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# UNITED STATES PATENT OFFICE

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## ELECTRIC LAMP

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3 Claims. (Cl. 176—16)

Our invention relates to electric lamps, more especially of the filament type, in which a metal filament is surrounded by a gas. It is an object of our invention to provide means whereby such lamps can be operated at higher temperatures than was hitherto possible, thereby improving the economy of the lamps.

Electric lamps of the metal filament type as hitherto constructed are filled with a suitable gas in order to diminish the evaporation of the metal forming the filament. The lamps nowadays in use which are provided with tungsten filaments are filled as a rule with argon or nitrogen or with a mixture of these two gases which diminish the evaporation of the tungsten filament to the extent that lamps of this kind can be operated at higher temperature than evacuated lamps without their life being shortened. Investigations have shown that the filaments in lamps filled with the gases mentioned above can be operated at a temperature of 2400° C. with an average life of 1000–2000 hours.

In view of the fact that this operating temperature is still about 900° below the melting point of tungsten, it has often been tried to find means for further increasing the operating temperature.

Extended theoretical and experimental investigations have shown that the life of a gas-filled electric incandescent lamp is determined mainly by the so-called Ludwig-Soret phenomenon, which may be explained as follows:

If a difference of temperatures exists in a gas mixture, a difference of concentration of the gas will arise and if one component of the mixture is present only in a relatively low percentage and if the molecular weight of this component is high as compared with the molecular weight of the other component, the gas, which is present only in a relatively low percentage, will migrate by diffusion from the point of higher temperature to a point of lower temperature.

As is well known the filament in a gas-filled lamp is surrounded by a gas envelope. The temperature of that part of this gas envelope which directly surrounds the filament is equal to the temperature of the filament itself, while the temperature of that part of the envelope which is farther away from the filament is lower and equal to the temperature of the body of gas surrounding the gas envelope. In consequence of this rule extremely high differences of temperature exist in a gas-filled lamp between relatively closely adjoining points. Obviously, owing to this circumstance, the Ludwig-Soret effect is very high also and in accordance with this rule the tungsten vapor being present in the gas in relatively low concentration and having a high molecular weight will migrate with great velocity towards the colder body of gas surrounding the hot gas envelope. These conditions prevail with the gases hitherto used in incandescent lamps, such as nitrogen and argon, the molecular weights of which (28 and 40, respectively) amount only to about one seventh and one fifth, respectively, of the molecular weight of tungsten.

Our invention is based on the fact that these conditions will be changed altogether if nitrogen or argon are replaced by a gas or gas mixture having a high molecular weight. We have found that if the molecular weight of the gas filling the bulb is about one third of the molecular weight of tungsten the lamps will be greatly improved and that if a gas of still higher molecular weight is used a further improvement results, for in this case the destruction worked on the filament in consequence of the Ludwig-Soret effect is greatly diminished or altogether prevented from arising and under favorable circumstances may even become a useful factor.

We have found that the rare gases of high atomic weight, crypton and xenon, are particularly suitable for this purpose, their molecular weight being 82 and 128, respectively. In contradistinction to mercury vapor which owing to its low disruptive strength is not suitable for this purpose, these gases possess a sufficiently high disruptive strength, more especially if mixed with some other suitable gas, such as for instance nitrogen or argon. We prefer filling the lamps with a mixture of crypton or xenon and nitrogen or argon in which the percentage by volume of the gas of high molecular weight corresponds at least to a partial pressure of 10 mm. mercury column. On the other hand nitrogen should be present in the mixture in a quantity of at least 5%.

It is to be understood that in the present specification and claims the term "gas" is intended to include not only the permanent gases but also any substance which at the normal operating temperature and at a pressure as usually occurring in gas-filled lamps can be present only in the gas phase.

Various changes may be made in the details disclosed in the foregoing specification without departing from the invention or sacrificing the advantages thereof.

We claim:—

1. An electric metal filament lamp containing a

tungsten filament and a mixture of crypton, xenon and nitrogen surrounding the filament.

2. An electric metal filament lamp containing a tungsten filament and a mixture of crypton, xenon, argon and nitrogen surrounding the filament.

3. An electric incandescent lamp comprising a bulb, said bulb having a tungsten filament therein, and containing a mixture of argon and an inert gas which is gaseous under ordinary conditions and the molecular weight of which is at least one third of the molecular weight of tungsten, said gas being the principal constituent of the mixture.

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