United States Patent

[11] 3,609,437

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[21] Appl. No. 711,763
[22] Filed Mar. 8, 1968
[45] Patented Sept. 28, 1971
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[32] Priority Mar. 31, 1967
[33] Netherlands
[31] 6704681

[54] **ELECTRIC DISCHARGE LAMP COMPRISING CONTAINER OF DENSELY SINTERED ALUMINUM OXIDE**
11 Claims, 6 Drawing Figs.

[52] U.S. Cl. 313/220, 174/50.61, 313/184, 313/216, 313/221, 316/17
[51] Int. Cl. H01j 17/16
[50] Field of Search 174/50.61, 50.63, 50.58; 313/220, 221

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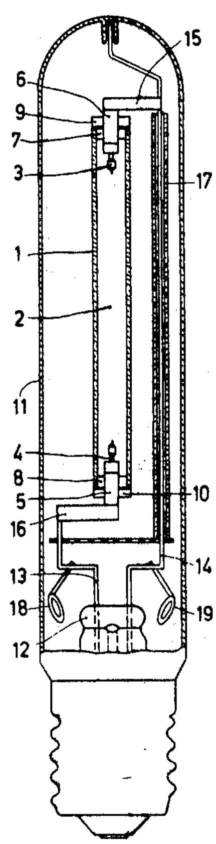
ABSTRACT: Electric gas discharge lamp having an envelope of densely sintered aluminum oxide and employing an alkali metal vapor as the discharge medium. A current supply member for an electrode assembly is sealed in each end of the envelope by means of a sealing element of densely sintered aluminum oxide which is sintered to the inner wall of the envelope and is provided with an aperture into which a cylindrical current lead-in supporting at one end an electrode assembly is secured in a gastight manner. The current lead-in member is provided with a cover for the envelope which is sealed to the latter by a sealing glass having a melting point higher than 800° C. and lower than the melting point of the aluminum oxide or the current supply member.



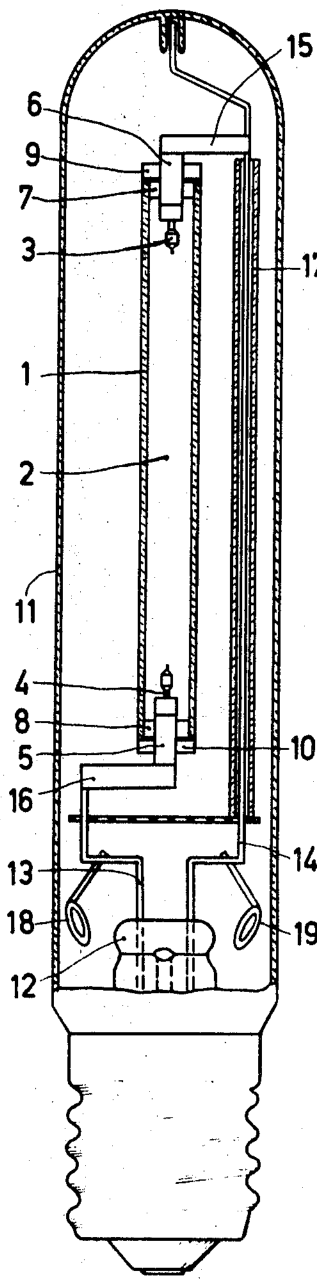


FIG.1

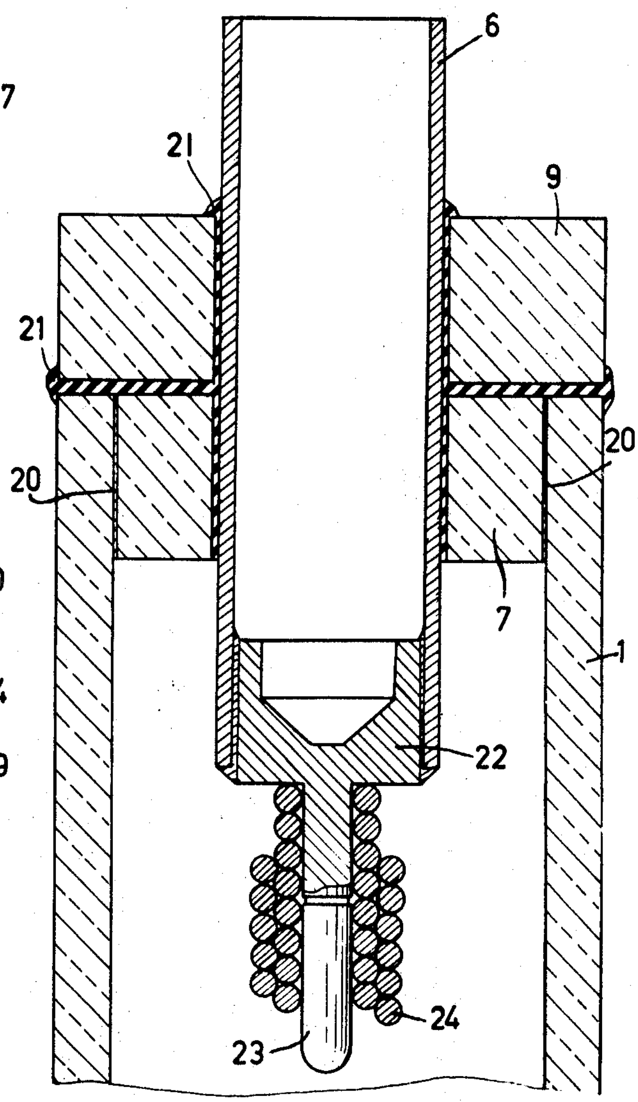


FIG.2

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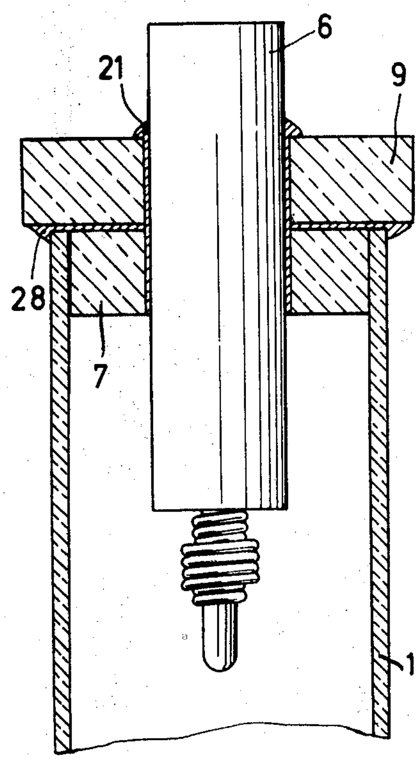

FIG. 3

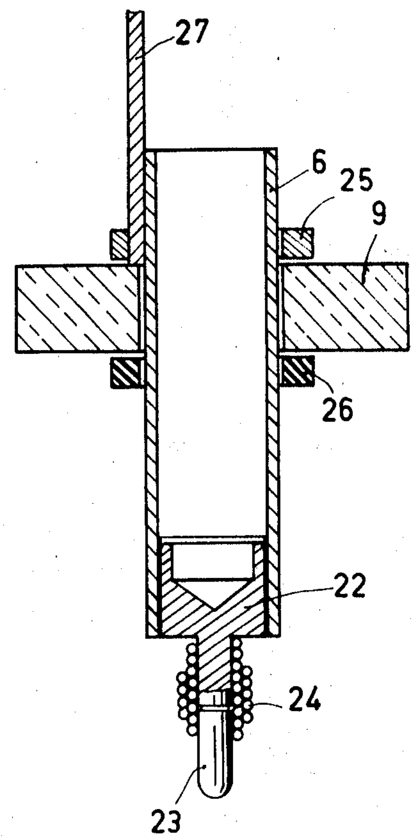

FIG. 4

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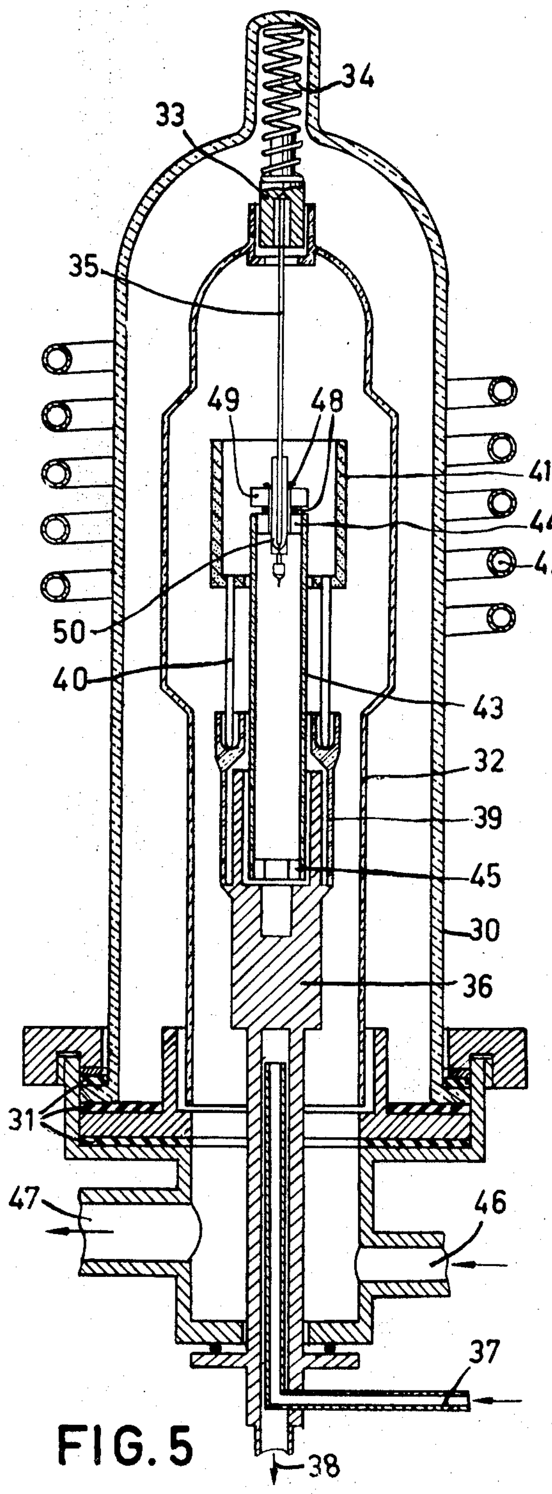

FIG. 5

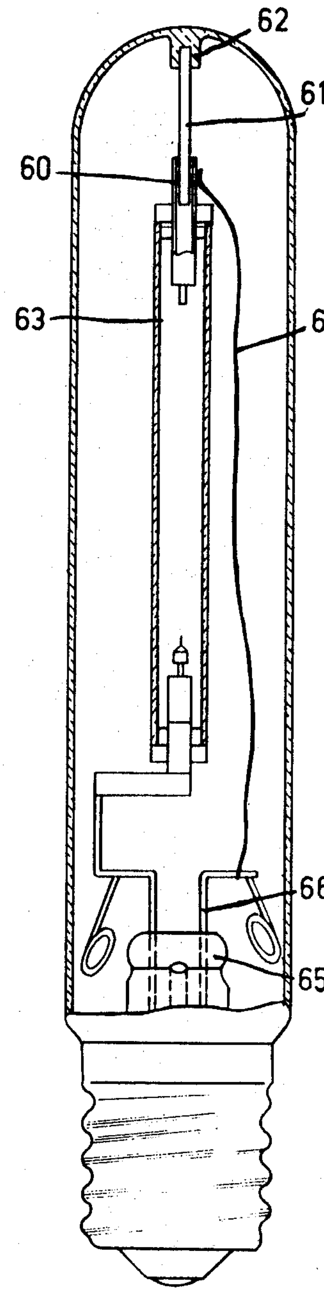

FIG. 6

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ELECTRIC DISCHARGE LAMP COMPRISING CONTAINER OF DENSELY SINTERED ALUMINUM OXIDE

The invention relates to electric gas discharge lamps having an envelope of the discharge space consisting of translucent densely sintered aluminum oxide and to a method of manufacturing such a lamp.

The wall of a gas discharge lamp must consist of a material which at the operating temperature during the whole lifetime of the lamp is resistant to the chemical action of the gas atmosphere in the discharge space. If the temperature during operation is high, and the gas atmosphere contains constituents of an aggressive nature, as is the case, for example, in high-pressure sodium vapor lamps in which the temperature during operation is between 700° C. and 1,500° C., materials such as normal glass or quartz glass, can no longer be used. Actually they are strongly attacked during operation and then show a considerable discoloration which deteriorates the light radiation. In addition the attack reduces the mechanical resistance of the envelope so that the possibility of fracture of the lamp is increased. In order to check these drawbacks as much as possible it is known to manufacture the envelope of such lamps from translucent densely sintered aluminum oxide. This is to be understood to mean a material which consists for at least 95 percent by weight of aluminum oxide and is formed by heating a mixture of mainly aluminum oxide and a temporary binder at a very high temperature after it has been given a shape in a manner conventionally used in the ceramic industry.

Besides for the use in high-pressure sodium vapor lamps it is of advantage to manufacture the envelope of high-pressure mercury vapor lamps also, and in particular of high-pressure mercury vapor lamps which contain iodine or iodides in the discharge space, from a densely sintered translucent aluminum oxide. In fact, this material is better resistant to the aggressive influences of the gas atmosphere than quartz glass which has so far been frequently used for such lamps.

As materials for the electrodes and the current lead-in members to be sealed in a gastight manner in the envelope, only a few metals are to be considered for these lamps, for example, tungsten, molybdenum and niobium; in particular niobium is particularly suitable for use as a current lead-in member since its coefficient of expansion readily matches the coefficient of expansion of the densely sintered aluminum oxide.

The manufacture of the gastight seals remains a very difficult operating also in the case of a suitable choice of the metal for the current lead-in members, in particular niobium. The main reason for this is the particularly high melting point of the aluminum oxide (higher than 1,925° C.) and the fact that aluminum oxide has no melting range, such as glass or quartz glass. Therefore a variety of constructions for the gaslight seals are already known.

One of the conventional means to improve the seals consists in using a tubular current supply member. Actually such a tubular current supply member has a certain flexibility as a result of which small differences in coefficients of expansion can more easily be compensated for. It is difficult to secure such a tube directly in the envelope and therefore the tube in a known construction is provided, in a separate operation and in a gastight manner, in a plug of translucent densely sintered aluminum oxide, which plug is again secured in a gastight manner in the envelope which consists of the same material as the plug.

In another construction a cover of densely sintered aluminum oxide is used of a plug being placed in the envelope, said cover being secured in a gastight manner on the outside against an opening of the envelope.

In another construction a likewise tubular current supply member is provided with a rather thin radial flange having a large diameter and said flange is directly secured in an aperture of the envelope of the discharge lamp. Such a seal is, of course, very flexible. A variation of said seal is a construction in which the flange is not sealed in an aperture of the envelope, but on the outside against it.

Most of the above described constructions use a connection glass between the component parts of the seal since without such a glass substantially no gastight connection can be obtained. Of course, high requirements must be imposed on the glass in connection with the high temperatures and the aggressive atmosphere to which the compounds are exposed both during the manufacture and during operation of the lamps.

Lamps with the above constructions are satisfactory in practice, but as a result of the particularly difficult manufacture the percentage of rejects right after the manufacture is always very high. It is the object of the invention to improve this.

An electric gas discharge lamp according to the invention comprises an envelope of the discharge space consisting of translucent densely sintered aluminum oxide and at least one current lead-in member secured in a gastight manner in the envelope, said envelope having a cylindrical part at the area of the current lead-in member which is characterized in that a sealing element which consists of translucent densely sintered aluminum oxide is arranged in the cylindrical part and is sintered in a gastight manner to the envelope. This sealing element is provided with an aperture in which the current lead-in member is secured in a gastight manner by means of a sealing glass having a melting point higher than 800° C. and lower than the melting point of the translucent densely sintered aluminum oxide and of the metal of the current lead-in member. The lamp further comprises a cover having an aperture for the current lead-in member and consists of translucent densely sintered aluminum oxide and bears against the end of the cylindrical part of the envelope and against the sealing element arranged therein. This cover is secured in a gastight manner to the envelope, the sealing element and the current supply member by a sealing glass having a melting point higher than 800° C. and lower than the melting point of the translucent densely sintered aluminum oxide and of the metal of the current lead-in member.

As already explained above, constructions are known in which a plug is secured in a tube of translucent densely sintered aluminum oxide in order to seal the discharge space therewith. In the known construction this plug is secured by means of a glass or a low melting point ceramic material in the tube which consists of translucent densely sintered aluminum oxide. Such a structure is not particularly reliable which is mainly due to the fact that the coefficient of expansion of the sealing material used is not always the same. As a result of this strains easily occur in the seals which may give rise to cracks. In addition, a rim of sealing material is formed in the corner joint between the plug and the envelope on the inner side. During operation of the gas discharge lamp this material is exposed to the aggressive gas atmosphere at the high operating temperature. As a result of this not only discoloring often occurs but frequently cracking of the sealing material often just sets in at that place and then continues in the material between the plug and the envelope. In a construction according to the invention in which the sealing element is sintered in the envelope all these drawbacks are avoided.

The cover of densely sintered translucent aluminum oxide which according to the invention is secured to the cylindrical part of the envelope and the sealing element with a sealing glass, provides a particularly large certainty that no leakage can occur, particularly not along the current lead-in member. Because also between the cover and the envelope and between the cover and the sealing element a thin glass layer is present, an even more reliable gastight seal is obtained. If desired, an extra glass rim may be arranged in the corner joint between the current lead-in member and the cover. This glass rim in fact is arranged on the outside of the whole construction and consequently cannot be attacked by the aggressive atmosphere in the discharge space.

The sealing glass with which the various parts are secured together must have a melting point above 800° C. because lamps according to the invention are often loaded so high that the temperature of the lamp increases to above 700° C. This is the case in particular when a high-pressure discharge is produced in the discharge space in an atmosphere which contains at least an alkyl metal, mercury and at least a rare gas. The invention may be used in particular in so-called high-pressure sodium vapor lamps in which the alkali metal is sodium and the rare gas is xenon.

In lamps according to the invention, as in the known lamp constructions, the current lead-in member, at least that portion which is secured in a gastight manner in the sealing member and in the cover, preferably consists of the metal niobium.

In a particularly advantageous embodiment of a gas discharge lamp according to the invention the cover projects beyond the cylindrical part and a rim of sealing glass is provided in the corner joint formed between these two parts. As a result of this an even more reliable gastight seal is obtained.

As in low-pressure sodium lamps, an evacuated outer envelope or an outer envelope filled with an inert gas, for example, argon, within which the envelope of the actual discharge container is arranged, may be used in lamps according to the invention. This outer bulb serves as a heat insulator as is the case in the low pressure sodium lamps. In a particularly advantageous embodiment of a discharge lamp according to the invention in which the current lead-in member consists of a tube which is open on the side remote from the discharge space a pinlike supporting member is arranged with some clearance in the tubular current lead-in member and is rigidly secured to the outer bulb. As a result of the fact that the pinlike supporting member is arranged with some clearance in the tubular current lead-in member, the actual discharge space can easily extend without forces being exerted on the current lead-in member which might result in breakage of the seal and/or the current lead-in member. Since the electric connection between the current lead-in member and the pinlike supporting member sometimes leaves much to be desired as a result of the clearance between said two parts, according to a particular embodiment of a lamp according to the invention a flexible electrically conductive connection is provided between the current lead-in member on the one hand and a pole wire which is provided in the outer bulb, for example, in a pinch thereof on the other hand.

The invention will now be described in greater detail, with reference to the accompanying drawings, in which:

FIG. 1 shows an elevation of an embodiment of an electric gas discharge lamp according to the invention showing the general construction;

FIG. 2 is a detailed view of the construction of the gastight connection of the sealing element, the cover and the current lead-in member;

FIG. 3 shows a variation of the construction of Figure 2;

FIG. 4 shows an assembly of a current lead-in member and a cover as it is used in a method of manufacturing a gas discharge lamp according to the invention;

FIG. 5 shows an apparatus for manufacturing a gas discharge lamp according to the invention, and in particular for manufacturing the gastight seals;

FIG. 6 shows a variation of the construction shown in Figure 1.

Referring now to Figure 1, reference numeral 1 denotes the envelope of a discharge space 2, in which a gas discharge can be generated in an atmosphere which consists, for example, of sodium vapor, mercury vapor and a rare gas, for example, xenon. The envelope 1 consists of translucent densely sintered aluminum oxide. The electrodes 3 and 4 which are constructed in known manner and comprise inter alia a tungsten coil are arranged at the ends of the discharge space 2. The electrodes 3 and 4 are secured to current supply members 5 and 6 which consist of niobium tubes. 7 and 8 denote two sealing elements which likewise consist of translucent densely sintered aluminum oxide; they are secured in the envelope 1 by sintering. 9 and 10 denote two covers which likewise consist of densely sintered translucent aluminum oxide and which are secured both to the envelope 1 and to the sealing elements 7 and 8. The discharge tube 1 is arranged within an outer bulb 11 which consists, for example, of hard glass. Said outer bulb comprises a pinch 12 in which two supporting wires 13 and 14 are secured which likewise serve as current lead-in members for the electrodes 4 and 3, respectively. 15 and 16 denote two striplike connection members which connect the electrodes 3 and 4, respectively, to the supporting wires 14 and 13, respectively. A quartz tube 17 is arranged around the supporting wire 14 for protection. 18 and 19 denote two gettering rings which maintain the vacuum in the outer bulb 11.

Figure 2 shows on an enlarged scale the construction of the upper end of the gas discharge tube 1 shown in Figure 1. In this Figure, corresponding components bear the same reference numerals as in Figure 1. The thick black lines 20 denote that the sealing element 7 of translucent densely sintered aluminum oxide is sintered in the envelope 1 which consists of the same material. 21 denotes a sealing glass with which, as shown in the Figure, the current lead-in member 6 is secured both to the cover 9 and to the sealing element 7. This sealing glass is also arranged between the cover 9 on the one hand and the envelope 1 and the sealing element 7 on the other hand. As a result of the large length and the favorable position of this sealing glass an excellent vacuumtight seal is obtained. In the corner joint inside the discharge space, between the current lead-in member 6 and the sealing element 7, substantially no glass is provided which could be attacked by the aggressive atmosphere in the gas discharge space. In the corner joint on the outside there is a glass rim but there exists no danger of attack by the aggressive atmosphere there. The actual electrode consists of an element 22 secured in the current lead-in member 6, and consisting, for example of molybdenum. This element is secured, for example, in known manner with titanium, to the tube 6 which may consist of niobium. The extremity of the element 22 is constructed as a pin and is connected to a tungsten pin 23. 24 denotes a tungsten coil which is coiled around the pinlike part and the pin. This tungsten coil may be coated, if desired, with a material which readily emits electrons.

The variation of the seal shown in Figure 3 comprises the same elements as in Figure 2 and these are referred to by the same reference numerals. In this embodiment the cover 9 has a larger diameter than the envelope 1. As a result of this a glass rim 28 can be formed in the corner joint between the cover 9 and the envelope 1 which is an extra guarantee for a ready gastight seal.

In manufacturing a gas discharge lamp according to the invention the envelop 1 is first provided with the sealing elements 7 and 8. These sealing elements comprise an aperture in which the current lead-in member is to be secured. This is preferably carried out as follows. An assembly as shown in Figure 4 is manufactured consisting of the tubular current lead-in member 6 with the electrode 22, 23, 24 secured thereto. The cover of translucent densely sintered aluminum oxide 9 is placed around the tube 6. Above and below this cover, rings 25 and 26, respectively, of a vitreous or glass-forming material are arranged, having a composition essentially consisting of aluminum oxide, calcium oxide, barium oxide, silicon oxide, magnesium oxide and strontium oxide. 27 denotes a narrow strip or wire, for example, of molybdenum, which is secured to the current lead-in member 6. It serves to prevent the current lead-in member 6 from falling through the aperture of the cover 9 and to ensure the correct position of the electrode in the envelope 1. After having manufactured the assembly as shown in the Figure, it is arranged on the sealing element in which the current lead-in member 6 is slid through the aperture in this sealing element. The rings 25 and 26 are then melted by heating. The melted glass secures both the current lead-in member 6 and the cover 9 in the sealing element. At the same time a glass layer is formed between the sealing element and the cover as already shown in Figure 2.

Figure 5 shows an apparatus with which the seals of a gas discharge lamp according to the invention can be made. This apparatus consists of a bell 30 which is connected to a base by means of packings 31. The bell 30 contains an inner tube 32 which at its upper side is provided with an aperture. A metal block 36 which can be cooled by water is arranged in the tube 32. This water can be supplied at 37 and can be conducted away at 38. A collar 39 of quartz having four tungsten pins 40 is arranged around the block 36. These pins 40 in turn support with their upper sides a cylinder 41 consisting of graphite. A high frequency heating coil 42 is arranged around the bell 30 near the graphite cylinder 41.

The manufacture of the gastight seal of the envelope 43 consisting of translucent densely sintered aluminum oxide is carried out as follows. Starting material is the envelope 43 in which the sealing elements 44 and 45, respectively, are already sintered and on which the assembly shown in Figure 4 is placed at one end. The whole is placed in the metal block 36. The tube 32 is then provided followed by the pin 35, the intermediate member 33 and the spring 34. The bell 30 is then provided as a result of which the pin 35 simultaneously presses the assembly shown in Figure 4. After all these parts have been provided, the cooling water is supplied at 37 and the whole space inside the bell 30 and the envelope 43 is filled with an inert gas, for example, argon. The graphite cylinder 41 is then heated by means of a high frequency coil 42, until the rings 48 of glass-forming material melts and the cover 49 and the current lead-in member 50 are connected in a gastight manner to the envelope 43 and the sealing element 44. After cooling, the bell 30 and the inner tube 32 may be removed. The envelope 43 with the manufactured seal may then be removed.

Manufacturing the seal at the other end is done in a similar manner. Before this seal is made, however, the required quantity of mercury may be provided in the envelope. This need not be effected in an inert atmosphere. The introduction of alkali metal must be carried out in an inert atmosphere. The same apparatus may be used for that purpose. The procedure in this case is as follows. The envelope which is sealed at one end is introduced into the block 36. The tube 32 is then provided after which through the supply 46 an inert gas, for example, argon is supplied. The outlet 47 is closed. The gas fills the whole space inside the tube 32 and it is ensured that the envelope 43 also is filled with this gas. The inert gas flows out of the tube 32 at the upper end. Then the required quantity of alkali metal, for example, sodium, is introduced into the envelope 43 through this aperture. The assembly shown in FIG. 4 is then arranged on the envelope. The flow of inert gas continues. The pressure device 33, 34, 35 and the bell 30 are then provided. The supply 46 is closed, and the whole space inside the bell 30 is evacuated through 47. The rare gas, for example, xenon, which is necessary in the finished tube is then supplied through 46. The second seal is then made in a similar manner as the first seal by heating.

In the embodiment shown in FIG. 6 which largely corresponds to the embodiment shown in FIG. 1 a pin 61 is provided in the uppermost tubular current lead-in member 60 and is secured in the outer bulb at 62. This pin 61 fits the tubular member 60 with some clearance. During operation of the lamp in which the actual discharge tube 63 may become very warm, it can expand without hindrance at the upper side. The pin 61 and the tube 60 slide relative to one another. The current lead-in to the member 60 takes place through the flexible wire 64 at one end is connected to said member and at the other end is connected to the pole wire 66 sealed in the pinch 65.

What is claimed is:

1. An electric gas discharge lamp having an envelope enclosing a discharge space and consisting of translucent densely sintered aluminum oxide, and at least one current lead-in member secured in a gastight manner in the envelope, said envelope having a cylindrical part at the area of the current lead-in member, a sealing element consisting of translucent densely sintered aluminum oxide disposed within the cylindrical part and sintered to the envelop in a gastight manner, said element having an aperture in which the current lead-in member is secured in a gastight manner by means of a sealing glass having a melting point higher than 800° C., and lower than the melting point of the translucent densely sintered aluminum oxide and of the metal of the current lead-in member, said lamp further comprising a cover having an aperture for the current lead-in member and consisting of a translucent densely sintered aluminum oxide and bearing against the end of the cylindrical part of the envelope and against the sealing element arranged therein, said cover being secured in a gastight manner to the envelope, the sealing element and the current lead-in member by a sealing glass having a melting point higher than 800° C. and lower than the melting point of the translucent densely sintered aluminum oxide and of the metal of the current lead-in member.

2. An electric gas discharge lamp as claimed in claim 1, wherein the cover projects beyond the cylindrical part and a rim of sealing glass is provided in the corner joint between said two parts.

3. An electric gas discharge lamp as claimed in claim 1 wherein the discharge space contains at least one alkali metal, mercury and at least one rare gas.

4. An electric gas discharge lamp as claimed in claim 3, wherein the alkali metal is sodium and the rare gas is xenon.

5. An electric discharge lamp as claimed in claim 1, wherein the current lead-in member consists substantially of niobium.

6. An electric gas discharge lamp as claimed in claim 1, in which the envelope of the discharge space is arranged within an outer bulb and at least one tubular current lead-in member which is open on the side remote from the discharge space, a pinlike supporting member being arranged some clearance in the tubular current lead-in member, the supporting member being rigidly secured to the outer bulb.

7. An electric gas discharge lamp as claimed in claim 6, wherein a flexible wire is connected at one end in an electrically conductive manner to a terminal which is secured in the outer bulb, and is connected also in an electrically conductive manner to the tubular current lead-in member.

8. An electric gas discharge lamp as claimed in claim 6 wherein the outer bulb is filled with an inert gas.

9. An electric gas discharge lamp as claimed in claim 7 wherein the terminal is secured in a pinch in the outer bulb.

10. An electric gas discharge lamp as claimed in claim 6, wherein the outer bulb is evacuated.

11. An electric gas discharge lamp as claimed in claim 1, wherein the lead-in member is tubular having a closed end in the discharge space.