

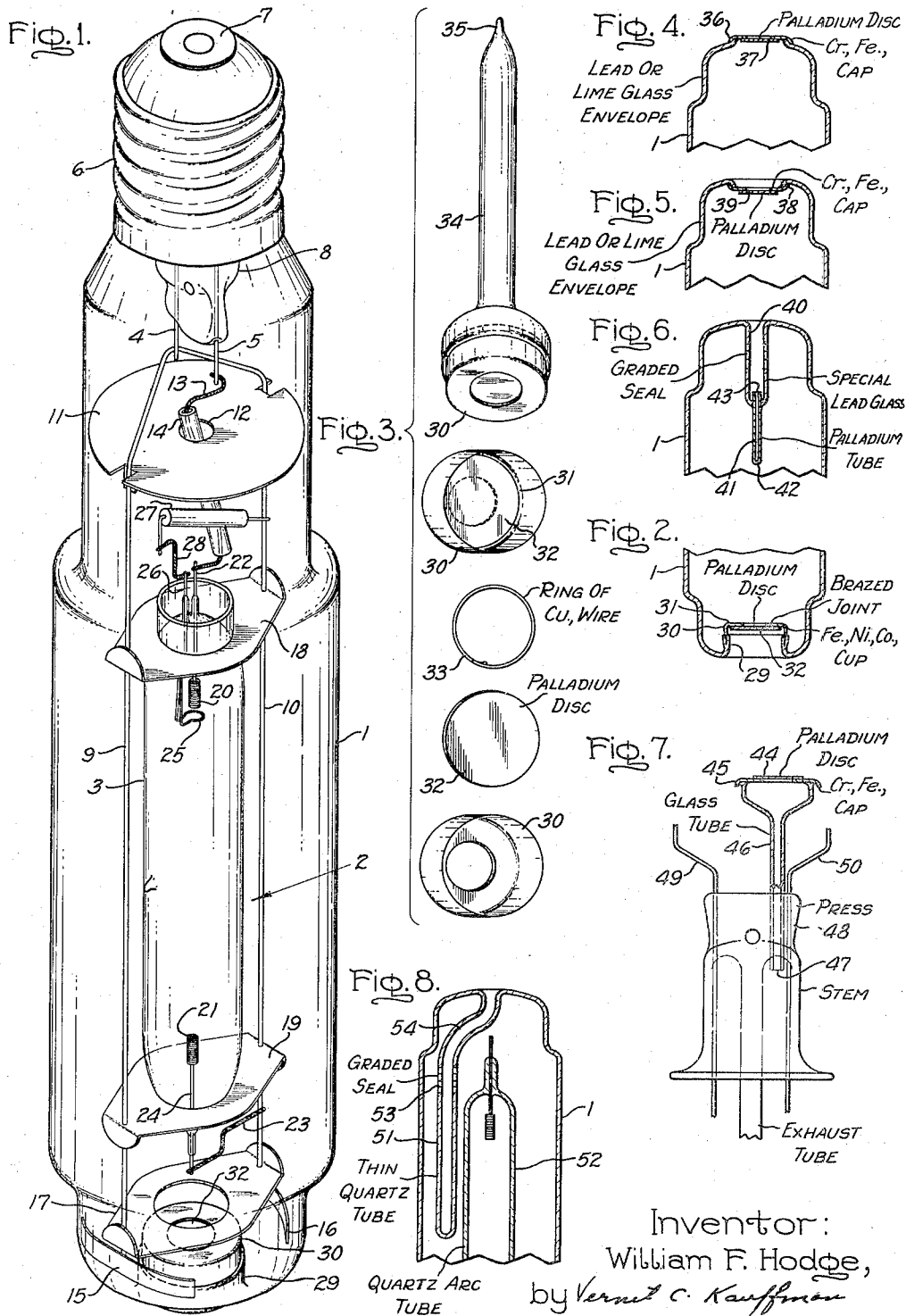
July 1, 1958

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2,841,733

ELECTRIC DISCHARGE LAMP

Filed April 29, 1953



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ELECTRIC DISCHARGE LAMP

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Application April 29, 1953, Serial No. 351,847

5 Claims. (Cl. 313-184)

My invention relates to electric discharge devices and more particularly to high pressure mercury vapor discharge lamps employing two or double envelopes, the innermost one of which encloses an arc discharge path.

High pressure electric discharge devices, such as high pressure mercury vapor lamps, have been employed commercially for a number of years not only in the production of visible radiation but also for the production of ultraviolet radiation in the near and far ultraviolet regions. As a general matter, these high pressure mercury vapor lamps have employed two envelopes, the inner one being of a tubular or elongated shape. Generally, the inner envelope or arc tube has been constructed of quartz because of its ultraviolet radiation transmitting qualities, its ability to withstand high temperature, and the relative facility with which lead-in wires and electrode structure may be sealed into the ends thereof. The outer envelope, generally, has been constructed of a hard or heat-resisting glass, and of course may be hermetically sealed to retain in the space between the inner and outer envelopes a quantity of a suitable gas such as nitrogen which serves as a heat transmitting medium and to prevent oxidation of seals and metal parts. Alternatively, the space between the inner and outer envelopes need not be filled with a gas but may be evacuated.

Considerable difficulty has been experienced during operation of such high pressure mercury vapor devices and lamps due to the generation during operation of appreciable quantities of hydrogen. Whatever the source of the hydrogen, it has been found that due to the ability of hydrogen to permeate or diffuse through the quartz, at the normal high operating temperature (about 600° C. to 900° C.) the hydrogen is found within the inner envelope or arc tube causing discoloration of the arc tube, and increase in starting voltage and operating voltage of the lamp with consequent reduction in life, lumen maintenance and efficiency throughout life.

Various improvements, many of which are worthwhile, have been made within recent years to reduce the rate at which the hydrogen is generated within a lamp of this general nature. One such improvement is that disclosed and claimed in United States Letters Patent No. 2,611,883, granted September 23, 1952, on an application of Edward B. Noel, and which is assigned to the assignee of the present application.

It has appeared that one of the most prominent causes of failure, or premature failure of lamps of the high pressure mercury vapor type, has been the appearance of hydrogen in the arc tube. Until quite recently, it had never been determined with any degree of accuracy whether this hydrogen evolved from the arc tube or from the outer glass envelope, although some investigations carried out showed that it did not come from some specifically investigated parts comprising the total lamp assembly. Recent work, however, has indicated that probably a substantial part of the hydrogen is evolved from

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the glass of the outer envelope by photochemical action of the ultraviolet radiation produced by the electric arc between the electrodes within the inner arc tube. This photochemical action continues for quite a long time.

It is impractical to completely drive off hydrogen during a preliminary or manufacturing baking process in devices using some types of glass. However, it is not to be assumed that all of the hydrogen produced is due to the above-mentioned photochemical action of the ultraviolet radiation. There is some evidence to indicate that a part, apparently a small part, is due to the operation of the lamp parts at the elevated temperatures of normal lamp operation.

It is an object of my invention to provide a new and improved electric discharge device.

It is another object of my invention to provide a new and improved high pressure mercury vapor electric discharge device or lamp having a greater life than that afforded by the prior art arrangements and which maintains a substantially higher lumen maintenance and efficiency throughout life.

It is a further object of my invention to provide a new and improved double-envelope high pressure mercury vapor ultraviolet generator or lamp which rather completely solves the problem of undesirable hydrogen within either the inner or outer envelope.

Generally speaking, in accordance with the broader aspects of my invention, I provide a means, such as a palladium diaphragm, in the envelope of an electric lamp, to diffuse to the surrounding atmosphere hydrogen which may be generated during normal operation of the lamp at temperatures within the range from 600° C. to 900° C.

More specifically, in accordance with the illustrated embodiments of my invention, I provide in a high pressure mercury vapor device or lamp constructions whereby hydrogen generated during normal operation of the device or lamp is diffused to the surrounding atmosphere through means sealed in the outer envelope. These embodiments of my invention may take several forms such as a palladium disc or diaphragm sealed in the outer envelope, a palladium disc construction sealed in a stem press and in communication with the outside atmosphere, or a thin quartz tube extending into the space between the inner arc tube and the outer envelope but in communication with the surrounding or outside atmosphere. The hydrogen permeable member, such as a member of palladium, quartz or other suitable material, is preferably mounted in a position where it will operate at as high a temperature as possible consistent with the normal operation of the device, since permeability of hydrogen increases with temperature. I have appreciated that, due to the low partial pressure of hydrogen in the atmosphere a material or substance pervious to hydrogen at normal operating temperatures of the device or lamp will serve as a means for automatically diffusing to the surrounding atmosphere a large percentage of the hydrogen which is generated within the lamp. This is accomplished by the equalizing action of the diffusing means which serves to diffuse the hydrogen to maintain a balance or equalization of the partial pressure of hydrogen within the interenvelope space with the partial pressure of the hydrogen of the outside or surrounding atmosphere. The hydrogen which may be present within the inner quartz envelope or arc tube will diffuse therethrough to the interenvelope space between the inner and outer envelopes and will accordingly be diffused to the outside atmosphere through the construction provided in the outer envelope for this purpose.

For a better understanding of my invention reference may be had to the following description taken in con-

nection with the accompanying drawing and its scope will be pointed out in the appended claims.

Fig. 1 is a view of a high pressure mercury vapor lamp employing one embodiment of my invention in which a palladium disc or diaphragm is sealed in the end of the outer envelope.

Fig. 2 is a detailed view of the palladium diaphragm construction.

Fig. 3 illustrates steps in the method which may be employed in the construction of the palladium disc or diaphragm constructions of Figs. 1 and 2.

Figs. 4 and 5 are further modifications showing different arrangements in which the palladium disc may be sealed to the outer envelope which may be either of the lead or lime glass type.

Fig. 6 is a still further embodiment in which a palladium tube is sealed to a re-entrant portion of the outer envelope.

Fig. 7 is a still further modification in which a palladium disc is connected to and supported by the stem press through a glass tube which is in communication with the outer atmosphere.

Fig. 8 is a still further modification in which a thin quartz tube is connected to a re-entrant part of the outer envelope and extends into the proximity of the arc tube and serves as the means for diffusing hydrogen from the inside of the outer envelope to the surrounding atmosphere.

Referring now specifically to the embodiment of my invention illustrated in Fig. 1, I there disclose it in connection with an electric discharge device or lamp of the high pressure type, commercially designated as the 400-watt EH-1 lamp, comprising an outer glass envelope 1 which houses a source of ultraviolet radiation such as a high pressure mercury vapor arc discharge device 2. The discharge device 2 may be of the type disclosed and claimed in United States Letters Patent No. 2,247,176—Pirani et al., granted June 24, 1941, and assigned to the assignee of this application. The starting and operating characteristics of such lamps are well known at present. During operation, the electric discharge is of the high pressure type, that is, it is constricted by the high pressure mercury vapor atmosphere so that it does not completely fill the entire cross section of the inner quartz envelope or arc tube 3, but appears as a luminous chord spaced from the inner wall of the envelope or arc tube 3. Arc tube 3 is of heat-resistant material, pervious to ultraviolet radiation, and is preferably constructed of quartz.

Electric lead-in wires 4 and 5 are connected to the threaded shell 6 and the metal eyelet 7, respectively, of the screw thread base, and pass through and are sealed in the stem press 8. The arc tube 3 is supported within the outer envelope 1 by a harness-like mount construction comprising metal support wires 9 and 10 which are curved at the uppermost portions and electrically connected and soldered to lead-in wire 4. A disc 11 suitably notched for accommodating the support wires 9 and 10 and holding them firmly within the inside surface of the outer envelope 1 is also provided with a centrally located aperture 12 through which a flexible conductor 13 extends downwardly through a ceramic tube insulator 14 for connection to arc tube electrode described hereinafter. This disc 11 also serves as a heat reflector to limit the operating temperature of the base and the stem press 8.

Metal spring fingers 15 and 16 are welded to the lower extremities of the support wires 9 and 10 and press against the wall of the envelope 1 to provide lateral support for the end of the arc tube mount. A metal type plate 17 is also attached to and between the free ends of the support wires 9 and 10 to increase the rigidity of the mount. At each end of the arc tube 3 at the contracted portions thereof I employ metal plate supports 18 and 19 through which the metal support wires 9 and 10 extend and which

are pressed against the enlarged parts of the arc tube 3 to hold it firmly in position.

Certain features of the arc tube supporting structure or mount including the U-shaped member defined by the support wires 9 and 10 which are bent together at the top and connected to the lead-in wire 4, and the plates 18 and 19, are disclosed and claimed in co-pending application Serial No. 246,268, filed September 12, 1951, in the name of J. A. St. Louis and J. M. Pomfrett. That application is assigned to the assignee of this application.

The arc tube 3 serves generally to define an arc discharge space, and there is provided within the arc tube electrodes 20 and 21, defining therebetween an arc path. Electrodes 20 and 21 may be of the activated type to facilitate the establishment of an arc discharge therebetween and for furnishing a copious supply of electrons during normal operation. Electrode 20 is connected to lead-in wire 5 through the flexible conductor 13 and lead wire 22 which is sealed into the end of the arc tube 3. In like manner electrode 21 is connected to lead-in wire 4 through metallic support 10, a flexible conductor 23 and the lead-in wire 24 which is sealed in the lower end of the arc tube. These seals may be of the type disclosed and claimed in United States Letters Patent No. 2,177,685, granted October 31, 1939, on an application of Bol et al.

As a means for starting the arc discharge between the principal electrodes 20 and 21, I provide an auxiliary or starting electrode 25 which is preferably of the type disclosed and claimed in co-pending patent application Serial No. 152,904, filed March 30, 1950, in the name of J. A. St. Louis and J. M. Pomfrett, and assigned to the assignee of the present application. That is, the electrode 25 is of tungsten, and for example may be a small thermal mass, and is mounted in the arc stream between the electrodes 20 and 21 to assume substantially the potential of the adjacent main electrode 20 during operation of the lamp. In this manner electrolysis of the vitreous material between the inleads 22 and 26 is eliminated, the latter being connected to the lead-in wire 4 and support wire 10 through a resistance 27 and a flexible conductor 28. Accordingly, before the arc discharge is established between the main electrodes 20 and 21, the starting electrode 25 is at the same potential as the remote electrode 21, establishing between the main electrode 20 and the associated starting electrode 25 sufficient voltage for initiating the arc discharge.

As disclosed in the above-mentioned Pirani et al. Patent 2,247,176, the atmosphere within the arc tube 1 may comprise starting gas, such as argon at a few millimeters pressure, and a quantity of mercury such that a mercury vapor pressure in the order of atmospheres is produced and all the mercury is vaporized at a temperature slightly lower than the operating temperature of the quartz envelope. During operation of the lamp the mercury vapor is thus superheated and the mercury vapor atmosphere undersaturated so that the effects of temperature and voltage fluctuations on the light output and the operation of the lamp are minimized.

As a means for diffusing to the surrounding atmosphere casual hydrogen generated within the envelope 1 during normal operation of the lamp, I provide at one end of the glass envelope 1, which may be either of the hard or heat-resistant type glass, or of the soft or soda-lime type glass, means capable of diffusing hydrogen at the normal operating temperature of the lamp. One form of such a construction is illustrated in the bottom of envelope 1 of Fig. 1 and may comprise the construction illustrated in detail in Fig. 2. Referring to the construction shown in Fig. 1, the envelope 1 is provided with a re-entrant portion 29 to which is sealed metallic collar or ferrule 30, preferably of the iron-nickel-cobalt composition where the outer envelope 1 is of the hard-glass type. The edge of the ferrule 30 to which the re-entrant portion 29 is sealed is preferably feathered to facilitate

the sealing operation and to reduce or eliminate the production of excessive strains in the seal structure. A flange 31 is provided in the ferrule 30 and to this flange is attached or brazed a palladium disc or diaphragm 32 pervious to hydrogen for diffusing to the surrounding atmosphere the hydrogen present within the envelope 1. In view of the fact that palladium is pervious to hydrogen the diaphragm 32 serves as a means for equalizing the partial pressure of the hydrogen within the envelope 1 and the partial pressure of hydrogen in the surrounding atmosphere. Inasmuch as the latter is very small, a large part of the hydrogen generated is dissipated to the surrounding atmosphere. In other words, the amount of hydrogen permitted to remain within the envelope 1 is maintained at a low value, or at a value which will not deleteriously affect the operation of the lamp or its life.

The views illustrated in Fig. 3 serve to indicate one way in which the palladium diaphragm construction may be incorporated in and sealed to the glass envelope 1. The iron-nickel-cobalt metal ferrule 30 is heated in a suitable reducing atmosphere such as a hydrogen furnace, or by induction heating, and the palladium diaphragm 32 is preferably brazed thereto by the interposition of a copper ring 33. The reducing atmosphere is necessary in order to obtain a proper union. The completed construction is also illustrated. I have found that the thickness of the palladium diaphragm 32 is preferably within the range from 1 to 3 mils, and that its exposed diameter may be within the neighborhood of 11 mm. for a lamp of the 400 watt EH-1 size and rating.

The sealing of the ferrule 30 to the envelope 1 may be accomplished as follows. The brazed assembly comprising the ferrule 30 with the palladium diaphragm 32 attached thereto is first sealed to a glass tubulation 34. The composition of this glass tubulation obviously should match the temperature coefficient of expansion not only of the ferrule 30 but also that of the glass envelope 1. (If desired, the tubulation 34 may be filled with a test gas to determine its hermetic properties and is tipped at its end 35.) The cup assembly and the tubulation are then sealed into the reentrant part 29 of envelope 1. A filling of nitrogen is preferably employed in the outer envelope 1 at an atmosphere of about 450 or 500 mm. of mercury pressure so that during normal operation the nitrogen pressure is approximately 1 atmosphere.

In the embodiment or modification of the invention illustrated in Fig. 4, instead of employing a re-entrant portion of the outer envelope 1, I have shown a construction which may be employed alternatively. In this arrangement where lead or lime glass is employed a flat metallic cap 36 of chromium and iron is sealed to the envelope 1 and a palladium diaphragm 37 which has been previously brazed thereto. Fig. 5 is a still further modification of the arrangement shown in Fig. 1 in which a metallic cap 37 and a palladium diaphragm 39 are inverted from the position shown in Fig. 4.

In the modification of the invention illustrated in Fig. 6, a re-entrant portion 40 of the envelope 1 is provided to which is attached a graded seal construction. Such a graded seal, as is now well known, comprises a number of vitreous materials or glasses having progressively varying temperature coefficients of expansion to serve as a match between the coefficient of expansion of the envelope 1 and the material or metal to which it is sealed. I provide a palladium diaphragm in the form of a tube 41 the inner end 42 of which is closed and the outer end 43 of which is open to provide a communication with the surrounding atmosphere. The palladium tube 41 is sealed to the envelope 1 through the graded seal construction and serves as a means for diffusing hydrogen from within the enclosing envelope 1 to the surrounding atmosphere.

A still different embodiment of Fig. 7 comprises a diaphragm in the form of a palladium disc 44 which is

brazed to an apertured chromium-iron disc 45 which in turn is sealed to a flared glass tube 46, the outer end 47 of which is open and in communication with the surrounding atmosphere. The tube 46 passes through the stem press 48 which also serves as the press for lead-in wires 49 and 50 corresponding in function to lead-in wires 4 and 5 of the arrangement shown in Fig. 1. In this modification, of course, the hydrogen also diffuses through the palladium disc 44 to maintain the envelope 1 substantially free of the undesired hydrogen. The base, of course, is not hermetically sealed.

Instead of employing a diaphragm of metal, such as palladium, as the means for diffusing hydrogen to the surrounding atmosphere, in the modification of Fig. 8 I have employed a thin quartz tube 51 which extends into the outer envelope 1 and in close proximity to an inner arc tube 52. The quartz tube 51 is preferably sealed to the envelope 1 through graded seal construction 53, which in turn is sealed to a re-entrant part 54 of the envelope 1. Quartz, at the normal operating temperatures of the lamp, is pervious to hydrogen, and hydrogen diffuses there-through to the surrounding atmosphere in accordance with the partial-pressure relationship to minimize the amount of hydrogen which remains within the lamp.

I have found that lamps constructed in accordance with the present invention, particularly the modification of the invention shown in Figs. 1 and 2, offer great improvements in life, lumen maintenance and efficiency. Tests conducted on lamps, including life tests, have indicated that the palladium diaphragm lamps show no tendency to change starting voltage during life. Control lamps with which the palladium diaphragm lamps have been compared, show a rise in starting voltage toward the end of life that is characteristic with lamps having an appreciable amount of hydrogen within the inner or arc tube.

Heretofore, the high pressure mercury vapor lamps having appreciable amounts of hydrogen therein show the brownish discoloration which results from the reduction of silicon dioxide to silicon oxide by the action of the hydrogen. Lamps employing palladium diaphragms were examined at the end of 6500 hours of life. While the arc tubes were somewhat discolored at the ends thereof, and some white devitrification was present, only during horizontal burning of the arc tube, no brown or yellow discoloration was present or visible indicating a minimum or negligible amount of hydrogen within the lamp.

On lamps tested at the end of 6500 hours, those with the palladium diaphragm indicated a substantially uniform efficiency of 41.4 lumens per watt, whereas the control lamps built according to the prior art arrangements showed an efficiency of only 26.1 lumens per watt. Some of the lamps tested indicated satisfactory operation at lives in excess of 9000 hours. This is particularly significant in view of the fact that many lamps constructed in accordance with the prior art arrangements, even incorporating some of the more recent improvements, failed at 6000 hours or under.

It is known that the rate of generation of the undesirable hydrogen within a lamp will be less if the outer envelope is of the soft-glass type. However, this does not indicate that the present invention may not be used effectively in lamp constructions employing soft-glass outer envelopes. Unquestionably the principal advantage lies from an economic point of view in the use of the hydrogen diffusing means in lamps employing hard-glass envelopes, particularly where it is desirable to obtain the advantages incident to the heat resistant or hard-glasses.

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

1. In an electric lamp, the combination comprising a sealed envelope, a source of radiation within said envelope causing operation of the lamp at an elevated temperature within the range from 600° C. to 900° C., said

lamp being subject to casual liberation of hydrogen in the space between said sealed envelope and said source during operation, and means sealed in the envelope wall comprising a palladium diaphragm exposed to the space within and the space without said envelope for diffusing to the surrounding atmosphere casual hydrogen produced during operation of the lamp.

2. In an electric discharge device, the combination comprising a source of radiation having a quartz envelope defining a discharge space, a pair of electrodes within said envelope and a quantity of mercury capable of supporting an arc discharge, an outer glass envelope surrounding the first-mentioned envelope, said device being subject to casual liberation of hydrogen in the interenvelope space between said quartz envelope and said outer envelope during operation, and means sealed in the wall of said outer envelope including a palladium diaphragm pervious to hydrogen at the normal operating temperature of the device, said diaphragm being exposed to both the space within and the space without said outer envelope for diffusing to the surrounding atmosphere the hydrogen which is produced during operation of said device.

3. In an electric discharge device, the combination comprising a source of radiation having a quartz envelope defining a discharge space, a pair of electrodes within said envelope and a quantity of mercury capable of supporting an arc discharge, an outer glass envelope surrounding the first-mentioned envelope, said device being subject to casual liberation of hydrogen in the interenvelope space between said quartz envelope and said outer envelope during operation, the glass envelope being provided with a re-entrant part, and means sealed to the re-entrant part of the glass envelope comprising a metallic flanged ferrule sealed to the re-entrant part and a palladium disc attached to said ferrule and exposed to both the space within and the space without said outer en-

velope for diffusing to the atmosphere hydrogen produced during operation of the device.

4. A high pressure mercury vapor discharge lamp deleteriously affected by hydrogen in its discharge space and comprising in combination a sealed outer envelope, a source of ultraviolet radiation within said envelope and having a quartz envelope, a pair of electrodes within said quartz envelope and a quantity of a starting gas and mercury therein operable within the superheated region, said lamp being subject to casual liberation of hydrogen in the interenvelope space between said quartz envelope and said outer envelope during operation, and means sealed in the first-mentioned envelope comprising a tube of palladium exposed to both the space within and the space without said outer envelope for diffusing to the surrounding atmosphere casual hydrogen within the interenvelope space during operation of the lamp.

5. A high pressure mercury vapor discharge lamp deleteriously affected by hydrogen in its discharge space and comprising in combination a sealed outer envelope, a source of ultraviolet radiation having a quartz envelope, a pair of electrodes within said quartz envelope and a quantity of a starting gas and mercury therein operable within the superheated region, said lamp being subject to casual liberation of hydrogen in the interenvelope space between said quartz envelope and said outer envelope during operation, and means comprising a glass tube sealed in a stem press of the first-mentioned envelope and including a palladium diaphragm sealed to the glass tube and exposed to both the space within and the space without said outer envelope for diffusing casual hydrogen within the interenvelope space during operation of the lamp.

References Cited in the file of this patent

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