March 3, 1959 T. C. RETZER ET AL 2,876,377

RIBBON SEAL AND METHOD OF FABRICATION

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Fig. 1.

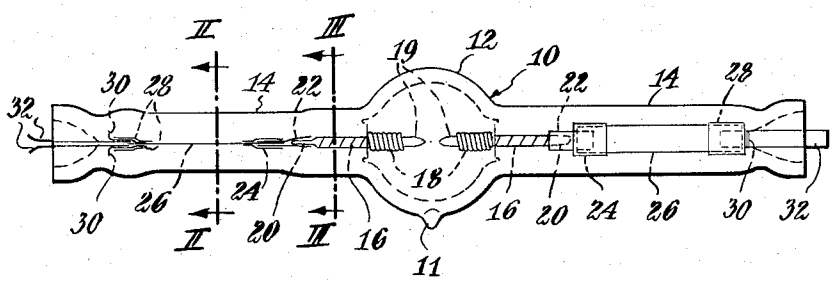


Fig. 6.

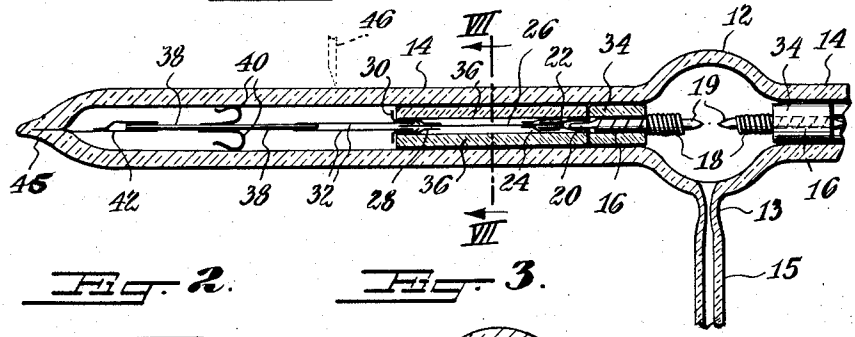


Fig. 2.

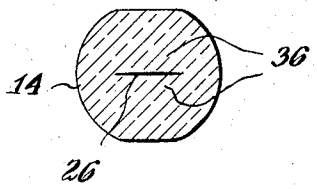


Fig. 3.

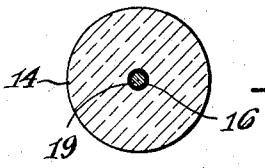


Fig. 7.

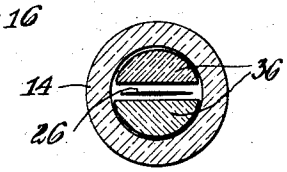


Fig. 4.

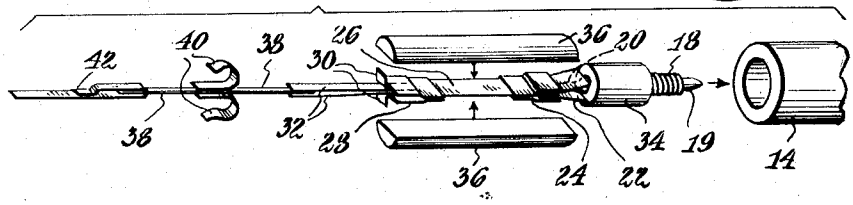
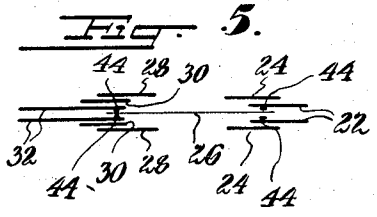


Fig. 5.



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RIBBON SEAL AND METHOD OF FABRICATION

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6 Claims. (Cl. 313—184)

This invention relates to seals and, more particularly to ribbon-type seals for high pressure gaseous discharge lamps, such as a quartz short arc mercury lamp, and to the method of protecting and maintaining the ribbon conductor in a desired preselected position within the stem portion of the lamp envelope during the sealing operation.

Seals capable of withstanding the high operating currents, temperatures, and pressures of mercury or xenon discharge lamps are generally fabricated by embedding an extremely thin leading-in ribbon conductor of refractory material, such as molybdenum, in a tubular quartz arm or stem tube which forms part of the lamp envelope. In order to facilitate electrical connection with the electrode and an external power supply connector strips of substantially greater thickness are usually attached to each end of the main ribbon conductor thereby forming a ribbon leading-in conductor assembly.

Heretofore, the ribbon assembly was either inserted into the tubular stem portion of the lamp envelope or, if extremely high current carrying capacity was required, a plurality of ribbon assemblies were affixed to the outer surface of a quartz retaining body which was then inserted into the stem tube. In either type of seal, after the ribbon assembly was inserted into the stem tube the end of the tube was sealed to permit evacuation of the envelope whereupon the stem tube was rotated in a high temperature fire until the quartz became plastic and was drawn into intimate contact with the ribbon conductor assembly to form a hermetic seal. Moreover, in order to effect a more perfect bond between the quartz and the metal ribbon conductor it has been found advantageous to gradually reduce the thickness of the ribbon extremities by a chemical etching process to form an extremely thin edge, or, as it is commonly referred to in the art, a feather edge. Due to the complexity of the type of seal required for high currents its use in the lower wattage lamps is not practical from an economic standpoint. Hence, where relatively low current carrying capacity is required, as in the case of short arc lamps of under 500 watts capacity, the ribbon conductor assembly is generally sealed directly into the tubular stem portion of the lamp envelope. It has been found, however, that when the main ribbon conductor, particularly one that has a feather edge, has been sealed in the stem tube in this manner the ribbon tends to become deformed or the edges become damaged when the stem tube is rotated during the sealing operation by virtue of the fact that the inner walls of the tube are considerably closer to the edges of the ribbon than to the flat surfaces thereof. This type of sealing assembly and method of fabrication has resulted in a large percentage of seals that leak, thereby causing high shrinkage in production or deleteriously affecting the useful life of the lamp.

It is the principal object of the invention, therefore, to avoid and overcome the foregoing and other difficulties and objections to the prior art by providing a seal for

short arc gaseous discharge lamps in which the thin ribbon conductor is not deleteriously deformed or the feather edges thereof damaged as a result of the operations required to make the seal.

A further object is to provide a ribbon leading-in conductor and electrode supporting assembly which will permit the electrode and ribbon conductors to be properly positioned within the lamp envelope and maintained in such position until the sealing operation has been completed.

Another object of the invention is to reduce manufacturing costs and improve the performance of short arc gaseous discharge lamps by providing a simple economic means of fabricating uniform ribbon-type seals of high quality.

A still further object is to provide a method of fabricating and sealing a leading-in conductor and electrode supporting assembly within the stem portion of a short arc gaseous discharge lamp without deforming the ribbon conductor or damaging the feather edge thereof.

The aforesaid objects of the invention, and other objects which will become apparent to those skilled in the art as the description proceeds, are achieved by enclosing the main ribbon conductor and a portion of the electrode in quartz members to form a laminous core of substantially cylindrical configuration having such dimensions that it makes a snug fit with the stem tube portion of the lamp envelope into which it is to be sealed. Specifically, the main ribbon conductor and electrode supporting assembly is so constructed that the ribbon portion thereof may be interposed between the two halves of a bisected quartz rod which halves are held in the proper position for insertion into the stem tube and are of substantially greater diameter than the width of the ribbon conductor so that the ribbon is totally enclosed and protected during the sealing operation.

For a better understanding of the invention reference should be had to the accompanying drawings, in which like numerals of reference indicate similar parts throughout the several views, wherein:

Fig. 1 is a front elevational view of a quartz short arc gaseous discharge lamp employing the seal of this invention and showing the envelope and two stem portions with the completed seal therein as it would appear if viewed from the side and top, respectively;

Fig. 2 is an enlarged cross-sectional view taken along the line II—II of Fig. 1 in the direction of the arrows, showing the main ribbon conductor hermetically sealed within the stem portion of the completed lamp;

Fig. 3 is an enlarged cross-sectional view of the stem portion of the lamp envelope taken along the line III—III of Fig. 1, in the direction of the arrows, showing the electrode with its metal foil wrapping hermetically sealed within the stem of the completed lamp;

Fig. 4 is a perspective view of the ribbon leading-in conductor and electrode supporting assembly just prior to its insertion into the stem tube portion of the lamp envelope;

Fig. 5 is an exploded side view of the ribbon portion of the assembly showing the various components and their relation to each other prior to their jointure to form one electrical unit;

Fig. 6 is a fragmentary cross-sectional view of a short arc lamp at one stage of its fabrication showing the ribbon conductor and electrode supporting assembly of this invention inserted into the stem tube and in position for the final sealing operation;

Fig. 7 is a cross-sectional view on an enlarged scale of the main ribbon conductor portion of the assembly taken along the line VII—VII of Fig. 6, in the direction of the arrows, showing the relationship between the ribbon

conductor, encasing core rod members, and stem tube just prior to the final sealing operation.

Although the principles of this invention are broadly applicable to the manufacture of other types of high pressure gaseous discharge lamps, the invention is usually employed in conjunction with the manufacture of short arc mercury discharge lamps and hence has been so illustrated and will be so described.

Referring now to the form of the invention shown in the accompanying drawings, particularly Fig. 1, a short arc mercury discharge lamp **10** of low wattage rating, as for example 300 watts, is shown which includes the ribbon conductor and electrode supporting assembly of this invention. As is well known, short arc lamps in general consist of an envelope of vitreous light transmitting material having a high melting point, such as quartz, and having a substantially spherical bulb portion **12** and two oppositely disposed arms or stem tube portions **14** of substantially equal length extending outwardly therefrom. Sealed within each of the stem tube portions **14** is a main ribbon conductor **26** one end of which is electrically connected to an elongated electrode **19** and the other end of which is connected to a pair of terminal strips **32**. A portion of each of the electrodes **19** is sealed in the stem portion **14** so that the electrodes **19** are positioned in a predetermined spaced relation within the spherical bulb portion **12**, which encloses a suitable ionizable medium such as mercury vapor or xenon gas. The electrodes **19** are preferably fabricated from tungsten and may have tungsten coils **18** affixed to their inner end portions which coils **18** may contain a small amount of efficient electron emitting material, such as thorium, to facilitate starting of the arc discharge, as is well known in the art. The essence of this invention resides in the fabrication of the ribbon leading-in conductor and electrode supporting assembly and the manner in which it is positioned and sealed within the stem portion **14** of the lamp envelope and these are hereinafter more fully described.

As illustrated in the exploded view of the ribbon portion of the assembly shown in Fig. 5, a main ribbon conductor **26** of thin refractory material, such as molybdenum ribbon approximately 5.5 mm. wide and .0012" thick, is interposed between two relatively long terminal strips **32** of a suitable refractory metal which serve as external electrical connectors for the lamp **10**. In order to facilitate connection with a source of electrical power it has been found desirable to fabricate the terminal strips **32** from moly ribbon having a substantially greater thickness than the main ribbon conductor **26**, as for example .004". To insure a strong electrical junction between the ribbon conductor **26** and terminal strips **32** during the life of the lamp **10** it has been found advantageous to place thin narrow strips **44** of a suitable metal foil (see Fig. 5), such as nickel or platinum of approximately .001" thickness, between the conductor **26** and each of the strips **32** to serve as a brazing agent. A more perfect bond between the quartz and edges of the main ribbon conductor **26** may be obtained and the overall quality and strength of the finished seal improved by fabricating the ribbon conductor **26** from a molybdenum ribbon ¼" wide and approximately .0016" thick which ribbon is subsequently chemically etched until its maximum thickness is no greater than approximately .0012" and its outer edge portions are gradually reduced to extremely thin sections to form a well known feather edge. Although the current carrying capacity of a ribbon of these dimensions is limited to approximately 10 amperes, increased current carrying capacity, as for example up to approximately 30 amperes, may be obtained by appropriately increasing the ribbon dimensions and force cooling the exposed portions of the moly terminal strips **32** to prevent the deleterious effect of oxidation which would occur at the high ambient temperature conditions generated by a lamp of such high wattage.

Superimposed over each of the terminal strips **32** and overlapping the end of the ribben conductor **26** are two retaining tabs **30** which may be fabricated from relatively short sections of resilient metal ribbon, such as molybdenum .004" thick. The end portions of the retaining tabs **30** which extend beyond the edge of the ribbon conductor **26** are bent at right angles to the plane containing the ribbon conductor **26** to form a pair of oppositely disposed end panels. In order to prevent cracks from occurring in the region of the juncture of the retaining tabs **30** and terminal strips **32** with the relatively thin main ribbon conductor **26** as a result of the ledge or sharp edges left exposed, a pair of protective strips or flaps **28** of refractory material, such as molybdenum .0006" in thickness, are provided and positioned so as to overlap the aforesaid connected members and form a sheath over the juncture formed therebetween. The protective flaps **28** also insure a good electrical connection between the members by obviating a high resistance juncture which could cause the ribbon to burn through and lead to subsequent lamp failure and serve to shield the electrical connection between the main ribbon conductor **26** and terminal strips **32** from any strains which may arise as a result of the unequal expansion and contraction of the quartz and metal portions of the seal during the normal operation of the lamp **10**.

The other end of the main ribbon conductor **26** is interposed between the ends of a pair of connector strips **22** of refractory metal, such as molybdenum, which serves to connect the ribbon conductor **26** to the electrode **19**. To facilitate electrical connection with the electrode **19** the connector strips **22** may be of substantially greater thickness than the ribbon conductor **26**, as for example .004". A firm bond between said conductor **26** and strips **22** may be obtained by inserting therebetween two strips **44** of suitable metal foil to act as a brazing agent (see Fig. 5). A pair of protective flaps **24** may be provided to present a substantially smooth curved sealing surface over the ledge formed by the juncture of the relatively thin ribbon conductor **26** with the connector strips **22** and to protect the electrical connection therebetween from excess strains during the heating and cooling of the completed seal. After the main ribbon conductor **26**, terminal strips **32**, retaining tabs **30**, connector strips **22**, metal foil strips **44**, and protective flaps **24** and **28** have been assembled as heretofore described, they are electrically joined together, such as by welding, to form the ribbon conductor member of the leading-in conductor and electrode supporting assembly which member is then ready for connection with the other parts of the assembly as hereinafter described.

An elongated electrode **19** having a coil **18** of refractory metal attached to its inner end portion is inserted into a section of heavy-wall quartz tubing **34** of suitable diameter, as for example ¼", and of such length that the other end of the electrode **19** projects beyond the edge of the tubing **34** when said tubing **34** is contiguous with the coil **18**. To facilitate connection with the ribbon portion of the assembly the exposed end of the electrode **19** may be preformed to form a flat wedge-shaped tip **20**. Before the electrode **19** is inserted into the quartz tubing **34** the electrode tip **20** and intermediate portions thereof up to the coil **18** may be encased in a wrapping of refractory metal foil **16**, such as molybdenum ribbon .0006" thick, to prevent cracks from occurring in the completed seal when the electrode **19** becomes heated and expands during the operation of the lamp **10**. The free end portions of the connector strips **22** which extend beyond the end of the main conductor **26** are bent outwardly to form a V-shaped pocket into which the foil encased electrode tip **20** is inserted and electrically connected. The terminal strips **32** are connected to a positioning tab **42** by a rod **38** of refractory metal such as molybdenum. For added strength the positioning tab **42** may consist of a pair of metal ribbons of unequal length

welded together and affixed to each side of the rod **38**. A pair of positioning clips **40**, such as of arcuate retroverted molybdenum strips for example, are attached to opposite sides of an intermediate portion of the rod **38** to serve as compressible members to insure accurate positioning of the electrode and ribbon conductor assembly within the stem tube **14**. A pair of plano-cylindrical quartz rods **36** are formed by bisecting a quartz cylinder of the same diameter as the aforementioned quartz tube **34**, as for example ¼". The rods **36** are inserted between the edges of the retaining tabs **30** and the quartz tubing **34** with their plane surfaces facing inwardly and are resiliently held in this position so that the main ribbon conductor **26** and its lapping end connections together with the electrode tip **20** are totally enclosed to form a composite laminous core member of substantially cylindrical configuration having one end of the electrode **19** and the terminal strips **32** and the associated electrode positioning elements attached thereto protruding from opposite ends thereof.

The cylindrical core member formed as hereinbefore described is then inserted into the tubular stem portion **14** of the lamp envelope, as shown in Fig. 4. The core member and electrode supporting assembly are inserted into the tubular stem portion **14** until the positioning clips **40** are forced into intimate contact with the inner surfaces of the tubular portion **14** and upon further penetration are compressed inwardly to frictionally engage the inner surfaces of the tube **14**. This enables the assembly to be accurately positioned within the stem tube portion **14** so that the electrodes **19** can be oriented in the desired preselected position within the spherical bulb portion **12**. After the electrodes **19** are properly positioned, the positioning tab **42** is sealed in the tube portion **14** to anchor the inserted core member and associated elements in their respective positions and to seal off the envelope for evacuation by heating the end of the stem tube portion **14** to plasticity and forming an air tight seal **45** around the tab **42**, as shown in Fig. 6. At this stage of the fabrication of the seal the main ribbon conductor **26** is interposed between the plane surfaces of the rods **36** of semi-hemispherical cross-section which rods **36** are, in turn, completely enclosed by the walls of the tubular stem portion **14**, as shown in Fig. 7.

The spherical bulb portion **12** and tubular stem portions **14** of the lamp envelope are now evacuated through an exhaust tubulation **15** having a constriction **13** formed therein adjacent to the spherical bulb portion **12**. After the envelope has been evacuated to the desired pressure, as for example .001 mm. of mercury, the exhaust tubulation **15** is sealed off at a point beyond the constriction **13** by suitable sealing fires (not shown). The outer end portion of the stem tube **14** is then held and rotated, as in a rotatable chuck for example (not shown), while a high temperature flame (also not shown) is directed to the region of the stem portion **14** adjacent to the outermost edge of the semi-cylindrical rods **36**, as viewed in Fig. 6 until the quartz becomes plastic and the wall portion of the stem **14** thereat is forced inwardly by atmospheric pressure and fuses with the rods **36** to form a solid mass. The tubular stem portion **14** is constantly rotated and the high temperature sealing fires progressively advanced inwardly toward the spherical bulb portion **12**, as viewed in Fig. 6, until the neck portion of the envelope between the tube portion **14** and spherical portion **12** is reached. The main ribbon conductor **26** and outer end portion of the electrode **19** are thus sealed in a solid cylinder of fused quartz, as shown in Figs. 2 and 3. Due to the vacuum within the envelope the quartz tube **34**, semi-cylindrical rods **36**, and the walls of the stem tube **14** are drawn into intimate contact with the metal portions of the core member when the quartz is in a plastic state. This permits a uniform high strength seal to be formed and the use of the quartz tube **34** and semi-cylindrical rods **36** as core members prevent the main conductor **26** from being deleteriously deformed or damaged during the sealing operation.

After the seal has been completed as hereinbefore described, the tip (not shown) previously formed on the exhaust tube **15** is broken and the envelope filled with a predetermined amount of mercury or suitable ionizable gas, such as xenon, and the exhaust tube **15** tipped-off by suitable fires at the constriction **13** to form a seal tip **11**. The outer end portion of the stem **14** beyond the region of the seal is then cut off by a wet cutting wheel **46**, as shown in Fig. 6, care being exercised to prevent cutting of the terminal strips **32**. After the cutting operation has been completed the terminal strips **32** are severed at a point adjacent to the end of the rod **38** thereby completing the fabrication of the lamp.

It will be recognized from the foregoing that a simple but most effective means of protecting a ribbon conductor and its edges from deformation and damage during the sealing operation necessary to embed it within the stem tube portion of a gaseous discharge lamp has been provided. Moreover, this is accomplished by providing a quartz tube and a pair of semi-cylindrical rods resiliently held in an abutting relation to totally enclose the main ribbon portion and end portion of the electrode and form a cylindrical core member to protect the ribbon assembly and maintain the electrode in the proper position during sealing.

Although a preferred embodiment of the invention has been illustrated, it will be understood that other modifications may be made without departing from the spirit and scope of the appended claims.

We claim:

1. A gaseous discharge lamp comprising an envelope having a bulb portion and outwardly extending fused stem portions, an ionizable medium enclosed within said envelope, and ribbon leading-in conductor and electrode assemblies sealed through each of said stem portions, each of said assemblies comprising a main ribbon conductor of thin refractory material having its outer end portion interposed between and fastened to a plurality of paired metallic strips arranged in overlapping relation therewith, at least one pair of said strips extending longitudinally of said main conductor to serve as external connectors and another pair of said strips adapted to serve as retaining members, an elongated electrode having an end adapted for connection with said main conductor, a wrapping of metal foil around said electrode end, and a second plurality of paired and overlapping metal strips joining the said foil enwrapped end of said electrode with the end of said main conductor opposite the first said plurality of strips, said assemblies being centrally embedded and hermetically sealed within said fused stem portions and longitudinally positioned therein so that the end sections of the said longitudinally-extending strips protrude from the stems and the free ends of the electrodes project into the bulb portion of the envelope in predetermined spaced apart relation.

2. A short arc gaseous discharge lamp comprising a light-transmitting envelope having a spherical bulb portion with two oppositely disposed arms extending outwardly therefrom, an ionizable medium enclosed within said envelope, and ribbon leading-in conductor and electrode assemblies sealed through each of said arms, each of said assemblies comprising a main ribbon conductor having its outer end portion interposed between and fastened to three pairs of refractory metal strips arranged in overlapping relation therewith, the inner pair of said strips being substantially greater in thickness than said main conductor and extending longitudinally thereof to serve as external connectors, the middle pair of said strips having bent outer end sections arranged to form oppositely disposed transverse end panels, and the outermost pair of said strips being proportioned and disposed to overlap the juncture between the main conductor and the said inner and middle pairs of strips to provide a

smooth sealing surface, an elongated electrode having one end shaped to form a flat wedge-shaped tip, a wrapping of metal foil around said flattened end portion and adjacent body portion of said electrode, and a second group of paired refractory metal strips comprising an inner pair of strips of substantially greater thickness than said main conductor attached to the end of said main conductor opposite the first said group of strips and connected to the said foil enwrapped end of the electrdoe in enveloping relation therewith, and an outer pair of strips proportioned and disposed to cover the juncture between the main conductor and said inner pair of strips, said main ribbon conductor having extremely thin tapered edges and said assemblies being centrally embedded and hermetically sealed within each of said arms and of sufficient length that the end sections of the said longitudinally-extending strips protrude from the arms and the free ends of the electrodes project into the spherical bulb portion of the envelope in opposite and predetermined spaced apart relation.

3. An electrically-conductive ribbon type seal for a gaseous discharge lamp having an envelope with a bulb portion and a fused tubular stem portion comprising a main leading-in conductor of refractory metal ribbon having extremely thin tapered edges, an elongated electrode having a flattened end portion adapted for connection with said main conductor, a wrapping of metal foil around said flattened end portion and adjacent body portion of said electrode, a pair of metal connector strips fastened to one end of said main conductor and the flattened foil-enwrapped end of said electrode, said main conductor and electrode ends being interposed between said connector strips in overlapping relation therewith, the other end of said main conductor being interposed between and connected to a plurality of paired metal strips arranged in overlapping relation, at least one pair of said strips extending longitudinally of said main conductor to serve as external connectors and another pair of said strips being adapted to serve as retaining members, and thin metal flaps covering the junctures between said strips and main conductor to provide a smooth sealing surface, said connector and longitudinally-extending strips being substantially greater in thickness than said main conductor, and said conjoined main ribbon conductor, strips and foil enwrapped portion of said electrode being centrally embedded and hermetically sealed within said fused stem portion and of sufficient length that the said longitudinally-extending strips protrude from the end of said stem portion and the free end of the electrode projects into the bulb portion of the envelope in predetermined spaced apart relation with the walls thereof.

4. A ribbon leading-in conductor and electrode assembly for sealing into the tubular stem portion of a gaseous discharge lamp comprising a main ribbon conductor of refractory metal, an elongated electrode having a flattened end portion and an enlarged opposite end portion, a wrapping of metal foil around the flattened end portion and intermediate body portion of said electrode adjoining said enlarged end portion, a section of vitreous tubing carried by the foil-enwrapped intermediate portion of said electrode, said tubing being seated against the enlarged portion of said electrode and of such length that the flattened end portion of the electrode protrudes therefrom, means connecting one end of said main ribbon conductor with the said protruding electrode end portion, the other end of said main conductor being interposed between and connected to a plurality of metal strips adapted to provide a longitudinally extending terminal and a pair of oppositely disposed retaining members, a pair of matching plano-cylindrical vitreous rods longitudinally inserted between said retaining members and the edge surfaces of said tubing, said rods being positioned so that their plane surfaces face inwardly toward each other, to totally enclose and protect said main ribbon conductor and form a composite laminous core member of substantially cylindrical configuration adapted to be received by said tubular stem portion.

5. A ribbon leading-in conductor and electrode supporting assembly for sealing into the tubular quartz arm of a short arc lamp comprising a main ribbon conductor of molybdenum having extremely thin tapered edges, an elongated electrode having a flattened end portion and a coil mounted at its opposite end portion, a wrapping of metal foil around the flattened end portion and intermediate body portion of said electrode adjoining said coil, a section of heavy-wall quartz tubing surrounding said foil-enwrapped intermediate portion of said electrode, said tubing being seated against the end of said coil and of such length that the flattened end portion of the electrode protrudes therefrom, connector strips joining one end of said main ribbon conductor with the said protruding electrode end portion, the other end of said main conductor being interposed between and connected to a plurality of metal strips adapted to provide a pair of longitudinally extending terminal strips and a pair of oppositely disposed and transversely projecting resilient end panels, a pair of matching plano-cylindrical quartz rods longitudinally inserted between said end panels and the edge surfaces of said tubing, said rods having substantially the same outer curvature as said tubing and being positioned so that their plane surfaces face inwardly toward each other to totally enclose and protect said main ribbon conductor and form a composite laminous core member of substantially uniform cylindrical configuration adapted to be received by the tubular arm of said lamp, and means attached to said terminal strips for longitudinally positioning said core member within said arm including compressible members operable to frictionally engage the inner wall surfaces of said arm and maintain said member in its assembled position during the sealing-in operation.

6. The method of fabricating and sealing a ribbon leading-in conductor and electrode assembly within the tubular stem portion of a gaseous discharge lamp envelope comprising, providing an elongated electrode having an enlarged body portion and a flattened end portion, wrapping said flattened end portion and adjacent part of said electrode adjoining the said enlarged body portion in metal foil, inserting the foil-enwrapped portion of the electrode into a section of vitreous tubing of such length that the flattened end portion of the electrode protudes therefrom when said tubing is seated against the said enlarged body portion, seating said tubing against said enlarged body portion, connecting the protruding flattened end portion of said electrode with a refractory metal ribbon, affixing a plurality of metal strips to the end of said ribbon opposite said electrode to provide a longitudinally extending terminal connector and a pair of oppositely disposed transverse members, placing a pair of matching plano-cylindrical vitreous rods between said transverse members and the edge surfaces of said tubing to enclose said metal ribbon and adjoining portions of said electrode and metal strips and thus form a composite laminous core member of substantially uniform cylindrical configuration, attaching an elongated positioning member having intermediate compressible extensions to the free end portion of said terminal connector, inserting said electrode and conjoined core member into the tubular stem portion until said extensions frictionally engage the inner wall surfaces of said stem, orienting said core member and electrode in predetermined longitudinal relation with said stem portion by means of said positioning member, sealing the end of said stem portion over said positioning member, evacuating said envelope and progressively heating the

section of said stem occupied by said core member until the tube walls collapse and fuse with the vitreous tubing and rod portions of said core member to hermetically seal the refractory metal ribbon and foil enwrapped section of the electrode in said stem portion, and thereafter separately severing said stem and terminal connector at different points remote from the fused outer end portion of said stem.

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