Aug. 30, 1955 E. B. NOEL 2,716,713

COLD ELECTRODE PULSE LAMP STRUCTURE

Filed March 22, 1950

Fig. 1.

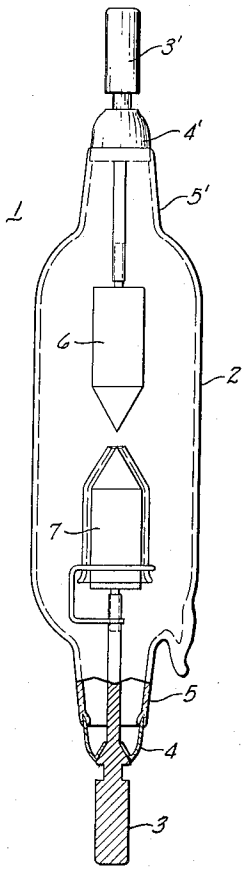


Fig. 2.

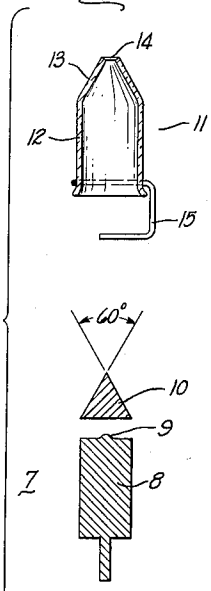


Fig. 3.

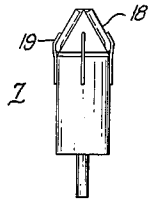


Fig. 4.

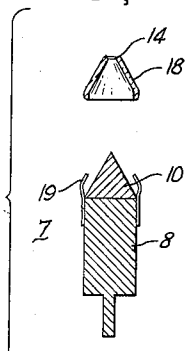
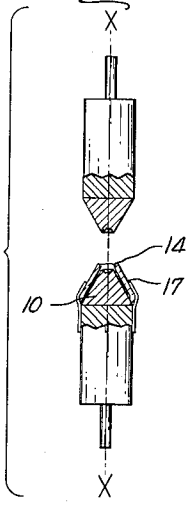


Fig. 5.



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2,716,713

COLD ELECTRODE PULSE LAMP STRUCTURE

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Application March 22, 1950, Serial No. 151,098

6 Claims. (Cl. 313—185)

My invention relates to gaseous electric discharge lamps generally, and more particularly to electrode structures for such lamps designed for repetitive pulse flashing.

In connection with the transmission of standard motion picture film over television systems, there has lately arisen a demand for a flash lamp capable of successfully withstanding repeated applications of tremendously high energy loadings, and on which very stringent requirements of constancy in operation have been imposed.

A system in which such a lamp is utilized is described in my co-pending application Serial No. 151,097 filed March 22, 1950, entitled "Thermionic Electrode Pulse Lamp Structure," and assigned to the assignee of the present invention. In film television it is necessary to reconcile the conflicting frame and sweep synchronization rates of standard film and standard television, film pull-down being at the rate of 24 frames per second, and television sweep being at the rate of 60 sweeps per second. In this particular film televising system these requirements are reconciled by providing a source of light which is pulsed alternately three times and two times for successive film frames. In this manner the film pull-down and television sweep are maintained in step and re-occur simultaneously at every 1/12 of a second, in which interval of time two film frames and five television sweeps occur.

In the aforementioned application a lamp structure for such a system is disclosed and claimed in which small thermionic electrodes composed of helixes of refractory metal wound around a refractory metal rod and containing a sliver of thorium are utilized. With electrodes of that type the difficulty was encountered that small deposits of tungsten, commonly known as "tree growths," occurred on the electrodes; these growths, and also the forward face of the cathode, glowed in between the flashes of light, and produced a direct or residual component of light which affected the televised image by producing so-called "travel ghosts." This problem was solved by constructing the thermionic cathode with a sleeve of a highly refractory insulating material such as quartz or alumina so that the "tree growths" occurred inside the sleeve and the direct component of light was eliminated.

The present invention is concerned with a lamp designed for essentially similar applications in which solid massive electrodes, which operate at a relatively low temperature, are used. The presently commonly accepted theory, though it is to be understood that it is not stated here as an uncontrovertible fact, is that the emission from these electrodes is due partly to field emission and partly to the formation of a hot spot. Such an electrode structure, for instance, is described in my Patent 2,459,579 assigned to the same assignee as the present invention. These electrodes comprise a massive body portion and an electron emissive tip or conical portion containing a small proportion of barium.

When lamps containing this type of electrode are used for repetitive pulse flashing, it has been found that the arc does not stay on the apex of the conical portion of

the cathode but wanders from one side to the other on the cone. This appears to be caused by the continuous vaporization of the barium under the cathode spot. This may be quite objectionable, particularly when the lamp is used in a film televising system in which a wide angle light-condensing system is utilized to focus the light on the film. The wandering of the arc causes rapid spasmodic fluctuations in the brilliancy of the televised image which produces considerable discomfort to the observer. This appears to be caused by the shifting of the arc in and out of the focal plane of the condensing system, depending upon whether it strikes on the tip of the conical electrode or on one side thereof.

Accordingly, it is an object of this invention to provide a new and improved lamp and electrode structure for preventing arc wander.

Another object of this invention is to provide an improved lamp for repetitive pulse flashing which assures an arc of constant intensity during successive flashes, and which is accurately maintained in a focal plane.

In accordance with the present invention these objects are achieved by means of a lamp containing a massive cathode of the hot cathode spot and field emission type. Preferably, the cathode has a conical tip, and over this tip a close-fitting conical cap of a highly refractory insulating material is fitted. The insulating cap has a small perforation in its apex through which the arc is constrained to enter, so that the external portion of the arc is stabilized, even though the hot spot may shift under the insulating cap.

For further objects and advantages and for a better understanding of the invention attention is now directed to the following description and accompanying drawing. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

In the drawing:

Fig. 1 is an elevation view of a gaseous electric discharge lamp embodying my invention.

Fig. 2 is an exploded sectional elevation on an enlarged scale of a cathode structure embodying my invention.

Fig. 3 is an elevation view of a cathode structure embodying a preferred form of my invention.

Fig. 4 is an exploded sectional elevation of the cathode structure of Fig. 3.

Fig. 5 is an elevation view of a pair of electrodes located in operative relation for the purpose of illustrating certain features of my invention.

Referring to Fig. 1, the lamp 1 shown therein comprises a tubular light-transmitting bulb 2 which may be made of quartz or of a hard glass having a high melting point and a low coefficient of expansion. The bulb is provided with tubular appendages or necks, to each of which is sealed a terminal structure comprising a heavy rigid lead-in conductor in the form of a post or prong 3 of steel having brazed thereto a thin metal ferrule 4, the rim of which is fused into the end of the neck 5. The ferrules 4 may be made of an alloy capable of hermetically sealing to a glass bulb, for example, a nickel-iron or nickel-iron-cobalt alloy, as is well known.

At the center of the bulb is an arc gap, preferably about 3 to 4 mms. wide, between two massive electrodes 6 and 7 which are suitably affixed, either by brazing or spot welding, to inward extensions of the posts 3, 3'. Where the lamp is to be utilized on alternating current both electrodes are made identically to the cathode 7 now to be described.

The cathode 7, whose construction may be more readily visualized with reference to Fig. 2, comprises a cylindrical body portion 8 also made of cold rolled steel and having on its upper circular surface a small projection or boss 9. The conical tip portion 10 of the electrode is composed of a combination of refractory and alkaline

earth metal, preferably a tungsten-nickel-barium alloy which may have a composition of approximately 89 per cent tungsten, 10 per cent nickel, and 1 per cent barium. The conical tip portion **10** is joined to the body portion **8** by a suitable electric welding process which in its essence consists of passing a heavy current through the tip and body portion simultaneously with the application of axial pressure to force both portions together, the boss **9** melting and flowing to form the weld. A suitable proportioning for electrode **7** is a body portion ⅜ inch in diameter and about 1 inch long, with the conical tip forming a 60 degree angle at its apex.

Over the cathode **7**, and proportioned to fit quite snugly thereon, I provide a cover **11** composed of a refractory insulating substance and shaped to conform to the dimensions of the electrode. Cover **11** comprises a cylindrical sleeve portion **12** and a conical cap portion **13** which is perforated at its apex by a small hole **14** which may be approximately 50 mils in diameter. The quartz cover is slipped over the electrode and held in position by means of a wire ring **15** fitting around the expanded base portion thereof and spot welded to the extension of the binding post **3**.

The bulb **1** contains a suitable ionizable medium such as a filling of argon, krypton, xenon, or mixtures of those gases with hydrogen. A presently preferred filling is xenon at a pressure of 600 mm. of mercury in a bulb 1¼ inch in diameter and about 3 inches long. The bulb with its filling at near atmospheric pressure is tipped off or sealed at the tabulation **12** by methods well known in the art.

When lamp **1** is operated as a repetitive pulsing source, I have found that the quartz cover substantially reduces or eliminates the tendency of the arc to wander from side to side of the conical tip of the cathode. Referring to Fig. 5, the arc always enters through the hole **14** along the axis XX, and strikes a hot spot on the conical tip portion **10**. In operation, the sharp apex of tip **10** slowly disintegrates and a crater **17** is formed under the hole **14**, as may be seen in dotted outline in Fig. 5. Quite surprisingly, the tendency of the arc to cut or burn away the edges of the hole **14** is much less than would be expected because of the fact that the arc does not penetrate in the crack between the quartz and the conical tip but, instead, strikes within the crater. This appears to be due to the fact that the width or lateral dimension of the crack between the cover and the electrode is quite small, so that the wall losses therein are too high to permit substantial ionization, and the arc cannot creep into the crack.

Referring to Figs. 3 and 4, there is shown a preferred structure wherein the cover is restricted to the conical tip portion **10** of the electrode. The cover in this case consists only of a conical cap **18** with the hole or perforation **14** at its apex and held in place by means of spring fingers **19** which are welded to the sides of the body portion **8** of the electrode. As may be seen in the drawing, the conical cap **18** covers only the conical tip portion **10** of the electrode, being secured in place by the fingers **19** extending into clamping engagement therewith. This structure requires less quartz so that it is more economical, but its operation is identical to that described with reference to Fig. 2.

Although the lamp of Fig. 1 shows only electrode **7** provided with a quartz cover, it will be understood that when such a lamp is to be used on alternating current both electrodes would be made identical to electrode **7** since each would act alternately as cathode and as anode. However, when the lamp is to be used with unidirectional pulsed current, I have found that there is little tendency for the arc to wander over the tip of the anode, so that a quartz cover therefor is unnecessary and need be provided over the cathode only.

Although I have described the electrodes as having a 60° conical tip, it is readily seen that the invention is likewise applicable to electrodes of this type having a tapered end, whether curved or pointed, of the general configuration which has been described. Likewise, other refractory insulating materials, such as alumina, beryllia, magnesia, thoria and zirconia, may be used for the insulating cap instead of the quartz which has been described.

The lamps in accordance with the present invention, and also those in accordance with my co-pending application entitled "Thermionic Electrode Pulse Lamp Structure," have, for the first time, made practical the television of film by means of a pulsed light system, as described in that application. Previously it had been impossible to produce a televised image sufficiently free from objectionable flicker to render this system competitive with the more conventional systems in which the light from a constant source is mechanically interrupted by a shutter. My present invention has permitted a reversal of this situation and enables the present system to compete on very favorable terms with the conventional shutter systems.

While certain specific embodiments have been shown and described, it will, of course, be understood that various modifications as to the shape, configuration and composition of the electrodes, as to the gas filling of the envelope, and as to the configuration and composition of the insulating cover, to mention but a few, may be made without departing from the invention. The appended claims are therefore intended to cover any such modifications coming within the true spirit and scope of the invention.

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

1. A high pressure electric discharge lamp comprising a light-transmitting envelope containing an ionizable gaseous filling, a pair of massive electrodes oppositely mounted in alignment within said envelope and defining a high intensity arc path, at least one of said electrodes having a tapered tip portion comprising refractory metal and alkaline earth metal, and a refractory insulating cover fitting snugly over said tapered tip portion and having a small perforation at its apex for stabilizing the path of the arc occurring between said electrodes.

2. A high pressure electric discharge lamp comprising a light-transmitting envelope containing an ionizable gaseous filling, a pair of massive electrodes oppositely mounted in alignment within said envelope and defining an arc path less than the transverse diameter of the envelope part surrounding them, at least one of said electrodes having a conical tip portion comprising refractory metal and alkaline earth metal, and a refractory insulating cover fitting snugly over said conical tip portion and having a small perforation at its apex for stabilizing the path of the arc occurring between said electrodes.

3. An electric discharge lamp comprising a light-transmitting envelope containing a filling of an inert gas at near atmospheric pressure and a pair of massive electrodes oppositely mounted in alignment within said envelope by lead-in conductors and defining an arc path less than the transverse diameter of the envelope part surrounding them, at least one of said electrodes having a conical tip portion comprising refractory metal and a small percentage of alkaline earth metal, and a refractory insulating cover fitting snugly over said conical tip, and having a small perforation at its apex for stabilizing the path of the arc occurring between said electrodes by forcing the arc to enter through said perforation, immaterially of the place of striking on said conical tip portion.

4. An electric arc discharge lamp comprising a light-transmitting envelope containing a filling of an inert gas at near atmospheric pressure and a pair of massive electrodes oppositely mounted in alignment within said envelope for defining a high intensity arc path shorter than the transverse diameter of the envelope part surrounding them, at least one of said electrodes having a conical tip portion comprising refractory metal and a small per-

centage of alkaline earth metal, and a refractory insulating conical cover conforming to and fitting snugly over said conical tip, said cover having a small perforation at its apex for stabilizing the path of the arc occurring between said electrodes by forcing said arc to enter through said perforation in forming a cathode spot on said conical tip portion, so that said arc remains stable in said path independently of the shifting of said cathode spot on said portion.

5. An electric arc discharge lamp comprising a light-transmitting envelope containing a gas, at near atmospheric pressure, of the group including argon, krypton, xenon, hydrogen and mixtures thereof, and a pair of massive electrodes oppositely mounted in alignment within said envelope for defining a high intensity arc path shorter than the transverse diameter of the envelope part surrounding them, at least one of said electrodes serving as a cathode having a solid conical tip portion comprising refractory metal and a small percentage of alkaline earth metal in order to operate partly through field emission with the formation of a cathode spot having a tendency to wander, and a conical cap of a highly refractory insulating material conforming to and fitting snugly over said conical tip portion, and having a small perforation at its apex for stabilizing the path of the arc occurring between said electrodes by forcing said arc to enter through said perforation in forming a cathode spot on said conical tip portion, so that said arc remains stable in said path independently of the shifting of said cathode spot on said portion.

6. An electrode for electric discharge lamps comprising a massive cylindrical body portion of metal having a comparatively high work function and terminating at one end in a conical tip portion of refractory metal and emissive material having a comparatively low work function, and a conical cap of refractory insulating material fitted snugly over and covering only the said conical tip portion and having a small perforation at its apex exposing only the apex of said conical tip portion, and spring finger members secured to the sides of said body portion and extending therefrom into clamping engagement with said cap to hold it against said conical tip portion.

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