Discharge Lamp Manufacture and assigned to the same assignee as the present invention. Briefly stated, a recess (shown dotted) is provided in the face of anode **9** in which the tip of cathode **8** is engaged prior to sealing in order to maintain the electrodes in alignment during sealing. After sealing, one end of the tube is heated to plasticity and the tube is stretched to disengage and draw apart the electrodes and set the arc gap.

Cathode inlead **4** at the rear end of the arc tube is welded directly into exhaust tube **24** which passes through an oversize aperture in reflector ferrule **18** and is brazed thereto with a copper washer **33** blocking the margin of the hole. Prior to brazing, the oversize aperture or hole permits movement of the exhaust tube in the XY plane normal to the Z axis in order to focus the arc tube. At the front end of the arc tube, anode inlead **5** is engaged in one end of a copper sleeve **34** in which it makes a sliding fit. A short wire piece **35** is welded in the other end of sleeve **34** and passes through a hole in the end wall of lens ferrule **21** to which it is brazed. Wire piece **35** does not require an oversize hole through the ferrule and fit which does not bind but snug enough to reduce gas leakage is preferred. In this way, prior to brazing, pivotal movement and sliding of the inlead connector at the front end of the arc tube may take place during focusing. After brazing, anode inlead **5** is constrained to the reflector axis but is free to move along the axis to accommodate expansion or contraction of the arc tube, by sliding relative to sleeve **34**. A pair of flexible braided straps **36** are arranged in loops bridging across from inlead **5** to sleeve **31** in order to assure good electrical conductivity without restricting movement. This construction prevents strain in the vitreous parts as a result of thermal cycling because expansion of the arc tube can take place freely along the Z axis, that is, along the optical axis of the reflector-lens enclosure, and has eliminated fracture from temperature cycling. The arc tube is otherwise rigidly fixed in the reflector envelope so that it remains accurately focused during operation.

In an improved method for mounting the arc tube within the reflector, the lens is sealed to the reflector

while the arc tube is located approximately along the optical axis with the axial inlead connectors at the ends extending freely through the apertures in the ferrules. Generally it is desirable to flow an inert gas into the reflector during sealing of the lens in order to prevent oxidation of the metal parts. Following lens-sealing and while a flow of inert gas is maintained through the reflector, the arc tube is operated and adjusted in position for maximum light at the second focus. Manipulation of the arc tube may conveniently be done using a universal crosshead, that is a jig adjustable along the X, Y and Z axes, to support exhaust tube **34** at the rear of the lamp while wire piece **35** at the front of the lamp merely extends through thimble **21**. Accuracy of focusing may be made to a thousandth of an inch with such a set-up. Then, without disturbing the final adjustment, exhaust tube **24** and blocking washer **33** are brazed to ferrule **18** at its outer extremity and this permanently fixes the arc tube in place. The lamp is then disconnected from the power source and sleeve **34** is brazed to ferrule **21** at its outer extremity. The reflector envelope is now sealed except for exhaust tube **24**; the pressure of inert gas such as nitrogen therein is adjusted to its final value such as ½ atmosphere, and tube **24** is then pinched off at **27** by means of a cold weld. Flexible leads **37**, **38** with eyelet terminals **39**, **40** may be brazed to the ferrules at the same time as the inlead connectors are brazed, or they may be attached later by using a lower melting point brazing solder. The fillets formed by the brazing metal are indicated by "*b*" in FIG. 3. The use of a braze or solder of suitable melting point is the preferred method of attaching the inlead connectors to the ferrules because it seals the openings at the same time, and does not disturb the positions of the parts.

The construction wherein the ferrule with the oversize hole is located in the reflector and the ferrule with the snug fitting hole is located in the lens, is preferred. However the arrangement may be reversed and the mounting method modified accordingly. The specific embodiments of the invention which have been illustrated and described in detail and the various methods of assembly of the lamp are intended as illustrative and not in order to limit the invention thereto. The scope of the invention is to be determined by the appended claims.

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

1. A reflector lamp comprising a vitreous outer envelope formed of a concave reflector and a light-transmitting cover peripherally sealed together, an arc tube mounted within said envelope with its longitudinal axis lying substantially in the optical axis of said reflector member and having an interelectrode gap located at the focus thereof, one ferrule centrally sealed to said reflector and another ferrule centrally sealed to said cover, said ferrules defining passageways into said envelope, said arc tube having inlead connectors at opposite ends extending through said ferrules and being fastened thereto at the outer ends thereof, said inleads providing the entire support for said arc tube.

2. A lamp as defined in claim **1** having a rearwardly projecting neck portion at the vertex of said reflector member into which one end of said arc tube extends and said one ferrule being centrally sealed to said neck portion.

3. A lamp as defined in claim **1** wherein the fastening of the inlead connectors to the ferrules at their outer ends consists of brazed joints.

4. A lamp as defined in claim **1** wherein one of the inlead connectors includes an expansion joint constraining the inlead to the optical axis but allowing longitudinal movement therealong.

5. A lamp as defined in claim **1** wherein one of the inlead connectors includes an expansion joint, said joint including a metal tube in which the inlead makes a sliding fit and a flexible conductor bridged over from the inlead to the metal tube.

6. A lamp as defined in claim **1** wherein one of the inlead connectors comprises a metal exhaust tube extending through an oversize hole in the ferrule, said exhaust tube being brazed to the ferrule at its outer extremity and tipped off beyond the ferrule.

7. A lamp as defined in claim **1** wherein one of the inlead connectors comprises a metal exhaust tube extending through an oversize hole in the ferrule and the other inlead connector includes an expansion joint, said joint comprising a metal tube in which an inlead portion makes a sliding fit and a flexible conductor bridged over from the inlead portion to the metal tube, said connectors being brazed to the ferrules at their outer extremities.

8. The method of making a reflector lamp having an outer vitreous envelope consisting of a reflector and lens and an arc tube axially mounted therein at the focus which comprises providing apertured ferrules centrally in the reflector and lens, providing axial inlead connectors to the arc tube, assembling the reflector and lens together with the arc tube therein having its inlead connectors projecting through the ferrules, peripherally sealing reflector and lens together, adjusting the arc tube to a focused position relative to the reflector, and permanently fastening the inlead connectors to the ferrules at their outer extremities without disturbing the arc tube's position.

9. The method of claim **8** wherein at least one ferrule has a hole therethrough which is oversize relative to the one inlead connector projecting therethrough, and the arc tube is adjusted in position by manipulating said one inlead connector.

10. The method of claim **8** wherein the inlead connectors are fastened to the outer extremities of said ferrules by brazing.

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