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GAS DISCHARGE LAMP, ESPECIALLY MERCURY LAMP

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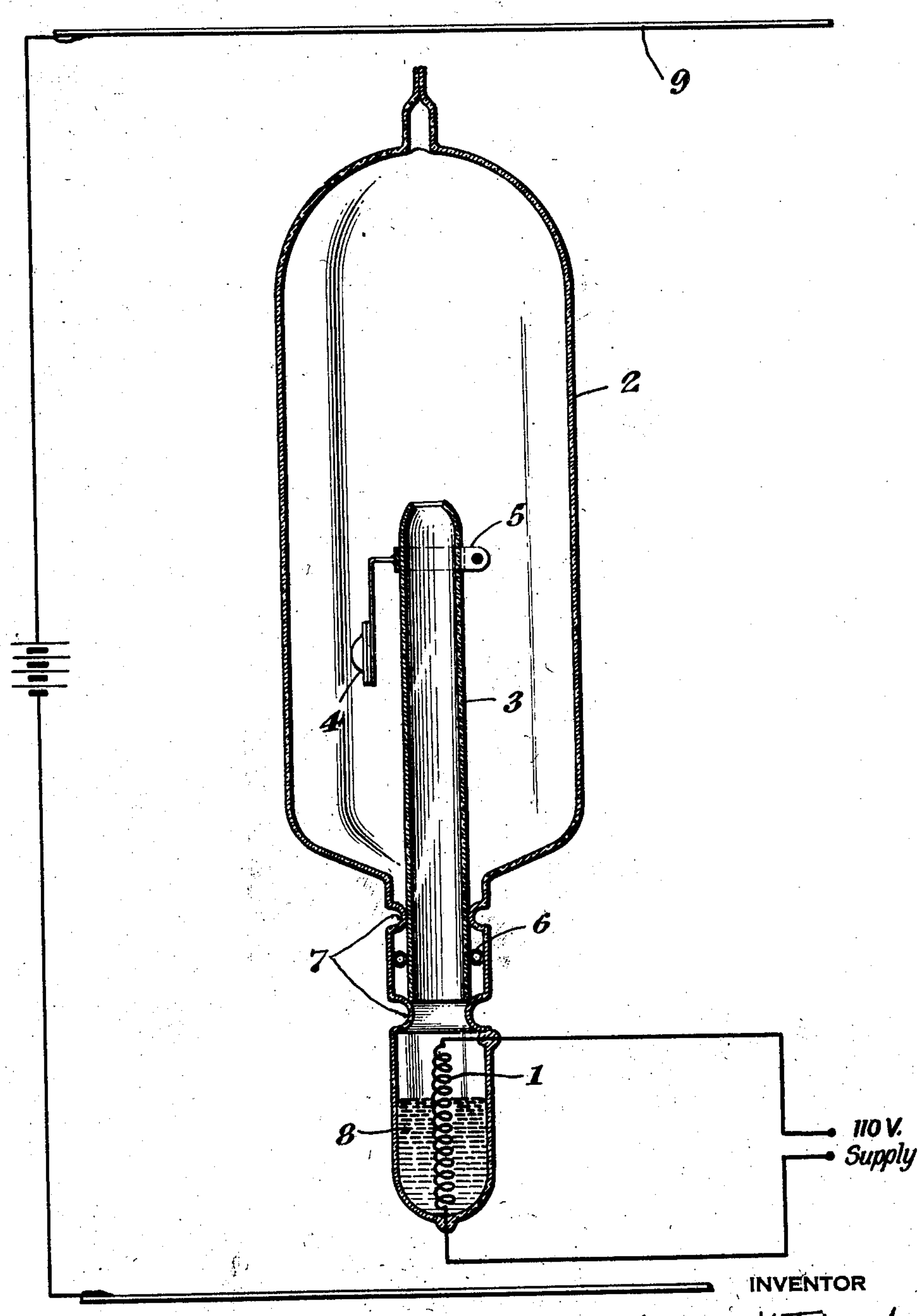

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GAS DISCHARGE LAMP, ESPECIALLY MERCURY LAMP

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3 Claims. (Cl. 176—124)

This invention relates to generating light from heat in a glass vessel in such a fashion that no transformers are required to give voltages particularly adapted to the lamps and no choke is required in series with the lamp. To do this, instead of giving electric charges a velocity relative to gas by putting electrodes in the lamp, I give the gas a velocity relative to a space charge of electricity, generated by the heat of the lamp and a static field or a field of 60 cycles. My invention is somewhat similar to an electrodeless lamp of the common form in that there is no metallic anode for the electrons and except that other means than a high frequency oscillator are used to obtain a suitable difference of velocity between the electrons and atoms of the gas.

It also does not differ greatly from the common mercury diffusion pump, much used to give high vacua, and which has a definite means of giving gases high velocities in the heat supplied to the boiling mercury, and which will often "flash" spontaneously, except that I provide a more constant and higher electric field than that self generated in some pumps. I also consider that it will usually be advisable to supply electrons in greater quantity than given off by hot mercury and have experimented with the introduction of electron emitting filaments in the stream of mercury vapor and mixing the mercury vapor with substances that emit electrons at low temperatures, such as caesium, for this purpose. I have also developed types of heaters which can have the usual 115 line voltage impressed on them while in mercury vapor without arcing. These are fully described in a patent application submitted with this one, Serial No. 695,791.

One form of the lamp is illustrated diagrammatically in the figure of the drawing. This is meant to be merely a diagrammatic representation showing a source of heat in diagrammatic fashion at **1**, said source being adjacent to a vaporizable and ionizable metal at **8** and capable of emitting electrons which together with the vapor pass into the tube **3** and are there subjected to an electric field tending to hold the electrons fixed with reference to the tube in the streaming gas, said field being in practice due to many causes, such as those operating in the mercury vapor aspirator pump and the diffusion of the electrons from their source but definite means are provided to secure a stronger field than in the mercury aspirator, capable of holding more electricity in a space charge, and not capable of being discharged by the currents flowing, which is not the case with the mercury aspirator or similar devices depending on frictional electricity. In practice the electric field might be produced in many ways and I would particularly prefer the method of generating an electric field which consists in allowing polar molecules to freeze in an electric field. This results in a permanent field and if the surface is clean, as it might well be if the polar molecules were those of a glass used as a lamp bulb, there is no reason why it should not be a rather high field, capable of holding many electrons in a space charge in close proximity to its surface. The amount of electricity which could be so held would follow rules similar to those for condensers, the closest analogy being perhaps with the capacity which exists between the space charge of electrons in a vacuum tube or gas discharge lamp and the elements of the same. The velocity with which the electrons would strike the gas atoms would depend on the degree to which the stream of gas displaced the electron cloud from its position of rest in the absence of the gas stream as well as on the number of electrons in the cloud.

Suppose for instance that the transparent tube shown at **3** were an "electret" as such seats of a permanent field are called, so poled that electrons would tend to gather on its inner surface. As soon as the stream of gas commenced to flow these electrons would be partially washed away due to elastic collisions with the gas. The stream would also wash away any droplets leaving the upper end of the tube at a negative potential sufficient to insure that some of the electrons would make inelastic collisions with the gas and produce light. Once the gas is so ionized a rather different set of conditions comes into play in that the conducting gas is not capable of sustaining any great potential differences and in that out of it electrons will diffuse in great numbers to the inner surface of the tube.

The problem now is not to light the lamp but to keep it lit continuously and brightly. For this purpose all that is necessary is that the elastic collision that the electrons of the "plasma" are making with the gas should be equivalent to a considerable current of electricity. This will be roughly proportional to the current of gas flowing down the tube and to the number of electrons in the stream. As the flow of gases through tubes is well understood, I will not discuss it further than to point out that a boiling substance at **8** is capable of generating considerable pressure differences between the ends of the gas path and particularly between the ends of the tube, due to the temperature differences which will exist. It also might be noted that such a substance as boiling mercury or sodium is capable of entraining considerable quantities of the more permanent gases, such as neon, in the fashion of a mercury diffusion pump, and that these might then be subjected to the process set out above. Various alloys and amalgams might also be used, particularly the amalgam of caesium which does not attack even ordinary glass very rapidly, is extremely effective in removing undesired gases, and is a rather heavy and large atom. A caesium pill is shown at 4.

Besides the quantity and kind of gas flowing, the amount of light will also depend on the quantity of electricity available to be displaced. This at best should be sufficient in amount so that the gas is somewhat hindered in its flow by being struck by electrons necessitating that the gas do work on the electricity. This will happen chiefly close to the wall, as the net charge of negative electricity will predominate there, and least in the center of the tube where the amount of positive and negative electricity will be approximately equal. So I have illustrated a rather small tube, mostly as a matter of practical convenience in manufacture, but also because such a tube has a greater ratio of wall area to volume than a larger tube, and can be more easily made with a thick wall than a larger tube while yet with the same potential gradient in the wall as a larger tube. In these lamps as in others of customary form it is approximately true that the voltage drop in unit length tends to be greater in a small tube than in a larger one.

One difficulty is that droplets tend to cloud the surface of the external envelope which is shown at 2. I have therefore shown a long narrow bulb in which the droplets condensing at the top will run down the wall and keep it fairly clear. This bulb may of course be made of anything transparent to light and particularly to ultra-violet light. As there is no connection between the tube 3 and the bulb, 2, the two may be of different materials. The droplets will return to the boiler by gravity against the pressure of the boiler but are somewhat hindered by the spring at 6 in such a fashion as to seal in the evaporating vapor and force it to travel up the tube, which results in a better flow of gas and also helps prevent clouding of the bulb.

The heater shown at 1 is a further possible source of light. If this is a tungsten filament of low voltage it may be operated at the temperatures of an incandescent lamp and is then an efficient source of light. Unless the tube which contains it is very narrow, or the equivalent effect is secured with baffles, it will however arc between its ends at about the ionizing potential of the gas used, which is a severe limitation on the voltage that may be used in a lamp of simple construction. I therefore prefer to use 115 volt heaters of a type described in the above mentioned application. If these are made of some high temperature metal such as platinum and a resistant substance such as thoria, they are capable of giving considerable light. The best substances for this purpose are, of course, tungsten for the metal, and either a highly heat resistant oxide such as thoria or one of the carbides of high electrical and heat resistance as will be well understood by anyone versed in the art of making incandescent lamps. Tungsten is said to be deposited by electrolysis and the technique of handling ceramics is well understood.

I claim:

1. In an electric discharge device for producing light a transparent envelope forming a discharge chamber, a gas in said chamber, a nozzle in said chamber opening out of a reservoir of vaporizable metal, means to heat the vaporizable metal in the reservoir, a return channel for condensed vapor connecting the chamber to the reservoir, and means for maintaining the discharge chamber in a substantially uniform electric field.

2. In apparatus for producing light from electric discharges in gases or vapors, a transparent envelope containing the said gas, vapor, or both; means to subject at least a portion of the space within the envelope to the field of an electret; and means independent of the field to accelerate or circulate the said gas, vapor, or both, in the field.

3. In apparatus producing a continuous light from electric discharges in gases or vapors, a transparent envelope containing the said gas, vapor, or both; means to subject at least a portion of the space within the envelope to the field of an electret; and means independent of the field to accelerate or circulate the said gas, vapor, or both in the field, together with electricity.

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