(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 241 599 A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 86118100.6

(51) Int. Cl.⁴: H01K 1/50

(22) Date of filing: 29.12.86

(30) Priority: 14.04.86 JP 55743/86

(43) Date of publication of application: 21.10.87 Bulletin 87/43

(84) Designated Contracting States: AT BE CH DE ES FR GB GR IT LI LU NL SE

(71) Applicant: Stanley Electric Co., Ltd.
2-9-13, Nakameguro
Meguro-ku Tokyo 153(JP)

(72) Inventor: Motooka, Hidetaka
5-22-4, Okamura Isogo-ku
Yokohama-shi Kanagawa-ken(JP)
Inventor: Chiba, Masatoshi
4-23-7-509, Kameari Katsushika-ku
Tokyo(JP)
Inventor: Murakami, Yukio
89-1-5-410, Oheda
Ksukabe-shi Saitama-ken(JP)

(74) Representative: Patentanwälte Schaumburg & Thoenes
Mauerkircherstrasse 31 Postfach 86 07 48
D-8000 München 80(DE)

(54) High efficacy incandescent lamp.

(57) A high efficacy incandescent lamp having the glass bulb outer diameter smaller than 40 mm is provided, wherein the glass tube is made of soft glass; the main component of filler gas to be filled in the glass bulb is an inactive gas whose atomic weight is larger than 80 and whose thermal conductivity is smaller than 25 x $10^{-6}cal \bullet cm^{-1} \bullet s^{-1} \bullet deg^{-1}$; and the pressure of the filler gas is between 1 to 3.5 preferably between 1.5 to 2.5 atmospheric pressure under non excitation of said bulb.

EP 0 241 599 A2

HIGH EFFICACY INCANDESCENT LAMP

The present invention relates to incandescent lamps for automobiles and more particularly to compact incandescent lamps made of soft glass and having improved luminous efficacy.

The glass tube of a conventional compact incandescent lamp of this type is maintained vacuum so as to prevent oxidization or burning of the filament made of tungsten. If the temperature of the filament is raised to improve luminous efficacy, the quantity of evaporation of the filament extremely increases, thus resulting in a very short lifetime of the lamp. In view of this, in case where luminous efficacy approximately greater than 10 lm/W is needed, conventional incandescent lamps have been filled with inactive gas, for example, argon gas at 0.5 to 0.6 atmospheric pressure to reduce the evaporation quantity of filament and avoid a short lifetime.

However, the quality of illumination, i.e., color rendering has recently been intended to be improved in the field of such compact incandescent lamps, e.g. in the field of illumination devices for automobiles. The improvement on color rendering is theoretically possible by raising the color temperature or in other words, the temperature itself of the filament. The temperature rise of the filament also results in a high luminous efficacy so that such operating state should be considered idealistic. However, with conventional technology, if a color temperature greater than those currently used (e.g., 2300 K to 2400 K for a wedge base lamp used in a dashboard of automobiles) is to be employed, the evaporation quantity of filament becomes extremely large in a vacuum state due to the temperature rise of filament. Thus, the lifetime becomes very short and becomes unsuitable for practical use. Further, even if inactive gas, e.g., argon gas is filled at 0.5 to 0.6 atmospheric pressure, the ability of preventing evaporation is near its limit at the current luminous efficacy of about 10 lm/W and therefore substantial and practical improvement on the efficacy can no more be expected. Furthermore, heat generation increases how small such improvement on the efficacy is, so that filled argon with its thermal conductivity (38.8×10^{-6} cal•cm^{-1}•s^{-1}•deg^{-1}) reaches the glass bulb to cause the temperature of the bulb made of soft glass such as soda glass excess over its limit value. Thus, there arise some problems in realizing such bulbs and it has been impossible to realize such bulbs.

The present invention seeks to solve the above problems and to provide a high efficacy incandescent lamp having the glass bulb outer diameter smaller than 40 mm.

According to the invention, this problem is solved by a lamp having a glass bulb outer diameter smaller than 40 mm characterized in that said glass tube is made of soft glass; the main component of filler gas to be filled in said glass bulb is an inactive gas whose atomic weight is larger than 80 and whose thermal conductivity is smaller than 25×10^{-6}cal•cm^{-1}•s^{-1}•deg^{-1} ; the pressure of said filler gas is between 1 to 3.5, preferably between 1.5 to 2.5 atmospheric pressure under non excitation of said bulb.

The following description illustrates an embodiment of the invention with reference to the drawings.

Fig. 1 shows the main part of the high efficacy incandescent lamp according to the present invention, wherein the process for filling filler gas at high pressure and sealing it in the bulb is schematically shown; and

Fig. 2 is an outer appearance of the incandescent lamp according to an embodiment of the present invention.

Next, the present invention will be described in detail in connection with the embodiment shown in Fig. 1.

Fig. 1 schematically shows the process for filling gas in the high efficacy incandescent lamp according to the present invention. In the figure, reference numeral 1 represents the glass bulb of an incandescent lamp wherein necessary elements such as a filament are housed. The glass tube 1 is coupled to a distributor tube 4 via a glass exhaust tube 2 and a stop valve 3. A vacuum pump and a container for filler gas are connected interchangeably (not illustrated) to the distributor tube 4. Therefore, the interior of the glass bulb 1 can be filled with filler gas by opening the stop valve 3, operating the vacuum pump and thereafter filling filler gas through the distributor tube 4.

After closing the stop valve 3, the glass bulb 1 is immersed into solution 5 such as liquid nitrogen to cool the filler gas in the glass bulb 1. The filler gas reduces its volume in accordance with the Boyle-Charles' law, i.e. , volume = νRT. The temperature of the solution 5 as of liquid nitrogen is about -200°C so that the volume becomes 75/(275 + 25) according to the above equation and reduces to one fourth. Thus, the inner pressure of the glass bulb 1 and the exhaust tube 2 becomes negative relative to the atmospheric pressure. In this condition, the exhaust tube 2 is heated with gas burners 6 and 6′ to the softening temperature of glass to compress the exhaust tube 2 by the atmospheric pressure, thereby sealing the filler gas within the bulb 1. Thereafter, the bulb 1 is picked up from the solution 5 and remains at room temperature to resume an ordinary state of the volume of the filler gas. Assuming that the pressure of the filler gas at the time of filling operation from the distributor tube 4 is 2.5 atmospheric pressure, the filler gas at the ordinary state becomes also 2.5 atmospheric pressure. However, in practice, some adjustment of the pressure becomes necessary in view of cooling efficiency or the like. Reference numeral 7 represents the filament.

As seen from the above process, the pressure of the filler gas is set at 1.5 to 2.5 atmospheric pressure as compared with conventional 0.5 to 0.6 atmospheric pressure. Therefore, it is possible to markedly reduce the evaporation quantity of filament and basically improve the luminous efficacy. According to the various experiments conducted in order to solve conventional problems, it has been confirmed that the evaporation quantity of filler gas depends on the atomic weight of inactive filler gas to be used. Further, it is obvious that the thermal conductivity is preferably small so that the temperature of the glass bulb 1 is hard to be raised. These conditions were examined for compact incandescent lamps such as those used for automobiles. The results for an incandescent lamp having its outer diameter smaller than 40 mm and its glass bulb made of soft glass showed that the most proper conditions are: the pressure of inactive filler gas is 1.5 to 2.5 atmospheric pressure; the atomic weight is larger than 80; and the thermal conductivity is smaller and 25 x 10^{-6}cal•cm^{-1}•s^{-1}•deg^{-1}.

In the following table, atomic weights and thermal conductivities are shown respectively for krypton and xenon serving as inactive gas meeting the conditions of the present invention, and for conventional inactive argon gas.

	Atomic weight	Thermal Conductivity (cal·cm^{-1}·s^{-1}·deg^{-1})
Krypton	83.8	21.2 x 10^{-6}
Xenon	131.3	12.4 x 10^{-6}
Argon	39.3	38.8 x 10^{-6}

Experimental data obtained for wedge base bulbs for automobile incandescent lamps are as in the following as compared with conventional ones: the luminous efficacy improved by 50% from 9 lm/W to 13.5 lm/W; the color temperature representative of color rendering improved from 2300 K to 2700 K; and the color rendering improved positively from red-yellow to yellow-white in visual sense. As to the lifetime, improvement by 350% was attained from 800 hours to 2800 hours. This fact means that by designing the filament so as to have the same lifetime as conventional, further improvement of the efficacy and color temperature is possible. With the above data, the surface temperature of glass bulbs did not exceed 300° C which is the allowable limit value of soft glass.

As described so far, according to the incandescent lamp of the present invention, inactive filler gas is filled in the glass bulb at the range of 1.5 to 2.5 atmospheric pressure to basically suppress the evaporation quantity of filament. Further, filler gas having its atomic weight larger than 80 is used to further suppress the evaporation quantity of filaments. Furthermore, the filler gas having its thermal conductivity smaller than 25 x 10^{-6} cal•cm^{-1}•s^{-1}•deg^{-1} is used to prevent the temperature rise of the glass tube. Therefore, it is possible to use conventional soft glass (soda glass) so that it is cost effective.

Still further, compact incandescent lamps whose dimension is defined by the specifications, such as automobile incandescent lamps, can adopt the conventional configuration and dimension with high efficacy being achieved.

Claims

1. A high efficacy incandescent lamp having the glass bulb outer diameter smaller than 40 mm **characterized** in that said glass tube is made of soft glass; the main component of filler gas to be filled in said glass bulb is an inactive gas whose atomic weight is larger that 80 and whose thermal conductivity is smaller than 25 x 10^{-6} cal• cm^{-1}•s^{-1}•deg^{-1}, and the pressure of said filler gas is between 1 to 3.5 atmospheric pressure under non excitation of said bulb.

2. A high efficacy incandescent lamp according to claim 1, wherein the pressure of said filler gas is between 1.5 to 2.5 atmospheric pressure under non excitation of said bulb.

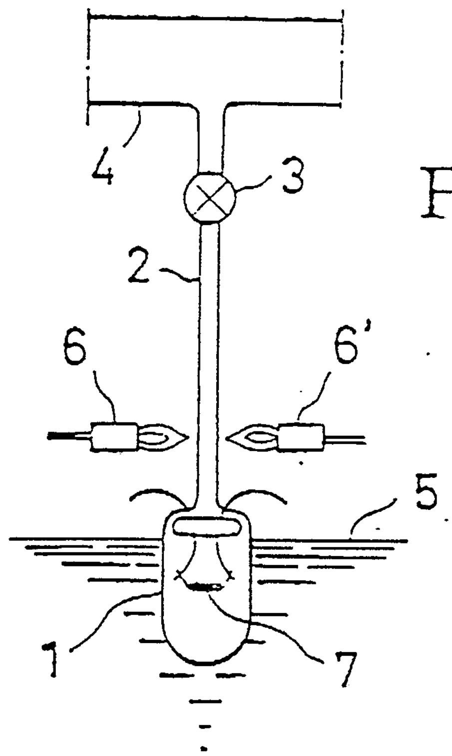

FIG.1

FIG.2