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E. B. NOEL

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ELECTRIC DISCHARGE DEVICE

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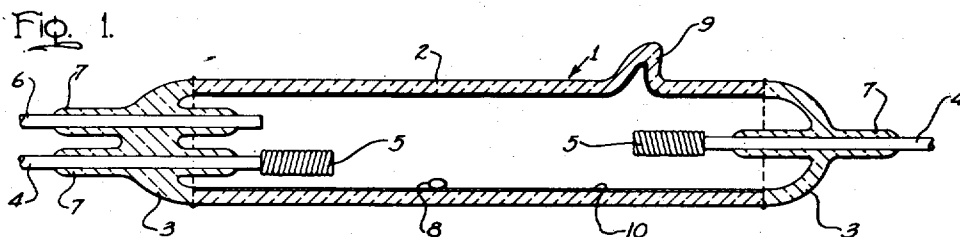


Fig. 3

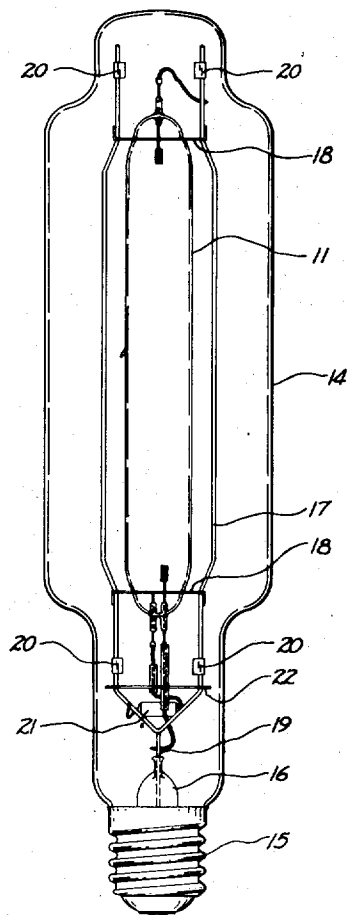
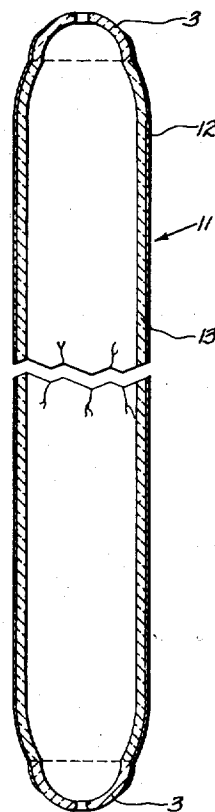


Fig. 2



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UNITED STATES PATENT OFFICE

2,568,459

ELECTRIC DISCHARGE DEVICE

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Application October 29, 1948, Serial No. 57,164

10 Claims. (Cl. 313-221)

1 This invention relates to electrical discharge devices of the type disclosed in my co-pending application (now abandoned) Serial No. 560,775, filed October 28, 1944 and owned by the General Electric Company, the assignee of the present application. This application is a continuation-in-part of my aforesaid co-pending application. As disclosed in my co-pending application, electrical discharge devices are known which have envelopes or internal parts of fused or vitreous silica or quartz (SiO_2) that tend to devitrify during operation, thus becoming granular, frosty, or cloudy in appearance, and more or less opaque to the desired radiation from inside the envelope. Common examples of such devices are discharge lamps of the positive column type in which a discharge between electrodes suitably spaced apart is constricted by pressure of the operating atmosphere into a narrow cord or thread, that is recognizably distinct from the characteristic phenomena closely associated with the electrodes themselves: e. g., the lamps marketed under the designations C-H5, AH-4, FH-4, AH-5, whose walls reach temperatures ranging from around 600° C. to around 1100° C., more or less. Generally speaking, portions of the envelope near the electrodes run hotter than other portions. Discharges which are constricted by pressure are usually referred to indiscriminately as "high pressure," notwithstanding that the actual pressure may be anywhere from around $\frac{1}{2}$ atmosphere absolute up to 100 atmospheres, or even higher. The operating atmosphere may consist of ionizable gas or vapor, or both—such as one or more of the rare inert monatomic gases like argon, xenon, etc., or one or more vaporizable metals like mercury, cadmium, zinc, or thallium, etc. The amount of such substance(s) in a lamp may either exceed what will vaporize during operation, or may be so much less than this that the device operates with an unsaturated atmosphere. When vaporizable substances are used, rare gases may also be included to assist in starting the discharge.

Fused quartz or "quartz glass" is about the most refractory light and radiation-transmitting material that is practicable for discharge envelopes, but it has the drawback of increasingly rapid devitrification at temperatures well below the softening point of quartz, about 1400° C. At temperatures around 900° C., more or less, devitrification becomes rapid enough to be a factor in limiting the useful life of the lamp. Devitrification is more rapid in devices whose electrodes are activated with somewhat volatile oxides like the

2 alkaline earth oxides, including those of barium and strontium, though it also occurs in devices having unactivated refractory metal electrodes, such as those disclosed in U. S. Patent No. 2,353,668 to Donald D. Hinman. Unlike the chemical attack and discoloration of glass envelopes by alkali metal vapor that is mentioned in U. S. Patent No. 2,238,777 to Lemmers and Goodwin, devitrification is a mere change of structure in the silica itself, from amorphous to crystalline.

Quite surprisingly, in view of this radical difference between the devitrification of quartz and the chemical attack and discoloration against which glasses have heretofore been protected by glazes as in Patent No. 2,238,777, I have discovered that quartz devitrification can be retarded and largely prevented by means of glazes applied to the quartz surface which is so highly heated that it would normally tend to devitrify. Quite obviously, the mechanism of inhibition must needs be very different in the two cases as is shown conclusively from the fact that devitrification of the highly heated inner surface of a quartz envelope containing a gaseous atmosphere chemically inert to quartz, such as rare gas and mercury vapor, is also inhibited when such a glaze is applied to the outer surface only of the envelope, the inner surface of which is left uncoated. Obviously, coating the outer surface of a glass or a quartz envelope containing an ionizable atmosphere chemically active with respect to glass or quartz would be ineffective for protecting the inner surface of such envelope from chemical attack by the gaseous atmosphere.

As disclosed in my co-pending application Serial No. 17,423, filed March 27, 1948, some commercial mercury vapor discharge lamps having quartz envelopes enclosed in sealed glass jackets filled with nitrogen and operated with the quartz envelope at elevated temperatures were short lived, about 1,000 to 2,000 hours, because of the presence of hydrogen in the quartz envelope. The hydrogen appeared after a comparatively short period of operation and caused a frosted appearance on the inner surface of the envelope and a gradual increase in the starting voltage of the lamp to terminate its useful life prematurely. By constructing the lamp to operate with lower envelope and jacket temperatures and by using a different glass for the jacket the life of such lamps was increased thousands of hours because hydrogen was eliminated from the interior of the quartz envelope. The lower temperature of the jacket reduced the amount of hydrogen in the jacket and the lower tempera-

ture of the quartz envelope reduced the rate of diffusion of hydrogen through the quartz. The starting voltage of the lamps remained constant and the inner surface of the envelope remained clear and unfrosted for a useful life of 5,000 hours and more under the same test conditions as the prior commercial lamps.

The application of a glaze to either the inner surface of a quartz envelope, as disclosed in my co-pending application Serial No. 560,775, or the outer surface thereof, as additionally disclosed in the present application, is effective for preventing devitrification of the quartz because, I now believe, it prevents the diffusion of hydrogen through the hot quartz by, in effect, closing the "pores" of the hot quartz. The effectiveness of such a glaze on the outer surface of the envelope has been demonstrated by operating lamps having glazed and unglazed quartz envelopes in a forming gas atmosphere at double rated load. The forming gas atmosphere consisted of 20% hydrogen and 80% nitrogen. The results showed a definite advantage for the lamps which had envelopes glazed on the outer surface.

The principal requirements of an effective glaze on the inner envelope surface are adhesion and permanence; it must not quickly crack or flake off, or be otherwise removed, destroyed, or deteriorated under exposure to the discharge and the high temperature which this entails. The glaze must also be sufficiently permeable to or transmissive of the light or other desired radiation from the interior of the envelope, and should not seriously affect or react with the electrodes or other internal parts of the device, or with the discharge atmosphere. A considerable variety of vitreous glazes have been found to answer, or can be modified to do so, including various known glazes such as the boric oxide types mentioned in the Lemmers and Goodwin Patent No. 2,238,777, or the silica, boric oxide, and alumina glasses that are known commercially as "790-H glass," marketed by Corning Glass Company, and "376-F flux glass," for which the formula is hereinafter stated. Many of the glazes that prevent diffusion of hydrogen through the hot quartz, and thus devitrification of quartz, will also protect it from chemical attack by metals which might be used for the operating atmosphere of a discharge device, such as cadmium or zinc, or their amalgams.

To facilitate the glazing and to unite the glaze more homogeneously with the underlying quartz, it is desirable to use material which fluxes or unites with the quartz or silica in a glass-forming sense. I prefer oxides of elements that are close to silicon in the Periodic System, and especially boric and phosphoric oxides (B_2O_3 and P_2O_5), which fuse and unite with the quartz at temperatures lower than its fusing or softening temperature. With such fluxing material may be associated other material that tends to stabilize the glaze coating or films against fusion or vaporization, or against absorption of atmospheric moisture. One preferred material of this character is alumina (Al_2O_3), which fuses at higher temperatures than quartz; another is additional silica (SiO_2) applied to the quartz surface in suitable form, such as fine powder mixed with the fluxing material.

But while the coaction of a flux material lower melting than silica and a stabilizing material higher melting than the flux (if not also higher melting than silica) is advantageous, the conjoint use of these components is not always essential. On the one hand, very good glazes can

be produced with mere fluxing material such as B_2O_3 and P_2O_5 (used either singly or together), without any higher melting material except the silica of the quartz article or part itself; on the other hand, stable and adherent glazes have also been formed on quartz with relatively high-melting oxides, such as alumina, thorium, zirconia, beryllia, and titanium dioxide, without the aid of any lower-melting flux. In general, nevertheless, I have been able to glaze quartz articles more easily, uniformly, and effectively when fluxing components like boric and phosphoric oxides are associated with higher melting oxides such as those just mentioned. Compounds of the alkali or alkaline earth metals should be avoided.

The coefficient of expansion of silica is so low (only about 6×10^{-7}) that it is difficult or impracticable to match it in a glaze, although such glazes may have relatively low expansion coefficients, such as 15×10^{-7} , as compared with some 90×10^{-7} , for ordinary glasses. In this connection, it is to be remarked that while both alumina and added silica stabilize B_2O_3 or P_2O_5 , alumina tends to raise the thermal expansion coefficient of the glaze. By making the glaze coating or film sufficiently thin, not only can flaking or cracking off of the film be avoided, but even the superficial cracking that is commonly known as "crazing" can be obviated; and yet such a thin film can still be quite effective against troublesome devitrification. Even though crazing of the glaze may not necessarily make it worthless, it naturally renders the device suspect, since it is always possible that the crazed film may flake off in service, or that the cracks may so far impair its continuity as to render it ineffective against devitrification, or even that the cracks may extend themselves into the quartz wall under the stress of high internal pressure in the device, and ultimately cause the latter to explode or collapse.

While I have mentioned boric, phosphoric, and other oxides as glaze materials or components, this refers to the composition of the final glaze on the article, and not to the form in which such materials are embodied as batch ingredients. Neither is any implication intended as to whether the glaze materials do or do not enter into chemical combination with one another, or with the underlying quartz of the glazed article. In some cases, the union is probably no more intimate than a condition of solid solution; in others, silicates or other such combinations may be formed. Also, chemical combinations between or among glaze components may be used as batch materials, such as $B_2O_3 \cdot P_2O_5$ or $SiO_2 \cdot P_2O_5$. In general, the use of phosphates in connection with borates has the advantage that the B_2O_3 is considerably stabilized in the glaze, and the latter is not strikingly hygroscopic like mere boric oxide.

To illustrate the possible variety of batch ingredients, it may be pointed out that boric oxide can be introduced in the anhydrous form of B_2O_3 , or in the hydrated form of boric acid, H_3BO_3 , or as boron nitride, BN, (which may in practice break down and react with the oxygen of the air to yield B_2O_3), or as a borate; phosphoric oxide may be introduced as such, or as the acid, H_3PO_4 , or in volatile base salts like the ammonium phosphate $(NH_4)_2HPO_4$, or as other phosphates; silica in finely divided pure commercial forms, or as a silicic acid like H_2SiO_3 . Borates or phosphates which do not break down may also be used for the same purposes as P_2O_5 ; and there is some question whether in practice boron nitride or titanium nitride do or do not break down and

5

react to form oxides. Compounds of alkali and alkaline earth metals should generally be avoided. In general, the raw or batch materials may be any which at the heat which they undergo lose all constituents except such as form desired or unobjectionable glaze ingredients.

A convenient method of applying the glaze material is by deposition over the inside of a quartz tube from a carrier liquid, such as acetone, for example, very much as fluorescent lamp tubes are commonly coated with phosphors. For this purpose the tube may be held upright and filled with the liquid mixture from the bottom, and the mixture then drained out. After drying out of the liquid from the deposited coating, the coating may be "fired in" by externally heating the tube. When this is done with the internal tube surface at a sufficiently high temperature (preferably at or close to the softening temperature of the quartz), the glaze materials interfuse into and unite with the silica in such a way that in the subsequent operation of the tube they do not readily evaporate and leave the silica unprotected, even though the tube wall temperature may in service exceed the temperatures at which P_2O_5 and B_2O_3 show substantial vapor pressures. These temperatures are for P_2O_5 well below its sublimation temperature of about 250° , and for B_2O_3 well below its boiling point of about 1500° C. Afterward the current leads to the electrodes may be fused and sealed into the tube ends in the usual way without destroying the glaze film, which covers the ends of the envelope cavity thus formed. End plugs or pieces of seal glass can be sealed into or to the tube ends as usual without injuring the glaze on the tube. Such end pieces are cooled by the current inleads extending through them to the electrodes in the envelope, and are not in practice subject to devitrification, or to attack by metals like cadmium or zinc.

The formula of one glaze which has given very good protection against devitrification is as follows:

Boric acid, H_2BO_3 -----g--	31.2
Precipitated silica -----g--	15.6
Acetone -----cc--	235

The fired-in boric oxide and silica coating resulting from this formula is extremely hygroscopic, so that it is necessary to make the tube up into a lamp and complete and seal off the latter at once, or to store it under effective precautions against absorption of moisture. This is because the boric oxide would in a short time be converted to boric acid by the moisture of the air, and the water vapor evolving from this boric acid during the exhaust-processing of the device (or after it had been sealed off and put in service) would spoil the device.

The formula of another good glaze which has proved more stable is as follows:

Precipitated silica -----g--	15.6
Diammonium phosphate, $(NH_4)_2HPO_4$ --g--	34.4
Acetone -----cc--	235
85% orthophosphoric acid, H_3PO_4 -----cc--	15

The fired-in coating resulting from this formula is much less hygroscopic, and need not be used so promptly or protected so completely from atmospheric moisture.

Another good glaze formula is that of the 376-F flux glass above mentioned:

	Per cent
Silica -----	83.5
Alumina -----	4.5
Boric oxide -----	12.0

6

Whatever the glaze batch used, care is taken not to coat the envelope too heavily and thus produce too thick a glaze film on the finished tube.

To bake or fire-in the glaze, the envelope tube may be heated externally with an oxy-hydrogen flame, which may be passed back and forth and shifted around to play on the tube from every direction. This may done with the tube exposed to the atmosphere, and before sealing into its ends the current leads to the electrodes, or the end pieces of seal glass that surround the leads. In this way, the tube wall may be heated nearly or approximately to the softening temperature of the quartz, thus expelling all unwanted gaseous or vaporizable matter from any thermally decomposable ingredients of the glass batch, and uniting or combining the residues with the silica at the inner surface of the tube, as already explained. When finely divided silica is included in the components of the glaze batch, the flux (e. g., B_2O_3 or P_2O_5) combines or interfuses with these finely divided particles of silica rather more readily than with the solid inner surface of the tube, so that a thicker coat or film of interfused B_2O_3 and SiO_2 is formed; yet enough of the B_2O_3 also unites or fluxes with the tube surface to anchor or bond this film to the latter effectively. During the heating of the tube as described, a current of inert gas such as nitrogen is preferably passed through it to carry off any and all volatiles from the glaze that might otherwise condense, and thus remain to vaporize after the tube has been completed and put in operation. Accordingly, any B_2O_3 or P_2O_5 that is not stabilized or held by the silica of the tube wall or by a stabilizing glaze component is gotten rid of.

As already mentioned, care should be taken not to have too thick a glaze coat or film on the interior of the tube. Ordinarily, the glaze batch formulas given result in a glaze of proper thickness. If the glaze film shows crazing, it should be thinner; if the tube shows little improvement over an unglazed one as regards devitrification during operation, the glaze needs to be thicker. In the case of a lamp containing only gas or mercury, a good glaze satisfactorily applied can be expected to allow operation three or four times as long as without glaze before devitrification becomes serious. In some cases, internally glazed tubes start less easily than unglazed ones, requiring a higher break-down voltage.

Another method of internally glazing tubes is to pass through the tube an atmosphere comprising suitable glaze constituents, and to heat the tube externally to cause these constituents to react, unite, or flux with the inner quartz surface. For example, methyl phosphate produced from methanol and phosphoric acid can be passed in mixed with air and burned in the tube to glaze it internally with P_2O_5 ; or methyl borate can be similarly produced and applied to coat the tube with B_2O_3 . This method can also be employed to glaze internally a lamp bulb that has been completed except for sealing in the electrodes, etc.

Instead of internally glazing a lamp bulb or tube, a hollow quartz slug can be internally glazed before being drawn out into tubing, the adherent glaze stretching with the quartz so that the tubing carries a uniform internal film. Such glazing may be done by any of the methods hereinbefore described. In this case, the glaze inside the slug may be thicker than would be desirable in the lamp, or the glaze in the lamp

7

may be made thinner than it could easily be made if the glaze were first applied to the actual lamp tube. After drawing to the desired bore and wall thickness, the tubing may be cut up into suitable lamp tube lengths and made into lamps.

In the drawing, Fig. 1 shows in longitudinal section one form of discharge device embodying the invention; Fig. 2 shows an envelope for a discharge device also embodying the invention; and Fig. 3 is a front elevational view of a lamp having a discharge device embodying my invention.

The discharge device 1 illustrated in Fig. 1 has an envelope 2 made up of a quartz tubular wall portion having hemispherical domes or caps 3 of borosilicate seal glass hermetically fused to its ends. The main tungsten inleads 4 for the main discharge supporting electrodes 5 and the inlead 6 for the auxiliary starting electrode are provided with seal glass 7 hermetically united therewith and with the glass caps 3 to seal said inleads 4 through the caps 3. Seals of this kind are disclosed and claimed in the U. S. Patent 2,177,685, issued October 31, 1939 to Bol et al. and assigned to the General Electric Company. Such seal glass is not subject to devitrification or to chemical attack by hot ionized metal vapors like zinc or cadmium, nor is the glass of caps 3. A supply of mercury which vaporizes completely at an envelope temperature slightly lower than the operating temperature of the envelope is indicated by a droplet 8. The device thus operates with an unsaturated or superheated atmosphere of mercury vapor as disclosed and claimed in the U. S. Patent 2,247,176, issued June 24, 1941 to Pirani et al. and assigned to the General Electric Company. The main discharge supporting electrodes 5 include tungsten wire coils welded around the inner ends of the two inleads 4, while the inner end of the extra tungsten inlead 6 serves as a starting electrode. The exhaust tip 9 is also shown through which the envelope is exhausted of air and the droplet of mercury, together with the usual starting gas, such as argon, at a pressure of a few mm. is introduced into the envelope during manufacture of the device. The electrodes 5 also include the usual material of higher electron emissivity than tungsten, such as barium and strontium oxide or thorium metal. The quartz tubular portion of the envelope 2 is internally glazed with a vitreous film 10 (whose thickness is greatly exaggerated in the drawing) which is not involved in the seals between the ends of the quartz tube and the glass caps 3.

To obtain good efficiency of light output, I prefer to use a current input for the device such that the pressure of the gaseous atmosphere is approximately 8 atmospheres absolute. At such pressures the quartz portion of the envelope is well above the temperature at which quartz is pervious to hydrogen, that is, above about 600° C. In prior devices having envelopes with unglazed quartz wall portions, such as the AH-4, FH-4, CH-5 and AH-5 lamps mentioned above, in a sealed glass jacket, hydrogen appeared in the envelope and resulted in short-lived lamps with devitrified inner quartz surfaces. As pointed out above, the glaze on the quartz prevents the diffusion of hydrogen therethrough to substantially increase the useful operating life of such lamps.

In Fig. 2 of the drawing, I have shown an envelope 11 similar to the envelope 2 shown in Fig. 1 except that a glaze 12 is applied to the outer

8

surface of the quartz tubular portion 13 and overlaps the fused joints between the ends of the portion 13 and the glass caps 3. The glaze 12 on the outer surface of the quartz is also effective for preventing the diffusion of hydrogen through the hot quartz and thus increases the useful life of the lamp incorporating the arc tube.

The external glaze may be applied conveniently by dipping the envelope 11 held in a horizontal position with the end caps 3 but not the electrode inleads mounted thereon into a thin suspension of milled boric anhydride (B_2O_3) in butyl acetate and rotating the envelope to cover the area indicated in the drawing. The coated tube is then heated with an oxy-hydrogen flame to near the working temperature of quartz. The resulting glaze does not craze and is not hygroscopic if properly applied.

After the glaze has been applied, the manufacture of the device is completed in the usual manner by mounting the electrodes in the envelope, through the openings in the glass caps 3, exhausting and then filling the envelope through the usual exhaust tube with a discharge-conducting atmosphere.

The devices described above may be incorporated in lamps having glass jackets, such as that shown in Fig. 3 which is of the type disclosed in my co-pending application Serial No. 17,423 mentioned above.

In a specific lamp of the structure shown in Fig. 3 and having a 1000 watt rating, the envelope 11 of the device had an inner diameter of 25 millimeters and a gap of 150 millimeters between its main electrodes. The enlarged center portion of the jacket 14 had an outer diameter of 3½ inches of 88.9 millimeters and a length of approximately 8 inches. The jacket 14 was first exhausted and then filled with nitrogen at ½ atmosphere pressure and consisted of 172 glass having the following composition:

	Per cent
SiO ₂ -----	56.4
Al ₂ O ₃ -----	20.8
Na ₂ O -----	1.6
B ₂ O ₃ -----	4.4
CaO -----	4.9
MgO -----	11.9

The outer surface of the quartz portion of the envelope 11 of the device had an external glaze thereon applied as described in connection with Fig. 2.

By using the glaze on the outer surface of the envelope the time required for exhausting the glass jacket was considerably reduced without hydrogen appearing in the envelope for a long useful life of the lamp.

As shown in Fig. 3 of the drawing, the lamp comprises a sealed outer glass jacket 14 having a screw type base 15 and a stem tube 16 at one end. The discharge device provided with a glaze on the outer surface of the quartz portion of its envelope 11 in accordance with this invention is supported in the jacket 14 by a U-shaped wire mount 17. The mount has bridging members 18 engaging the envelope 11 and is welded at one end to an inlead 19 passing through the stem 16 and electrically connected at its other end to the upper electrode of the device. A pair of spring braces 20 bearing against the jacket 14 and attached to opposite ends of the mount 17 are provided to strengthen the latter. The starting electrode at the lower end of the device is electrically connected to the mount 17 through a resistance 21

and the lower main electrode is connected to an inlead (not shown) passing through the stem 16. The two inleads passing through the stem 16 are connected to the contacts on the base 15 in the usual manner. A heat shield 22 in the form of a perforated metal disc attached to the mount 17 is provided to protect the stem 16 from excessive heating by the discharge device.

It will be readily appreciated by those skilled in the art that the glaze on the quartz portion of the envelopes of high pressure discharge devices making the quartz impervious to hydrogen at temperatures at which hydrogen diffuses through unglazed quartz makes possible a reduction in the size of the envelope having such a quartz portion to lower the cost of a device of given wattage without shortening the useful operating life of the device.

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

1. A gaseous electric discharge device deleteriously affected by hydrogen in its discharge conducting gaseous atmosphere comprising a sealed envelope containing a discharge conducting gaseous atmosphere free from hydrogen and having a quartz wall portion, said device being designed for operation with the said quartz wall portion at a temperature at which quartz is pervious to hydrogen and an alkali and alkaline earth free glaze consisting essentially of material of the group consisting of boric oxide and phosphoric oxide on the external surface of said quartz wall portion making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the atmosphere without said envelope.

2. A gaseous electric discharge device as in claim 1 wherein the device comprises also a sealed vitreous jacket enclosing the sealed envelope.

3. A gaseous electric discharge device deleteriously affected by hydrogen in its discharge conducting gaseous atmosphere comprising a sealed envelope containing a discharge conducting gaseous atmosphere free from hydrogen and having a quartz wall portion, said device being designed for operation with the said quartz wall portion at a temperature at which quartz is pervious to hydrogen, said atmosphere being chemically inert to quartz at said temperature, and an internal alkali and alkaline earth free glaze consisting essentially of material of the group consisting of boric oxide and phosphoric oxide on said quartz wall portion making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the atmosphere without said envelope.

4. A gaseous electric discharge device deleteriously affected by hydrogen in its discharge conducting gaseous atmosphere comprising a sealed envelope containing a discharge conducting gaseous atmosphere free from hydrogen and being made up of a quartz tube closed at each end by glass caps, said device being designed for operation with the quartz tube at a temperature at which quartz is pervious to hydrogen, said atmosphere being chemically inert to quartz at said temperature, and a vitreous alkali and alkaline earth free glaze consisting essentially of material of the group consisting of boric oxide and phosphoric oxide on said tube making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the atmosphere without said envelope.

5. A gaseous electric discharge device deleteriously affected by hydrogen in its discharge conducting gaseous atmosphere comprising a sealed envelope containing a discharge conducting gaseous atmosphere free from hydrogen and having a quartz wall portion, said device being designed for operation with the said quartz wall portion at a temperature at which quartz is pervious to hydrogen, said atmosphere being chemically inert to quartz at said temperature, and an alkali and alkaline earth free glaze consisting essentially of material of the group consisting of boric oxide and phosphoric oxide on said quartz wall portion making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the atmosphere without said envelope.

6. A gaseous electric discharge device deleteriously affected by hydrogen in its discharge conducting gaseous atmosphere comprising a sealed envelope containing a discharge conducting gaseous atmosphere free from hydrogen and having a quartz wall portion, said device being designed for operation with the said quartz wall portion at a temperature at which quartz is pervious to hydrogen, said atmosphere being chemically inert to quartz at said temperature and including mercury the vapor of which is luminosity producing during operation of the device, and an alkali and alkaline earth free glaze consisting essentially of material of the group consisting of boric oxide and phosphoric oxide on said quartz wall portion making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the atmosphere without said envelope.

7. A gaseous electric discharge device deleteriously affected by hydrogen in its discharge conducting gaseous atmosphere comprising a sealed envelope containing cooperating main discharge supporting electrodes and a discharge conducting gaseous atmosphere free from hydrogen and having a quartz wall portion, said device being designed for operation with the said quartz wall portion at a temperature at which quartz is pervious to hydrogen, said atmosphere being chemically inert to quartz at said temperature, and an alkali and alkaline earth free glaze consisting essentially of material of the group consisting of boric oxide and phosphoric oxide on said quartz wall portion making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the atmosphere without said envelope.

8. A high pressure gaseous electric discharge lamp deleteriously affected by hydrogen in its discharge conducting gaseous atmosphere comprising a sealed vitreous jacket and a sealed envelope enclosed within said jacket and containing a discharge conducting gaseous atmosphere free from hydrogen and having a quartz wall portion, said device being designed for operation with the said quartz wall portion at a temperature at which quartz is pervious to hydrogen, said atmosphere being chemically inert to quartz at said temperature, and an alkali and alkaline earth free glaze consisting essentially of material of the group consisting of boric oxide and phosphoric oxide on said quartz wall portion making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the jacket.

9. A gaseous electric discharge device deleteriously affected by hydrogen in its discharge con-

11

ducting gaseous atmosphere comprising a sealed envelope containing a discharge conducting gaseous atmosphere free from hydrogen and having a quartz wall portion, said device being designed for operation with the said quartz wall portion at a temperature at which quartz is pervious to hydrogen and an alkali and alkaline earth free glaze consisting of boric oxide on said quartz wall portion making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the atmosphere without said envelope.

10. A gaseous electric discharge device deleteriously affected by hydrogen in its discharge conducting gaseous atmosphere comprising a sealed envelope containing a discharge conducting gaseous atmosphere free from hydrogen and having a quartz wall portion, said device being designed for operation with said quartz wall portion at a temperature at which quartz is pervious to hydrogen, said atmosphere being chemically inert to quartz at said temperature, and an alkali and

12

alkaline earth free glaze on said quartz wall portion making it impervious to hydrogen at said temperature to keep the gaseous atmosphere within said envelope free from casual hydrogen in the atmosphere without said envelope, said glaze being composed of material selected from the group consisting of boric oxide, phosphoric oxide, silica and alumina and containing at least one of the first two of said materials.

EDWARD B. NOEL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,558,524	Winninghoff	Oct. 27, 1925
1,968,822	Gaidies	Aug. 7, 1934
2,001,504	Schmidt	May 14, 1935
2,135,663	Hanlein	Nov. 8, 1938
2,238,777	Lemmers & Goodwin	Apr. 15, 1941