

[54] **SEALED HIGH-PRESSURE ARC LAMP AND SOCKET THEREFOR**

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[51] Int. Cl.**H01j 1/92**

[58] Field of Search.....**313/204, 205, 221, 217, 283, 313/284, 285, 289, 288, 220, 113**

[56] **References Cited**

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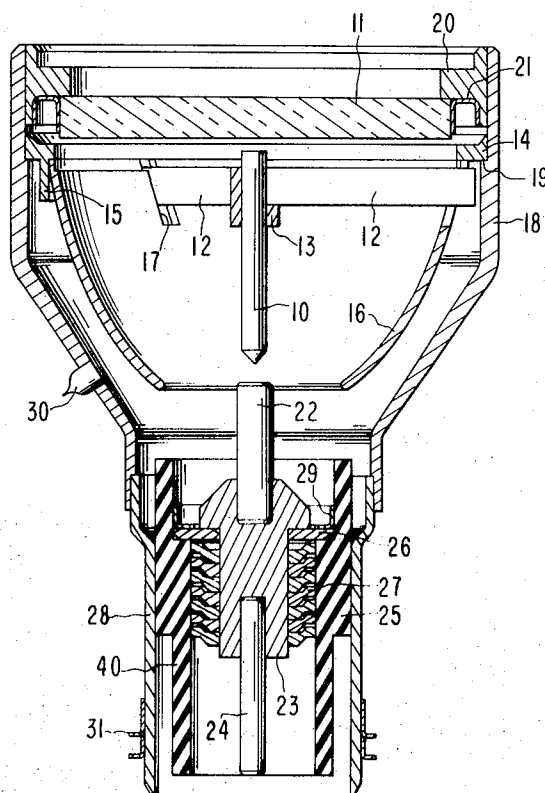
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[57] **ABSTRACT**

A sealed beam arc lamp is disclosed wherein the lamp exterior is at a single electrical potential. The non-window portion of the lamp exterior can be of high strength metal alloy. Electrical insulation is provided by a thermally conductive ceramic cylinder internal to the lamp and disposed so as to avoid tensile stresses, and by a sealed labyrinthine passage defined by a removable socket.

6 Claims, 3 Drawing Figures



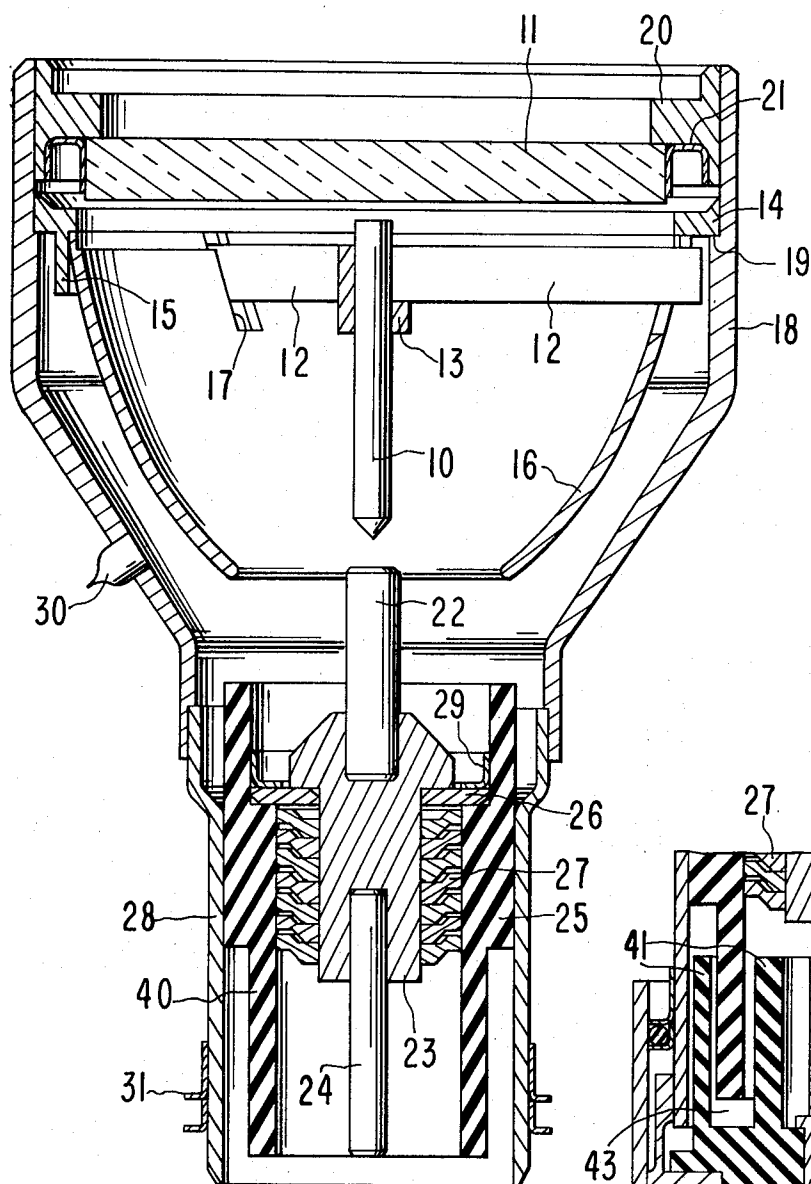


FIG. 1B

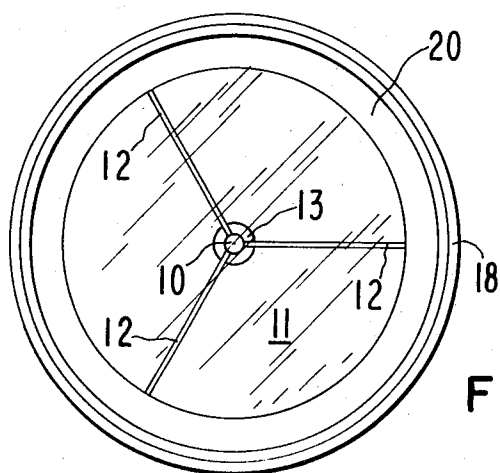


FIG. 1A

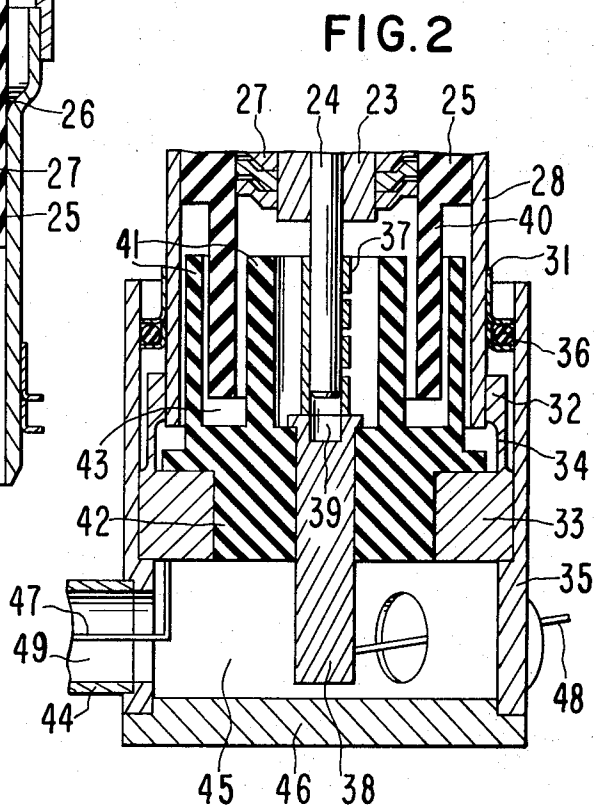


FIG. 2

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SEALED HIGH-PRESSURE ARC LAMP AND SOCKET THEREFOR

BACKGROUND OF THE INVENTION

This invention relates to gaseous discharge devices and in particular to an improved envelope and socket design for a sealed beam short arc lamp. The invention herein described was made in the course of or under a contract with the Department of Defense.

Sealed beam short arc lamps require relatively low voltage to operate, e.g. 10-50 volts, but require very high voltages, e.g., 10-35 kilovolts or higher, to start, depending on such things as lamp design, internal pressure, type of gas, and lamp age. This high starting voltage is required across the gap between the electrodes in order to ionize the gas in the gap. As noted, once started the ionization continues at low voltage.

In any lamp design various electrically conductive members will be at the same potential as one or the other electrode. It is necessary, therefore, to provide sufficient insulation between the various member pairs which are at different potential. This insulation must be disposed so as to prevent electrical breakdown between the electrically conductive members when the starting voltage is applied except, as noted, across the gap between the electrodes.

In prior art lamps, such as those described in U.S. Pat. No. 3,502,929 issued Mar. 24, 1970, and U.S. Pat. applications Nos. 109,527 and 109,537, both filed Jan. 25, 1971, and assigned to the same assignee as the present invention, a ceramic cylinder was used which had a face as part of the lamp exterior. Such designs place major limitations on lamp operation.

One limitation is that the ceramic cylinders are primarily under tension during operation because the high pressure in the lamp tends to push the lamp apart. Safe design stress limits for ceramics in tension have not been determined for uses of this type and the stress must therefore be kept below clearly safe levels.

A second major limitation arises because portions of the lamp exterior adjacent to the ceramic cylinder are at different potentials. If the lamp is operated in an atmosphere capable of carrying a current, e.g., in the rain or under water, the lamp can easily arc across the ceramic cylinder, especially at the high starting voltage. Similarly it is dangerous to handle the lamp during start up.

A third major limitation arises from the technique required to seal the ceramic insulator to the metal end members. The ceramic is commonly metallized and the metallized portion of the ceramic is then brazed to the metal members with copper or an alloy that melts at reasonable brazing temperatures. Under the forces imparted by the internal gas pressure, the brazed joint is either under tension or shear. Because of the very low creep strength of copper and the commonly used brazing alloys, the allowable stress in the joint must be kept very low, resulting in a severely limited operating temperature of the joint. This results in severe safety limitations for the lamp and limits its use in many applications.

A fourth major limitation arises from the limitations on cooling the lamp. High strength ceramic must be used because of the previously noted strength requirements. These ceramics have relatively low thermal con-

ductivity, limiting the heat removal rate from the area of the lamp comprising the ceramic. High thermal conductivity ceramics such as BeO are noted used because of their much lower strength. Most of the heat in such lamps is removed by conduction through the metal member opposite the window. Further, limitations are placed on the methods of heat dissipation. If a cooler is attached directly to the metal member, then it must be carefully located in respect to the lamp holder so that insulation from the high voltage starting pulse is maintained. Also the metal surfaces carrying the high voltage are exposed to the ambient cooling air, an undesirable practice in many applications, e.g., when air that is electrically conductive (e.g., from high moisture or salt content) must be used to cool the lamp. If the lamp is sealed in an enclosure to protect it from the electrically conductive ambient cooling air, then means must be provided to conduct the heat out of the enclosure. This results in a relatively long and inefficient heat path.

Another disadvantage of the prior art lamp is the requirement that electrical connections for the two electrodes be a substantial distance apart.

Summary of the Invention

The present invention is an improved envelope and socket design for a sealed beam short arc lamp. The ceramic cylinder provided electrical insulation between the electrodes and a short cooling path for one of the electrodes is internal to the lamp and socket. The exterior of the lamp is at a single potential and, except for the window, can be completely metallic. A labyrinthine sealed passage is formed when the lamp is inserted in its socket, preventing any breakdown between the electrical connections for the two electrodes.

The internal placement of the ceramic insulators means that it will be primarily under compressive or shear stress during operation, which is desirable for safest operation. The metallic exterior can better withstand tensile stress. It also provides advantages of superior cooling ability, higher strength so as to enclose gas at higher pressure if desired, and higher temperature operating capability since allowable stress for alloys at elevated temperatures are well established by the ASME Boiler Code. A single exterior potential makes it possible to start and operate the lamp in any atmosphere, including under water. It also allows a single socket to be used for the electrical connections to both electrodes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B are a top view and cross-sectional view, respectively, of an embodiment of the short arc lamp of the present invention, without the socket.

FIG. 2 is a fragmentary, cross-sectional view of the embodiment of the arc lamp of FIG. 1 inserted into a socket of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. 1A and 1B illustrate a sealed beam short arc lamp of the present invention removed from the socket providing electrical connections. One electrode, shown

as cathode 10, is mounted in the forward part of the lamp adjacent to window 11. The support for cathode 10 is shown as the type described in detail and claimed in copending U.S. application Ser. No. 143,377 filed May 14, 1971, and assigned to the same assignee as the present invention. Cathode 10 is supported by struts 12 which are abutted to cathode 10 in slotted sleeve 13. The other ends of struts 12 are attached to ring 14 at flaps (not shown) cut into lower portion 15. These flaps are detailed in the mentioned U.S. application Ser. No. 143,377. Reflector 16 is suspended from ring 14 and has slots 17 to accommodate struts 12. The importance of the various surfaces on ring 14 are described in detail in copending U.S. application Ser. No. 143,165 filed May 13, 1971, and assigned to the same assignee as the present invention. Briefly these surfaces allow for accurate referencing of the tip of cathode 10 to the focal point of reflector 16 and to the rest of the lamp.

The exterior of the forward portion of the lamp is cylindrical shell 18 made of a high strength metallic alloy, such as stainless steel. Ring 14 is attached to shell 18 at surface 19, cut into shell 18 and perpendicular to the axis of shell 18. This surface 19 controls the referencing of the rest of the lamp to the tip of cathode 10, as mentioned above. Window 11 is attached to ring 20 by generally U-shaped sealing ring 21. Ring 20 is attached to shell 18 to complete the forward subassembly. Rings such as ring 20 and sealing ring 21 are convenient to use to support window 11 because sealing ring 21 is under very little stress caused by the high pressure gas pushing against window 11. This stress is in window 11 itself and ring 20. Sealing ring 21 can therefore be thin and can relieve the stress caused by the radial expansion of window 11 as it heats up during assembly and operation of the lamp.

A second electrode, here an anode, is supported in the rear of the lamp. Here the anode assembly is in three parts: a forward cylindrical portion 22 which is the tungsten anode and defines the arc gap between the electrodes, a base cylindrical portion 23 which provides surfaces for attachment to other parts of the lamp and from which heat is dissipated, as described below, and a rear cylindrical portion 24 to which electric power is applied. The anode structure is supported on the axis of ceramic cylinder 25 by metallic ring 26 and heat transfer members 27. These members 27 are described in detail in copending U.S. Pat. No. application 135,472 filed Apr. 19, 1971 and assigned to the same assignee as the present invention. In the present embodiment members 27 are of copper and are generally cone shaped. These members 27 deform in order to relieve stresses caused by the differential expansion and contraction of the tungsten anode portion 23, copper members 27 and ceramic cylinders 25. Surrounding and attached to the ceramic cylinder 25 is a high strength metal alloy shell 28, of a material having approximately the same thermal expansion coefficient as the ceramic, such as an alloy of iron, nickel and cobalt sold under the trademark Kovar. Heat from the anode is in part dissipated out through ceramic cylinder 25 and shell 28 to the lamp exterior where it can be removed by cooling means (not shown). A sealing ring 29 of, for example, Kovar is used to seal metallic ring 26 to ceramic cylinder 25. This provides the hermetic seal between the anode assembly and ceramic cylinder.

The connections on inner and outer faces of rings 27 need not be hermetic but merely thermally conductive.

The importance of the backward extending portions of the anode structure 24, of cylinder 25 and of shell 28, together with O-ring seat 31 are discussed in connection with the socket shown in FIG. 2. The forward extending portion of cylinder 25 helps to electrically insulate the anode structure from the lamp exterior.

The rear and front portions of the lamp are connected by attaching metallic shell 28 to metallic shell 18. Air is evacuated and the lamp is filled with gas under pressure through pinch-off 30. With the lamp so assembled, in its socket, the lamp exterior, except for window 11, is metallic.

It is recognized that shear stress may be resolved into tensile and compressive components. It is the object of the invention to minimize the tensile component because of the very high compressive strength of ceramics and the comparatively much lower (and more unreliable) tensile strength. It is the further object of the invention that the tensile strength of ceramic available for use be used not purely to support the internal gas pressure but to support primarily the thermal stresses that arise when heat flows through the ceramic. When heat flows through ceramic, despite the high thermal conductivity of the ceramic used, a difference in temperature will arise between the area of entrance of the heat and the area of exit. Because of the thermal expansion of ceramic with increased temperature and the relating non-ductile nature of ceramic, internal tensile stresses will arise because of the temperature gradient.

It is necessary to distinguish the stress arising from different thermal expansion coefficients of sleeve 28 and ceramic 25 from the stress applied to sleeve 28 by internal pressure bearing against the anode assembly and that force transferred through ceramic 25 to sleeve 28. It is desirable when brazing sleeve 28 to ceramic 25 to select dimensions such that when the assembly cools from brazing a hoop-tensile force is residual in sleeve 28 and hoop-compressive force in ceramic 25. Then, when the lamp is pressurized and operating, a greater capacity to absorb the tensile component of the shear and thermal stresses results. The force on the anode assembly caused by the internal pressure is taken by the ring 26 which imparts a compressive force on the end of the cylinder 25. The force on the anode assembly and the cylinder 25 results in shear stresses in cylinder 25 near sleeve 28 and in the brazement, which, in this embodiment, is the means of attaching cylinder 25 to sleeve 28.

Electric power for forward electrode 10 is provided at the back end of shell 28, as described below, from where it passes through shell 18, ring 14 and struts 12 to reach forward electrode 10. This means that the lamp exterior is at a single potential and therefore the lamp can be operated in an atmosphere capable of conducting electricity, which the prior art lamps could not.

FIG. 2 illustrates the improved socket of the present invention with the lamp inserted therein. The primary electrical contact for the forward electrode is provided by prongs 32. These can be of any convenient form meeting the requirement of providing a good electric contact when metallic shell 28 is pushed into the socket. In the embodiment illustrated, prongs 32 have

thin portion 34, allowing prongs 32 to act as springs so as to remain in contact with shell 28. Prongs 32 are attached to ring 33 to which electrical power will be applied as described below. Metallic outer shell 35 of the socket overlaps metallic shell 28 of the lamp. Shell 35 is attached to ring 33 and is therefore at the same potential, giving the lamp-socket combination a strong metallic casing at a single potential. The two shells (28 and 35) are spaced apart by O-ring seal 36 in seat 31. This seal 36 allows the interior of the socket to remain at atmospheric pressure and prevents an electrically conductive atmosphere from entering the socket, as discussed below. The placement of the prongs 32 and O-ring 36 are a matter of convenience. The prongs could, for example, contact the inside of the sleeve 28 and the O-ring could be on the socket.

The electrical connection for the rear electrode is made to rear portion 24 by metallic flexible sleeve 37 attached to metallic cylinder 38. Sleeve 37 is of any convenient design providing a good electrical contact when electrode portion 24 is inserted therein. Electrical power will be applied to cylinder 38, as described below.

A ceramic cylinder 42 separates the various members at the potential of forward electrode 10 (e.g., ring 33, sleeve 28) from the members at the potential of rear electrode 22 (e.g., cylinder 38, electrode portion 24). If this cylinder 42 were of regular form so as to simply abut the end of ceramic cylinder 25 of the lamp, a surface, or worse a gap, could be present between these ceramic cylinders providing an easy path for electrical discharge between members at different potential. Even if the cylinders 25 and 42 had precisely matching surfaces when the lamp and socket were new, in use dirt can enter the socket or members can deform slightly, leaving a path for such a discharge. Therefore, a labyrinthine passage 43 of sufficient length to prevent discharge is formed between members of different potential. One or more cylindrical extensions 41 are formed in cylinder 42 with complementary cylindrical extensions 40 formed in cylinder 25. Axial spacing is controlled by an external holder (not shown) attached to the socket and forward portion of the lamp, with passage 43 and hole 39 in cylinder 38 allowing space for axial expansion of the various members. A total of three extensions are shown but more or less can be used to create the necessary path length. For example at a starting voltage of 15 kv, three extensions are sufficient. The labyrinthine passage 43 is sealed from the lamp exterior by sealing ring 36, as noted above, so that pressure can be maintained in the socket when the lamp is operated in an atmosphere of reduced pressure and to keep out an electrically conductive atmosphere. Pressure must be maintained because corona discharge occurs more easily at lower pressures.

Electrical connections for both electrodes enter the lamp through tubes 44 inserted through shell 35 into the base of the socket. Three equally spaced tubes 44 are normally used for convenience in external mounting but only two are used for the electrical connections, namely, wires 47 and 48 attached to ring 33 (forward electrode) and cylinder 38 (rear electrode), respectively. Wire 47 could be attached to the socket exterior but it is convenient to use an interior connection for greater safety and reliability of electrical contact. Elec-

trical insulation is provided by filling the spaces 45 and 49 with an appropriate material, such as liquid porcelain. A cap 46 is placed over the end of the socket to protect the insulation.

While the socket has been described in terms of a removable lamp, it can of course be permanently attached. Then a hermetic seal could be used in place of O-ring 36 and flexible connectors (sleeve 37 and prongs 32) are not required. A single piece exterior shell could then be used in place of shells 28 and 35 and a single rear electrode portion 24 could be used, eliminating separate cylinder 38. The same type of electrical connection could be used although ring 33 could be eliminated.

Other types of electrical connections could be used with the present invention. For example, shell 35 and cylinder 38 could be, in effect, extended as far as desired in the form of a normal cable attached thereto.

What is claimed is:

1. An arc lamp comprising:

a sealed envelope including a base and an Optical window opposite said base, said envelope containing an ionizable gas at a pressure higher than atmospheric pressure,

the exterior of said lamp comprising a metallic portion,

a first electrode supported within said envelope opposite said base by conductive support means providing electrical contact between said first electrode and said metallic portion whereby the exterior of said lamp can be maintained at the same electrical potential as said first electrode,

a second electrode supported in said base, means for connecting the second electrode to a source of power,

a ceramic cylinder disposed between said second electrode and the exterior of said lamp so as to form at least part of the electrical insulation of said second electrode from the exterior of said lamp, and a reflector supported within said envelope.

2. An arc lamp as claimed in claim 1 wherein said ceramic cylinder comprises a heat dissipating material to transfer at least part of the heat from said base second electrode.

3. An arc lamp as claimed in claim 1 wherein the stress caused by said high-pressure ionizable gas upon said ceramic cylinder is primarily compressive.

4. An arc lamp as claimed in claim 1 wherein the base of said lamp is insertable into an electric power providing socket which comprises said means for connecting the second electrode to a source of power.

5. An arc lamp as claimed in claim 4 wherein the ceramic cylinder of said lamp comprises one or more extensions whereby when the base of said lamp is inserted into a socket which also comprises a ceramic cylinder having one or more extensions, the extensions of said socket cylinder being interspersed with respect to the extensions of said lamp cylinder, a labyrinthine passage is created.

6. An arc lamp as claimed in claim 1 wherein the base of said lamp is irremovably attached and hermetically sealed to a member comprising a ceramic cylinder having one or more extensions whereby a sealed labyrinthine passage forming part of the electrical insulation of said second electrode from said lamp exterior is created.

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