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K. ITTIG ET AL
HIGH PRESSURE GAS LAMP

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Fig. 2

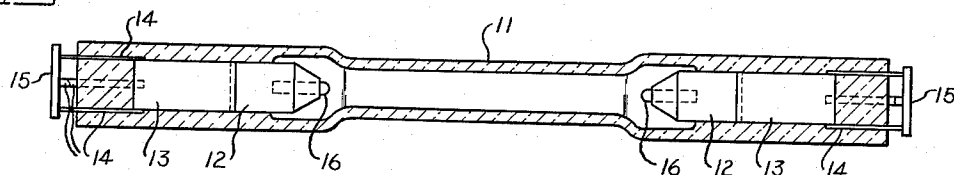


Fig. 1

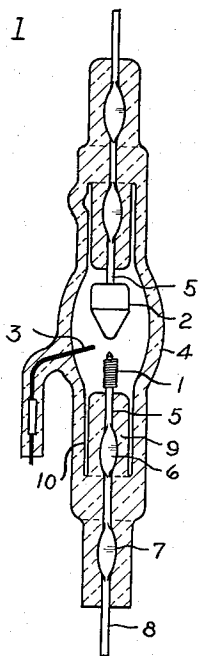


Fig. 3

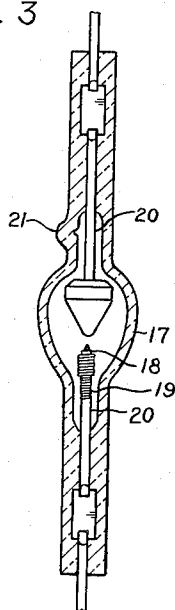


Fig. 4

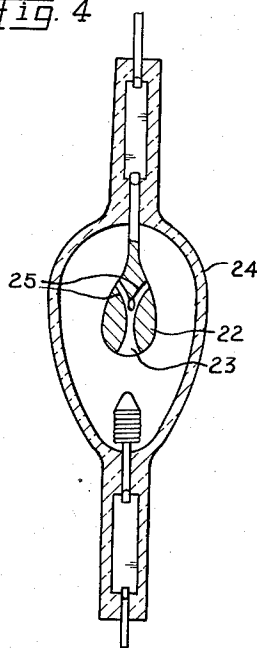
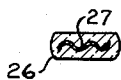


Fig. 5



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HIGH PRESSURE GAS LAMP

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2 Claims. (Cl. 313—217)

The invention relates to electric high pressure discharge lamps in which the high pressure discharge between solid, usually activated, hot electrodes occurs at pressures in excess of one atmosphere in a discharge container preferably made of quartz glass transparent to visible and/or invisible radiation, and containing a gas filling, preferably of rare gases, especially krypton and/or xenon. In comparison with metal vapor lamps, these high pressure gas lamps do not need heating for the production of vapor and are ready for operation at once. Such high pressure gas lamps are suitable, according to the gas filling, for lighting, irradiation, color film photography, and further for spectral absorption analysis, ultraviolet therapy, as well as flashtubes, especially for impulse current operation and so forth.

According to the invention, high pressure gas lamps, especially rare gas high pressure lamps, have considerable advantages, particularly in respect to the degree of effectiveness of the radiation production, when the discharge container, preferably without dead areas, is formed in such a way that in operation of the lamp an even temperature distribution occurs across the entire discharge container and the wattage loading in watts/cm.² results in the highest surface area load permissible for the material of which the container is made.

In constructing high pressure lamps of this kind, it is necessary to insure that the electric arc is sufficiently stable, because the arc tends to burn irregularly on account of the low gradient in the gas filling in comparison with that in mercury vapor lamps. Under irregular burning is to be understood the back and forth springing of the electric arc with appearances of flickering, the side-ward bending, and frequent change of appendage point of the arc on the hot electrode.

One way of improving the stability of the electric arc is through the use of direct current, whereby the hot area of the anode, which is situated preferably vertically above the cathode, often becomes greater than that of the hot cathode situated below. It may develop to a size 5 to 10 times greater than that of the hot cathode, whereby the disintegration of the anode can be held low.

According to another feature of the invention, use is made of a laminated convection current and the development thereof may be helped through suitable shaping of the anode. To this end, the anode may be built streamlined, thereby getting a Jukowsky or teardrop profile, so that the hot gases stream up on it, preferably without whirl. There is also an advantage in providing an axial hole in the anode body with a diameter approximately one-third of the size of the maximum diameter of the anode measured normal to the electric arc axis. Then the hot electric arc gases will stream vertically upward through the anode, contributing to the stabilization of the arc. Some kind of suction often appears through chimney effect.

In some cases it may be advantageous to produce the

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hot cathode from several (4—10) closely joined single wires made of tungsten or thoriated tungsten. The cross section of the wires may be determined such that the current density of the discharge, occurring at the same time on the front face of all wires, attains or exceeds 1000 amp./cm.². The single wires may be of round cross section, and the spaces between them may be filled with activating substances, preferably thorium oxide.

High pressure lamps with a comparatively long arc column and wherein the electrode distance is greater than the size of the cross section of the discharge tube in order to make use of wall stabilization achieve good stabilization of the electric arc, if the current density measured in amp./cm.² is selected greater than 50 times the filling pressure measured in atmospheres. The discharge tubes, generally made of quartz glass, are in such case artificially cooled by means of gas or liquid flow.

In certain instances we have found it advantageous for the stabilization of the electric arc to provide within the discharge tube between the electrodes, transverse to the electric arc axis, one or several perforated discs made of quartz, ceramic or metal. Some high pressure lamps with comparatively long arc columns achieve stabilization through a curvature of the discharge tube; in such case, care must be taken not to overheat the curved wall areas containing the arc. Such overheating may be prevented through corresponding outside cooling.

The form or shape of the discharge container of high pressure gas lamps is of practical importance, because with gas fillings at very high cold pressures of 20 to 50 atmospheres and over it is necessary to counteract the danger of explosion. The smaller the dimensions of the discharge container, the greater is its solidity and there is less possibility of explosion. Therefore, according to another feature of the invention, the lamp container is not shaped like a globe or ball, but rather is egg-shaped with the tip pointed downward, whereby to obtain an even temperature distribution over the entire container and therewith eliminate local over-temperature or container stress. When the electrodes are arranged in such a way, that at least 60%, preferably 75%, of the inside surface of the container is situated above the appendage point of the arc on the anode, then the wattage may be selected 30—50% higher than for instance in a globe-shaped discharge container with the same inside surface.

With a given operating gas pressure, the smallest cold gas pressure occurs if the lamp container is built extremely small and therefore the highest possible operating temperature is reached. It is advisable to reduce the discharge container of bulbs made of quartz glass to avoid dead areas in such a manner that the burden or loading of the inside surface reaches at least 50 w./cm.². It is therefore important to build the lamp container of high melting material, meaning quartz glass or even higher melting glasses with added aluminum oxide, magnesium oxide or zirconium oxide. From other points of view, for instance inexpensive manufacture by reason of ease of working, it would be appropriate in some cases to use comparatively low melting hard glass, whereby again an even temperature distribution is of importance. It is also feasible to provide artificial liquid cooling of high pressure gas lamps similar to that of high pressure mercury lamps with good results, whereby a gas filling of very high cold pressure, e.g. 50 atm., may be accommodated in explosion-proof manner within a capillary discharge tube of about 5 to 10 millimeters inside diameter. Generally, the ends of such a tube have to be widened somewhat for the accommodation of the electrodes. Lamps of this kind usually have a burning voltage of over 40 v. and considerable power consumption,

for instance about 1000 w., and constitute very high intensity sources.

In using rare gas fillings, e.g. krypton and/or xenon, one obtains by operating at high current intensity very high radiation output even in the visible spectrum. A xenon lamp with 30 atm. operating pressure and a discharge current of 200 amperes gives a light output of about 40 lumens/watt in an extensive continuous spectrum with high red content, so that such lamps are very suitable for the purpose of color tests and irradiation.

Because most gas high pressure lamps are operated at high current intensities, the current conductor or lead-in is of great importance in these lamps. Good results were attained by a lead-in seal, in which two molybdenum foils are arranged one behind the other with some distance in between, or a crimped molybdenum foil is melted-in.

Rare gas lamps, especially with a filling of krypton and/or xenon, intended to provide an extremely high light intensity with a solid lighting area for the purpose of projection, may have the anode situated close to the cathode, so that the positive column of the discharge is extensively suppressed, and only the immediate vicinity of the cathode radiates. A current intensity of 10 to 50 amperes is suitable for an electrode distance of 0.5 to 2 millimeters.

For the purpose of film projection, the discharge lamp may be supplied with alternating current with a picture frequency of 24/sec. in 50 periods.

In using rare gas lamps for the purpose of film projection with a normal presentation apparatus of 24 hertz, the rare gas lamp may be supplied current pulses through a condenser discharge in such a way that during each light period two or more light flashes occur, one of which should occur in the beginning, the other one shortly before the end of the light period. If these pulsating discharges are controlled in such a way that they only occur during standstill of the film, then the usual shutter may be omitted.

High pressure gas lamps having cold pressures of 0.5 atm. to 100 atm. and higher should preferably use rare gases. Rare gases with the highest atomic weights, namely, krypton and xenon, give the best results. In some cases there are advantages in using mixtures of rare gases, or mixtures of rare and other gases. For instance, a lamp filled with krypton and/or xenon, with an operating pressure of 30 atm., shows an increase of light density and light output if its basic gas filling receives an added 1 to 5% of gas with an atomic weight of 20 or less, e.g. hydrogen, helium or neon.

To obtain a definite spectral distribution or color effect, or for increasing the potential gradient and therewith the wattage consumption of the lamp, supplementary agents may be added to the gas filling, e.g. metals whose vapors are also excited in the operation of the lamp and produce radiation.

A rare gas high pressure lamp, especially a xenon lamp with at least 5 atm. cold pressure and at least 5 amp. operating current, may achieve in an economical way an extremely accurate imitation of daylight, if the discharge container or envelope is made of filter glass containing 0.1-0.5% nickel oxide. The resulting loss is small, because the xenon high pressure arc already furnishes extensively the spectral distribution of daylight. Lamps of this kind are suitable for research on color.

The hot electrodes of the high pressure gas lamps are furnished in most cases from difficultly vaporizable activating substances, e.g. thorium oxide. The thorium oxide may be incorporated in the sintered electrode body. Thoriated tungsten wires may also be used for the construction of the electrodes. In some cases, there are advantages in using only polished tungsten electrodes, in which instances attention must be paid to utmost cleanliness, and therewith giving up any activation. Giving

those tungsten bodies and polished top parts of activated electrodes a high density is also of advantage. This may be attained by sintering the tungsten bodies from fine-grained tungsten powder and using high pressures at high sintering temperatures and extensive hammering of the finished sintered tungsten bodies. By so doing, lamp life and lumen maintenance are considerably improved because of the decrease in soiling and blackening.

From the point of view of life and maintenance, the use of getter materials is advantageous, especially the installation of auxiliary bodies of tantalum, zirconium or thorium. These bodies have to be arranged in such a manner that they attain absorbing temperatures during operation of the lamp.

In using direct current, the installation of a choke coil in the current circuit is of advantage for improving the stability of the arc.

Since the light output increases with pressure, it is suitable to insert the actual discharge container into an outer bulb filled to a pressure substantially higher than atmospheric, but not higher than 80% of the pressure in the discharge container.

Instead of pure tungsten electrodes or electrodes with thorium oxide, one may use electrodes which employ other high melting and difficultly vaporizable metals favorable for arc appendage and/or ignition, beside tungsten, e.g. sinter mixtures of tungsten and zirconium, molybdenum, tantalum or platinum metals, whose gettering characteristics can then also be utilized. The point of the electrode suitable for appendage of the arc may consist of pure tungsten of especially high density, so that its good operating characteristics, especially with regard to evaporation, may be utilized, while mixed sinter bodies situated behind take part in ignition and gettering.

For instance, a tungsten mixture sinter body, containing one or more auxiliary metals of this kind, may have an axially inserted tungsten wire of high density, which at the same time forms the point of the cone-shaped, continuous mixture sinter body.

The drawing shows by way of example high pressure lamps with gas filling and solid hot electrodes constructed in accordance with the invention. In the drawings:

Fig. 1 shows in side section an air-cooled quartz glass lamp for direct current operation;

Fig. 2 shows a liquid-cooled quartz glass lamp for A.C. operation;

Figs. 3 and 4 show other air-cooled quartz glass lamps for D.C. operation with egg-shaped bulbs for achieving even temperature distribution;

Fig. 5 is a cross-sectional view of a sealing nipple which may be used in lamps according to the invention.

Fig. 1 shows an air-cooled quartz glass lamp for direct current operation, which contains a filling of xenon of about 12 atm. The lamp is drawn to scale, the over-all length of the quartz body being approximately 11 centimeters. The hot electrode 1, situated below, consists of a cone-shaped, pointed thoriated tungsten pin, onto which two thin wire tungsten coils are solidly screwed with closely joined windings. To facilitate ignition, thorium oxide may be applied between the turns of the coil. The anode 2 situated above is substantially larger in construction and consists also of a cone-shaped tungsten sintered body. A tungsten ignition wire 3 is positioned beside the discharge path to ignite or control the lamp at low voltage. The central portion of discharge container 4 is formed to a slightly oval shape. It will be noted that in this lamp, as also in the other lamps presently to be described, the maximum diameter of the envelope or container transverse to the arc gap is not greater than a few times the maximum transverse diameter of the anode. Cathode 1 and anode 2 are supported by molybdenum wires 5, which are hammered at two places 6 and 7 to flat foils of oval shape. These foils are melted or squeezed vacuum tight into the surrounding quartz glass. The outer foil 7 is situated so far from the discharge space

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that it experiences only a slight heating during operation of the lamp; as a result, harmful oxidation of the outer molybdenum wire end 8 is avoided. The quartz glass re-entrant body 9, wherein foil 6 is embedded vacuum tight, is surrounded by a capillary ring or cleft 10 connected to the discharge space and therefore is also subject to the high pressure of the gas filling. This causes in an advantageous way a release of pressure on the seal. A tight seal of the current conductor is assured by the series connection of the foils as illustrated.

Fig. 2 shows a high pressure lamp in tube form designed for water cooling and A.C. operation. The lamp is drawn to scale and the over-all length of the quartz body is approximately 16 centimeters. The well-known jacket device which surrounds the lamp for conduction of the water is not shown in the drawing. The lamp is filled with xenon at about 1 atm. and is designed for an operating current of about 100 amp. The somewhat widened end parts of the quartz discharge tube 11 enclose tightly the electrode bodies 12, behind which the molybdenum foils 13 are arranged. The foils extend over the backward part of the electrode and are connected on the other end with several current supply wires 14. The supply wires are connected with each other by the contact discs 15. The foils 13 are hull-like, that is, they do not close to form complete cylinders; the inside of the foils is filled by a hollow quartz body, which is put under pressure in the manufacture of the seal and which, as a result, presses outward against the container end socket, thereby effecting a vacuum-tight seal of the foil.

The electrodes 12 consist of cone-shaped pointed tungsten sintered bodies, of which the forward parts are built with the rounded point of a thoriated tungsten wire 16 situated in the sintered body. In place of, or in addition to the thoriated wires, one may accommodate activation or getter material in the borings of the electrode bodies 12. It is also possible to incorporate materials of this kind into the electrode sintered bodies.

The high pressure lamp as shown in Fig. 3 has an egg-shaped lamp container 17. The cathode core wire 18 carries again two thin wire coils; the inner coil 19 is extended backward for better heat conduction. The capillary ring or cleft 20 behind the electrodes, in conjunction with tubulation 21, facilitates the installation and removal of the pump stem in manufacture and the insertion of the gas filling as a liquid at very low temperatures.

Fig. 4 shows a high pressure lamp, with a streamlined anode body 22 to obtain laminar flow and having an axial boring 23, which opens into side channels 25 on the rearward (upper) end of the electrode. Discharge container 24 is built egg-shaped in such a way that during operation of the lamp an even high temperature occurs across the entire inside.

Fig. 5 shows in cross section a melt-in nipple comprising a quartz glass body 26 into which is fused a molybdenum foil 27 of crimped section and tapered toward its sides. Such a nipple may be fused into the end of a quartz tube to provide a sealed lead-in wire.

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The crimped configuration permits a smaller nipple, that is, one of lesser width, to carry a heavier current and may permit avoiding resort to a relatively expensive foil ring arrangement such as shown in Fig. 2.

While certain specific embodiments of the invention have been shown and described in detail, these are intended as illustrative examples and not in order to limit the invention thereto. Obviously, the invention is applicable to discharge lamps differing in shape, configuration, size and rating from those which have been illustrated and specifically described. The appended claims are intended to cover any such modifications coming within the true spirit and scope of the invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A high pressure electric discharge lamp comprising a quartz glass envelope having a pair of solid hot electrodes sealed therein, the internal area of said envelope being such as to result in a wall loading of at least 50 watts/cm.² in normal operation of said lamp, said lamp containing a filling at a cold pressure in excess of 0.5 atmosphere and consisting of a gas from the group consisting of xenon and krypton and mixtures thereof and 1 to 5% of gas having an atomic weight not greater than 20.

2. A high-pressure electric discharge lamp for operation in a vertical position on direct current comprising a light-transmissive envelope having a pair of solid hot electrodes sealed therein and containing a filling of inert gas at a cold pressure of several atmospheres, said electrodes comprising a cathode situated lowermost and a considerably bigger anode situated vertically thereabove and defining therewith a relatively short arc gap, said anode being streamlined and shaped substantially like a teardrop in vertical section and having an axial hole therethrough terminating at its lower face and leading into lateral channels on its rearward end whereby to achieve laminar flow of the filling gas therethrough, said envelope having a diameter transverse to the arc gap not greater than a few times the maximum transverse diameter of the anode and being egg-shaped with the tip pointed down, said electrodes being positioned relative to the envelope such that at least 60% of the inside surface of the envelope is situated above the appendage point of the arc on the anode.

References Cited in the file of this patent

UNITED STATES PATENTS

50	2,060,043	Cox	Nov. 10, 1936
	2,093,892	Lemmers	Sept. 21, 1937
	2,459,579	Noel	Jan. 18, 1949
	2,567,491	Mitchell	Sept. 11, 1951
	2,697,183	Neunhoeffter	Dec. 14, 1954
55	2,707,247	Anderson	Apr. 26, 1955

FOREIGN PATENTS

485,489	Great Britain	May 20, 1938
920,517	France	Apr. 10, 1947