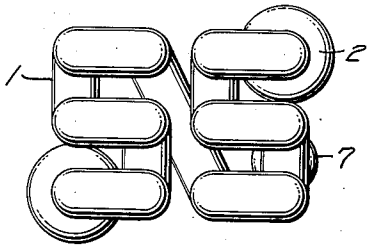
Feb. 21, 1933. J. H. BYRNES 1,898,615

LUMINOUS TUBE

Filed Aug. 13, 1928

FIG. 1.



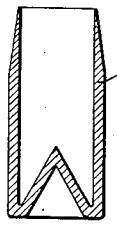


FIG. 4.

FIG. 2.

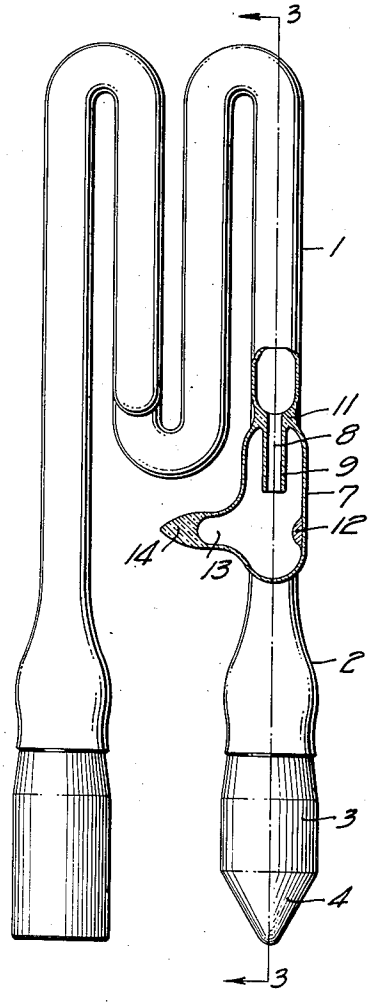
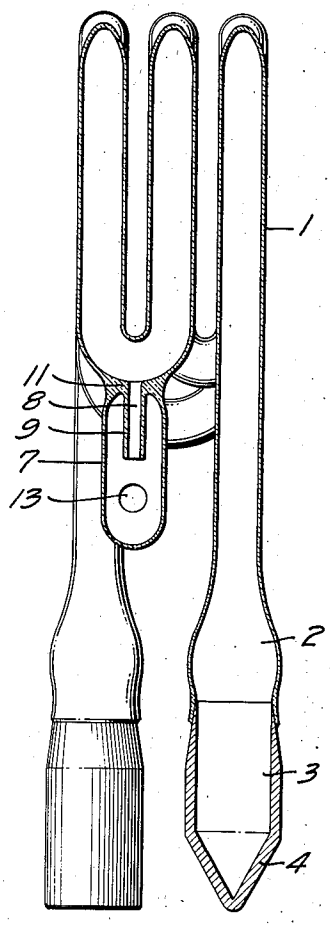


FIG. 3.



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UNITED STATES PATENT OFFICE

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LUMINOUS TUBE

Application filed August 13, 1928. Serial No. 299,288.

This invention relates to luminous or inert gaseous discharge tubes, some forms of which are now in common use for advertising and display purposes.

The successful operation of such tubes present numerous difficulties. For example, the intensity of light emitted is proportional to the current used. But since the heat developed is proportional to the square of the current passing thru the tube and since the vaporization of the electrodes is proportional to the heat developed, the intensity of light is limited unless some means is provided for cooling or conveying away the heat developed at the cathode. Needless to say, vaporization of the electrodes is detrimental for various reasons; the pressure within the tube is changed, the metallic vapor is likely to be ionized, a metallic deposit is condensed on the walls of the tubing impairing its transparency and there is a disintegration of the electrodes.

And since for advertising purposes tubes of this nature are exposed to atmospheric conditions it is essential that they be operated at substantially atmospheric temperatures in order to prevent breakage. It is also conceivable that for reasons other than that above stated, it might be desirable to pass relatively heavy currents thru these tubes.

Sputtering of the cathode is another phenomenon that is detrimental to the operation of the tube inasmuch as the metallic particles thrown off from the cathode and deposited on the walls of the tubing eventually occlude or entrap sufficient quantities of the gas used as a working medium to decrease its pressure below its critical pressure of operation. Unlike vaporization, sputtering is attributed to the electrical condition prevailing on the surface of the cathode rather than to any heat effects. It has been found that sputtering takes place in a direction normal to the electrode surface.

Another difficulty encountered in the successful operation of gaseous discharge tubes is the elimination of the presence of foreign gases within the working medium used (inert gases such as neon, argon, helium, etc.), for the very slightest trace of a foreign gas may wholly alter, or entirely obliterate the visible spectrum of the rare gas. Great care must therefore be taken in purifying the working medium to be used and in driving off the foreign gases occluded in both the electrodes and in the walls of the glass tubing used.

In general it is the object of this invention to provide a luminous tube provided with means for continually purifying the working medium used during the operation of the tube and having a cathode capable of being cooled and so constructed as to materially decrease the detrimental effects of sputtering.

The invention possesses other advantageous features, some of which with the foregoing will be set forth at length in the following description where I shall outline in full that form of my invention, which I have selected for illustration in the drawing accompanying and forming part of the present specification. In said drawing I have shown one form of my invention, but it is to be understood that I do not limit myself to such form since the invention, as set forth in the claims, may be embodied in a plurality of forms.

Referring to the drawing:

Fig. 1 is a plan view of a luminous tube embodying the features of my invention and especially designed to be used as a beacon.

Fig. 2 is a front elevation partly in section showing the construction of a getter trap depending from one of the coils of the tube.

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 2.

Fig. 4 is a vertical section of a modified form of electrode.

My invention contemplates the use of the usual form of glass tubing 1 bent into any desired form such as letters. In the modification shown, the tubing has been bent upon itself a number of times in order to form a plurality of spaced coils as clearly shown in Figs. 1, 2 and 3. This particular construction produces a concentrated light which has been found to be very desirable for use as beacons or pilot lights. The spaces between adjacent coils serve to insu-

late them from each other thereby preventing a breaking down of the walls of the tubing when it is being operated at high potentials.

The cathode end 2 of the glass tubing 1 is outwardly flared and is sealed to a cylindrical copper electrode 3. The outer end of the electrode 3 is closed by means of conical walls 4. Since, as above stated, sputtering occurs normal to the surfaces of emission, it will be noted that sputtering from the end walls 4 of the electrode 3 result in the deposition of the particles so sputtered on the cylindrical walls of an electrode 3. Sputtering from the cylindrical walls of the electrode results in a deposition of the particles on the cylindrical walls diametrically opposite the surface of emission. This construction therefore substantially prevents any deposition of sputtered particles on the walls of the glass tubing per se. As is well recognized, the deposition of sputtered particles on the walls of either or both of the electrode and glass tubing results, in the occlusion or entrapment of sufficient amounts of the working medium used to decrease its pressure below its critical value. However, molecules of the working medium entrapped by the deposition of sputtered particles are released by re-sputtering. It will therefore be seen that as long as the form of electrode used is such as to permit re-sputtering, a condition of equilibrium will eventually be reached whereby the amount of working medium being occluded or entrapped due to sputtering is exactly equal to the amount of working medium being liberated by re-sputtering. Sputtering and re-sputtering is only possible from the electrode surface itself or from a metallic continuation thereof. This is possibly explicable on the theory that sputtering is not a consequence of heat, but rather a result of the electrical condition existing on the electrode surfaces. At all events, sputtering or re-sputtering from a metallic deposition on the walls of the glass tubing and insulated by portions of the glass tubing from the electrode, cannot take place. It will therefore be seen that in order to maintain the pressure of the working medium above its critical value it is advantageous to confine all depositions due to sputtering to the walls of the electrode or to metallic continuations thereof. Consequently it is preferable that the outer end of the cathode be closed by walls substantially non-perpendicular with its axis.

For the purpose of continually purifying the working medium within the tube during its actual operation, the tubing 1 has been provided intermediate its ends with a getter trap 7. Communication between the tubing 1 and the trap 7 is effected by a restricted opening 8 in a nipple 9 depending from and secured to the juncture 11 between the trap 7 and the tubing 1. A small quantity of a chemical getter 12 such as metallic sodium, potassium or caesium is introduced into the trap 7 thru an opening in any convenient branch 13 of the trap sealed by a teat 14. Since the ionization potentials of the vapors of chemical getters usually used in cleansing gaseous discharge tubes prior to placing them in operation, are below the ionization potentials of the inert gases used as a working medium, the vaporization of the chemical getters within the trap 7 would be fatal to the proper operation of the tube. However, the degree of heat necessary for effecting the vaporization of the getter within the trap 7 is never attained for the trap 7 is placed at some distance from the electrodes and since it is not in the direct path of the ionized working medium, it cannot be subjected to a bombardment thereby. The nipple 9 precludes the possibility of the getter 12 in its solid state from entering the tubing 1. A continuous purification of the working medium used is effected by the getter 12 due to the fact that this getter either absorbs or combines with such impurities during the actual operation of the tube. Following Dalton's law of partial pressures, the pressure of the working medium is not reduced below its critical pressure by such a reaction, for in a mixture of gases each gas exerts the same pressure as it would exert if it were alone present in the volume occupied by the mixture.

The difficulties customarily encountered in operating the usual form of gaseous discharge tube have in a measure been diminished in the luminous tube as above described. Since a substantial portion of the external surface of the electrodes 3 may be placed in contact with the atmosphere or other suitable cooling fluid, the heat generated by the current passing thru these electrodes, may be quickly radiated or conveyed away, thereby cooling the electrodes and preventing undue vaporization. If desirable cooling fins may be provided on the electrodes. This permits of the use of far greater current densities than otherwise possible, and since the intensity of the light produced is proportional to the current density, the intensity of the light produced may be greatly increased. The particular form of the closed end of the electrodes confines the deposition of the small particles of the electrodes caused by sputtering, to the surfaces of the electrodes or to a continuation thereof. This, as above explained, decreases the detrimental effects of sputtering. The provision of a continuously operating getter trap obviates the necessity of driving off the gases occluded in the electrodes and the walls of the glass tubing prior to placing it in operation, and since the driving off of gases so occluded materially increases the cost of production, the

trap as above described is greatly to be desired.

In Fig. 4 is shown a modified form of electrode 3, in which the cone enclosing its end has been inverted from the positon as shown in Figs. 1, 2 and 3.

Needless to say the anode may be of the same form as the cathode or of any other convenient form and like the cathode, may be cooled in any suitable manner.

It will be found that if on long continued use the sodium, potassium or other purifying agent used in the trap 7 becomes coated due to its combination with the impure gases in the tube, it may be readily resurfaced by a slight application of heat. In doing this there is no danger of sodium, potassium or other vapors passing into the main tubing line for what vapors are formed are quickly recondensed on cooler portions of the trap before they have a chance to pass out thru the nipple 9. This resurfacing process is of course carried out while the tube is out of use and may conveniently be done by a match flame.

I claim:

1. A luminous tube of the character described sealed at one end with a hollow tubular cathode having a closed conical end, said cathode having a substantial portion of its surface external to said tube.

2. A luminous gaseous discharge tube of the character described comprisng a tubular glass wall open at its opposite ends, metal thimble-like electrodes secured to and sealing the ends of the tube with their open ends facing opposite the open ends of the tube and the extreme end of at least one of said electrodes being of conical form interiorly.

3. A luminous gaseous discharge tube of the character described comprising a tubular glass wall open at its opposite ends, metal thimble-like electrodes secured to and sealing the ends of the tube with their open ends facing opposite the open ends of the tube and forming substantially a continuation of its walls and the extreme end of at least one of said electrodes being of conical form interiorly.

4. A luminous gaseous discharge tube of the character described comprisng a tubular glass wall open at its opposite ends, metal thimble-like electrodes secured to and sealing the ends of the tube with their open ends facing opposite the open ends of the tube and the extreme end of at least one of said electrodes being outwardly exposed to atmosphere and of conical form interiorly.

5. In a luminous gaseous discharge lamp of the character described a glass tube provided with a thimble-like metal electrode sealing the end of the tube, said electrode being a comparatively deep hollow cylinder extending beyond the tube with its outer end closed by a wall arranged at an angle with the sides of the tube in such a manner that substantially all lines extending perpendicularly from the inner surface of said wall will impinge against the inside of said electrode.

6. A luminous gaseous discharge tube of the character described comprising an elongated glass tube provided with electrodes at opposite ends, and a trap extending outwardly from the side of said tube at a point intermediate of and relatively remote from the electrodes, said trap containing a quantity of an alkali metal and provided with a restricted orifice communicating with the interior of the tube.

7. A luminous gaseous discharge tube of the character described comprisng an elongated glass tube provided with electrodes at opposite ends, and a trap extending outwardly from the side of said tube at a point intermediate of and relatively remote from the electrodes, said trap containing a gas absorbing material and provided with a neck extending substantially within its interior pierced by a restricted orifice communicating with the interior of the tube.

8. A luminous gaseous discharge tube provided with a side trap containing a chemical gas purifier, said trap comprising a bulbous appendage extending from the side of the tube, and a relatively small neck extending from the tube well into the trap pierced by a relatively small passage.

In testimony whereof, I have hereunto set my hand.

JAMES H. BYRNES.