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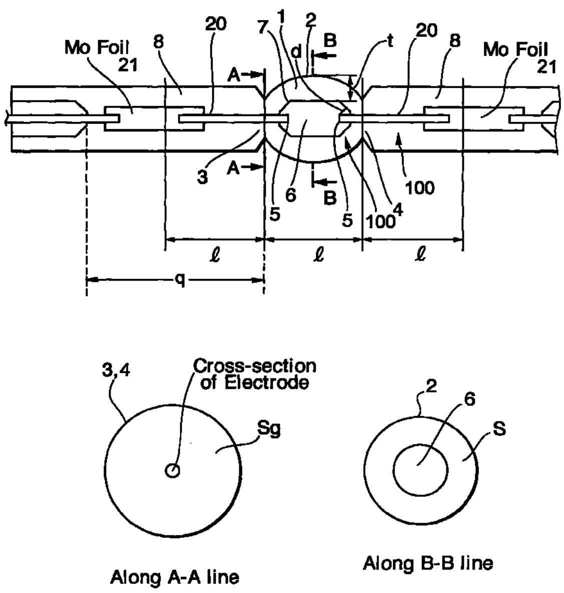
(54) Double-end type metal halide bulb with low power consumption

(57) The double end type ScI_3-NaI metal halide lamp with rated power consumption smaller than 35 W, more specifically 20-30 W, of the present invention comprises a pair of electrodes (20) whose diameter ∅ n is equal to or smaller than 0.25mm (∅n ≤ 0.25 mm), and the diameter ∅ P of the electrode tip portion (5) is equal to or larger than the diameter ∅ S of the remaining electrode portion (∅P ≥ ∅S). The electrode tip portion (5) is spherical or cylindrical, and the cross section area of the electrode (20) increases as a cross section moves toward the tip portion (5) for mitigating thermal emission from the electrode tip portion (5) and preventing low light emission efficiency due to small input power. The arc chamber (6) is substantially a sphere, elliptic, or any similar shape to them, and comprises the pair of electrodes (20), mercury, rare gas, and at least one kind of metal halide sealed therein. Since rare gas, more specifically Xenon gas, is sealed within an arc chamber (6) in high pressure, when applied excessive current, instant lumen output is achieved.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a double end type metal halide bulb or lamp with low power consumption for use in automotive lighting, and more particularly to a composition of the metal halide bulb or lamp capable of providing sufficient light emitting efficiency in spite of a small input power of less than 35 W. The shape or diameter of the electrodes are adjusted in order to keep a temperature within a discharge chamber in a rated power range of 20-30 W, thereby obviating or preventing the evaporation of any amount of the metal halide and also preventing the strength of the metal spectrum from decreasing.

Discussion of the Related Art

[0002] Metal halide bulbs or lamps are used in various fields including illumination in sports facilities, because of their characteristics such as high color rendering property and high efficiency. In recent years, energy saving is becoming more important, and it is expected to further improve the efficiency of the metal halide lamps. Specifically, low power consumption and size reduction are major subjects when developing new models.

[0003] One of the most popular usages of a metal halide bulb or lamp is in endoscopes. The metal halide lamp in an endoscope operates with 21 W having arc length 1.2 mm, resulting in high incidental efficiency to an optical fiber. In the automotive lighting industry, 35 W metal halide bulbs have started to prevail, and are used in some automobile models in Europe and Japan. In Europe, standards for 35 W metal halide bulbs for use in automobiles are on the way to be established, and in Japan discussions for establishment of standards will start in the near future.

[0004] Fig. 4 illustrates the spectrum of the metal halide composition included in these low wattage metal halide bulbs or lamps. The major element of the metal halide is ScI_3-NaI. The composition having ScI_3-NaI as a major element of the metal halide composition enables the metal halide lamp to provide high radiation efficiency in visible wavelengths and also high efficiency, as compared with the metal halide composition of Na-Tl-In, or Dy-Tl-(In).

[0005] In recent years, a metal halide bulb or lamp having a ScI_3-NaI composition with an efficiency of 901 m/W has been developed as a result of the study of the shape of a glass envelope, the structure of the sealed end of the glass envelope, and the composition ratio of the metal halide.

[0006] This double end type metal halide lamp with low power consumption has a relatively short arc length, is substantially a dot light source, and a large amount of light is obtained. Specifically, the 35 W metal halide bulb for use in automobiles is required to have instant lumen output, and a rare gas is sealed in said bulb by applying predetermined pressure for enabling a very high, i. e. excessive current flow at start-up of the metal halide lamp.

[0007] Fig. 5 illustrates such a conventional double end type metal halide lamp with low power consumption which is optimally designed in terms of thermal capacity for obtaining a sufficient temperature within a glass envelope in order to start and keep the evaporation of metal halide therein. The dimensions of the glass envelope are as follows. The thickness t of the glass envelope at a maximum external diameter portion 62 is more than 1.5 mm (t > 1.5 mm); the diameter ∅ a of an arc chamber 66 is more than 2.6 mm (∅a > 2.6 mm); in the arc chamber 66, a distance d between a tip portion 65 of an electrode 69 and a wall 67 of the arc chamber 66 is equal to or more than around 1.0 mm (d ≥ 1.0 mm).

[0008] Fig. 6(a) illustrates an enlarged cross sectional view Sg of the first neck portion 63 and the second neck portion 64 of the glass envelope made of quartz glass. Fig. 6(b) illustrates an enlarged cross sectional view S of the maximum external diameter portion 62 along a surface perpendicular to the longitudinal axis of the glass envelope. The enlargement ratio between the Sg and S is around 0.26 (Sg/S = 0.26) .

[0009] The volume Vg of the glass envelope at the arc chamber portion 61 having a length l between the first neck portion 63 and the second neck portion 64, the volume Vs_1 of the glass envelope at an adjacent portion extending the length l from the first neck portion 63 toward a nearer end of the glass envelope, and the volume Vs_2 of the glass envelope extending the length l from the second neck portion 64 toward the nearer end of the glass envelope, have the following relationship: $Vs_1 = Vs_2 = 73.7\ mm^3$ and $Vg = 95.8\ mm^3$.

[0010] The pair of electrodes 69 is substantially a cylinder, respectively, and its diameter ∅ is equal to or more than 0.25 mm. The electrode tip portion 65 has substantially the same diameter as the remaining portion of the electrode 69. The pair of electrodes 69, respectively, have electrical connections to a molybdenum foil, whose end has a shape like a knife blade or a wedge, for obtaining predetermined air-tightness and avoiding excessive stress concentration; said foil having the following dimensions: thickness 20-28 µm, width 1.5-2.0 mm, and length 6-8 mm.

[0011] As described above, on designing of the 35 W automotive metal halide lamp, it is sufficient to consider just the entire shape and end portion structure of the glass envelope for obtaining sufficient temperature to start and keep the evaporation of metal halide within the glass envelope, and it is not required to determine in detail the entire shape or diameter of the electrode. However, when designing the ScI_3-NaI metal halide lamp with a power consumption of less than 35 W, it is required to determine more specifically the electrode structure, because light color shifts to blue due to low light emitting efficiency. As the input power is small, the evaporation amount of metal halide is also small.

[0012] The conventional metal halide lamp with low power consumption has the following problems. On designing a metal halide lamp with a power consumption less than 35 W, it is impossible to achieve sufficient a temperature in an arc chamber 66 by downsizing the scale of designing parameters of the parameters for 35 W bulbs. When each of the designing parameters is just downsized, the evaporation amount of the metal halide is insufficient such that the light emitting efficiency decreases and the light color shifts to blue. The aforementioned metal halide lamp with an operating power 21 W has overcome the light emitting efficiency problem to the extent that it can be used as an endoscope. However, designing parameters are different for uses between endoscope and automobile. Since the endoscope is not required to have instant lumen output property, the metal halide lamp in 21 W has not yet overcome the standards of start-up properties for use in automobiles.

SUMMARY OF THE INVENTION

[0013] The present invention is directed to an automobile headlight that substantially obviates one or more of the above problems due to the limitations and disadvantages of the related art.

[0014] It is an object of the invention to provide a double end type Scl_3-Nal metal halide lamp for use in automobile with rated power consumption smaller than 35 W, more specifically 20-30 W, being capable of an instant lumen output.

[0015] The above object is achieved by sealing Xenon gas under high pressure and applying excessive current at start-up of the metal halide lamp, and by providing an electrode structure capable of enduring excessive current at start-up of the metal halide lamp. The electrode structure is achieved by adjusting the designing parameters of electrode such as the diameter or entire shape, for mitigating thermal emission from electrode tip portions such that the temperature in the glass envelope is maintained. Thereby low light-emitting efficiency due to low power input and light color shift to blue are prevented.

[0016] The double end type Scl_3-Nal metal halide lamp with rated power consumption smaller than 35W, more specifically 20-30 W, of the present invention comprises a pair of electrodes whose diameter Ønn is equal to or less than 0.25 mm (Øn ≤ 0.25 mm), and the diameter Ø P of the electrode tip portion is equal to or larger than the diameter Ø S of the remaining electrode portion (ØP ≥ ØS). The electrode tip portion is spherical or cylindrical, and the cross section area of the electrode increases as a cross section moves toward the tip portion for mitigating thermal emission from the electrode tip portion and preventing low light emission efficiency due to small input power. The arc chamber is substantially a sphere, ellipsoid, or any similar shape, and comprises the pair of electrodes, mercury, rare gas, and at least one kind of metal halide sealed therein. Since a rare gas, more specifically Xenon gas, is sealed within an arc chamber under high pressure, when excessive current, is applied instant lumen output is achieved.

[0017] Additional objects and advantages of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims.

[0018] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The accompanying drawings, which are incorporated in and which constitute a part of this specification, illustrate several embodiments of the invention and together with the description, serve to explain the principles of the invention.

Fig. 1 illustrates a front view and cross sectional views of a first preferred embodiment of the present invention.

Fig. 2 (a) illustrates an electrode structure of the first preferred embodiment of the present invention.

Fig. 2 (b) illustrates an electrode structure of the second preferred embodiment of the present invention.

Fig. 2 (c) illustrates an electrode structure of the third preferred embodiment of the present invention.

Fig. 2 (d) illustrates an electrode structure of the fourth preferred embodiment of the present invention.

Fig. 3 is a graph showing light emitting efficiency as a function of power in comparison between the double end type metal halide lamp with low power consumption of the present invention and a conventional one.

Fig. 4 illustrates spectrum distribution of a Scl_3-Nal metal halide lamp.

Fig. 5 illustrates a front view of a conventional double end type metal halide lamp with low power consumption.

Fig. 6 (a) illustrates an enlarged cross sectional view of the first and second neck portions of the glass envelope along the A-A line in Fig. 5.

Fig. 6 (b) illustrates an enlarged cross sectional view along the B-B line in Fig. 5 which is perpendicular to the longitudinal axis of the glass envelope and passes through the glass envelope at a portion having the maximum external diameter.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Reference will now be made in detail to the preferred embodiments of the present invention. Whenever possible, the same references numbers will be used throughout the drawings to refer to the same or like parts.

[0021] Fig. 1 illustrates a front view and cross sectional views of the first preferred embodiment of the present invention. The double end type metal halide bulb or lamp with low power consumption being operated with a power of less than 35 W comprises a glass envelope 100, an arc chamber 6, an electrode structure comprising molybdenum foils 21 and a pair of electrodes 20. The glass envelope 100 comprises an arc chamber portion 1 surrounding the arc chamber 6 and at least one sealed portion 8 adjacent to the arc chamber portion 1. The length q of the sealed portion is shown in Fig. 1. The entire shape and end structure of the glass envelope is adjusted as described in Japanese patent application No. HEI 10-195647. Detailed description about how to determine dimensions of the glass envelope will be provided later.

[0022] Figs. 2 (a)-(d) illustrate electrode structures of the first to fourth preferred embodiments of the present invention. The electrode material of the present invention is tungsten (including W-1.7% ThO_2). The first electrode structure in Fig .2(a) comprises a molybdenum foil 21 and a first or second electrode 20 which is electrically connected to the molybdenum foil 21 and is projected within arc chamber 6. A diameter Ø n of the first or second electrode 20 is equal to or less than 0.25 mm (Øn ≤ 0.25), thereby mitigating thermal emission from the electrode 20 and maintaining the temperature in the glass envelope. Tip portions 23 of the electrodes 20 have substantially the same diameter as the remaining portions 22 of the electrodes 20.

[0023] The second electrode structure in Fig. 2(b) comprises a molybdenum foil 21 and a first or second electrode 20 which is electrically connected to the molybdenum foil 21 and is projected within an arc chamber 6. The electrode 20 comprises a spherical electrode tip portion 23 and remaining electrode portion 22. A diameter Ø S of the remaining electrode portion 22 is equal to or smaller than the diameter Ø P of the spherical electrode tip portion 23, and the diameter Ø P of the spherical electrode tip portion 23 is equal to or less than 0.25 mm (ØS ≤ ØP ≤ 0.25 mm). Since the cross section area of the spherical electrode tip portion 23 is enlarged enabling the mitigation of thermal emission from the electrode tip portion 23 to the extent of maintaining evaporation of metal halide, sufficient light-emitting efficiency is achieved in spite of small input power.

[0024] The third electrode structure in Fig. 2(c) comprises a molybdenum foil 21 and a first or second electrode 20 which is electrically connected to the molybdenum foil 21 and is projected within an arc chamber 6. In this embodiment, the shape of the electrode tip portion 23 is a cylinder. The electrode 20 comprises said cylindrical electrode tip portion 23 and remaining electrode portion 22. A diameter Ø Y of the remaining electrode portion 22 is equal to or smaller than the diameter Ø X of the cylindrical electrode tip portion 23, and the diameter Ø X of the cylindrical electrode tip portion 23 is equal to or smaller than 0.25 mm (ØY ≤ ØX ≤ 0.25 mm). The cross section area of the cylindrical electrode tip portion 23 is further enlarged as compared with the second preferred embodiment. The third electrode structure is also able to mitigate thermal emission from the electrode 20 such that evaporation of metal halide is maintained. Accordingly, it is prevented to decrease light-emitting efficiency even though input power decreases.

[0025] The fourth electrode structure in Fig. 2(d) comprises a molybdenum foil 21 and a first or second electrode 20 which is electrically connected to the molybdenum foil 21 and is projected within an arc chamber 6. In this embodiment, the cross section area of the electrode 20 increases as a cross section moves toward the projecting end of the electrode 20. A diameter Ø K of the projecting end of the electrode 20 is equal to or smaller than 0.25 mm (ØK ≤ 0.25 mm). The fourth electrode structure is also able to mitigate thermal emission from the electrode 20, and it is prevented from decreasing the light-emitting efficiency even though input power decreases.

[0026] In all the preferred embodiments described above, the entire shape and end structure of the glass envelope is adjusted as described in the Japanese patent Application No. 10-195647. Such preferred dimensions of the glass envelope are briefly explained as follows based on the metal halide lamp in Fig. 1.

[0027] The thickness t at a portion 2 having the maximum external diameter of the glass envelope is equal to or smaller than 1.5 mm (t ≤ 1.5 mm). The maximum internal diameter of the arc chamber Ø a is equal to or smaller than 2.6 mm (Øa ≤ 2.6 mm). The thickness t and the maximum internal diameter Ø a are determined for the purpose of maintaining the temperature within the glass envelope for achieving sufficient light emitting efficiency in spite of small input power.

[0028] The distance d between an electrode tip portion 5 and a wall 7 of the arc chamber 6 is 0.6-1.3 mm (0.6 mm ≤ d ≤ 1.3 mm). The maximum value 1.3 mm is determined for the purpose of maintaining temperature in the glass envelope and achieving sufficient light emitting efficiency in spite of small input power. The minimum value 0.6 mm is determined for preventing occurrence of a non-stabilized arc which may cause a sudden turn-off of the metal halide lamp.

[0029] The ratio of the cross section area is adjusted as follows: the cross section area Sg of the first neck portion 3 or the second neck portion 4 is equal to or less than the cross section area S which is perpendicular to the longitudinal axis of the glass envelope and passes the maximum external diameter portion 2 ($Sg/S \leq 0.85$) ; preferable Sg/S values are within a range from equal to or more than 0.15 up to equal to or less than 0.25 ($0.15 \leq Sg/S \leq 0.25$), the optimized Sg/S value is around 0.2 ($Sg/S = 0.2$). These values are determined such that thermal emission from the arc chamber portion 1 of the glass envelope 100 is mitigated and the temperature in arc chamber portion 1 is maintained, thereby it is able to achieve sufficient light emitting efficiency in spite of small input power.

[0030] The volumes of the glass envelope 100 at the arc chamber portion 1 surrounding the arc chamber 6, and sealed portions 8 are determined as follows. The volume Vg of the arc chamber portion 1 having a length l between the first neck portion 3 and the second neck portion 4, the volume Vs_1 of the sealed portion 8 extending the length l from the first neck portion 3 toward a nearer end of the glass envelope 100, and the volume Vs_2 of the sealed portion 8 extending the length l from the second neck portion 4 toward a nearer end of the glass envelope 100, have the following relationship: $0.4Vg<Vs_1$, and $Vs_2<0.9Vg$. These values are determined such that thermal emission from the arc chamber portion 1 of the glass envelope is mitigated and the temperature within the arc chamber portion 1 is maintained, thereby sufficient light emitting efficiency is achieved in spite of small input power. The value of 0.4Vg is determined for preventing excessive thermal emission from the arc chamber portion 1 of the glass envelope.

[0031] The above-identified double end type metal halide lamp with low power consumption comprises a spherical or elliptic arc chamber 6 which includes a pair of electrodes 20, mercury, rare gas, and at least one kind of metal halide. The metal halides ScI_3 and NaI are sealed within the arc chamber 6 with a ratio from 3:1 to 1:8 (ScI_3:NaI = 3:1-1:8) in weight. The rare gas, Xenon gas, is also sealed in the arc chamber 6 under high pressure enabling an excessive current flow at the start-up of the bulb or lamp. The excessive current flow is required for instant lumen output which is essential for use in automobiles.

[0032] As described in the specification of the Japanese Patent Application No. 10-195647, the adjustments of the glass envelope described above are sufficiently effective when each adjustment is individually made. However, combination of each adjustment makes it more effective.

[0033] The conventional 35 W metal halide lamp is able to provide high temperatures to the extent of enabling sufficient evaporation of the metal halide. However, on designing a metal halide lamp with a smaller input power consumption than 35 W, it is essential to adjust e. g. the entire shape or diameter of the electrode structure because, without such adjustments, light emitting efficiency decreases when the input power is smaller than 35 W, and the light color may shift to blue.

[0034] By adjusting not only the structure of the glass envelope, such as the entire shape, or the shape of the end portions, but also the electrode structure, thermal emission from the electrode tip portion is mitigated, and the temperature of the glass envelope is maintained. Thereby sufficient light emitting efficiency is achieved in spite of small input power. This adjustment is highly effective for metal halide lamps whose power consumption is smaller than 35 W, specifically 20-30 W.

[0035] Fig. 3 is a graph showing light-emitting efficiency of the metal halide lamp with low power consumption as a comparison between the preferred embodiment of the present invention in a solid line and a conventional 35 W metal halide lamp in a broken line. In the preferred embodiment, an electrode 20 has a diameter smaller than 0.25 mm, and the electrode tip portion 23 has larger diameter than the remaining electrode portions 22. Additionally, the arc chamber portion 1 and sealed end of the arc chamber portion 1 are adjusted as described in the Japanese patent application No. 10-195647. As shown in this graph, the preferred embodiment of the present invention achieved light emitting efficiency of 60-90 lm/W in spite of small input power. The operational advantages of the metal halide lamp according to the preferred embodiment of the present invention will now be described. First, even though the power consumption of the metal halide lamp is less than 35 W, the arc chamber portion is maintained in a sufficiently high temperature for metal halide evaporation. Therefore, although the power consumption decreases, light emitting efficiency does not decrease very much and light color shift to blue is prevented. Second, instant lumen output is achieved in spite of a small input power of less than 35 W, specifically in the range of 20-30 W. This is achieved by adjusting the electrode shape and structure, by sealing ScI_3 and NaI in the arc chamber, and by applying an excessive current at start-up of the lamp. The combination of these parameters is able to provide more effective metal halide lamps.

[0036] It will be apparent to those skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof. Thus, it is intended that the present invention cover the modifications and variations of this invention.

Claims

1. A double end type metal halide bulb or lamp being operated at a rated power less than 35 W comprising a glass envelope having an arc chamber (6), at least one kind of metal halide included in the arc chamber (6), an arc chamber portion (1) surrounding the arc chamber (6), and sealed portions (8) adjacent to the arc chamber portion (1), a first electrode (20) partly projecting into the arc chamber (6), a second electrode (20) partly projecting into the

arc chamber (6), characterized in that a diameter ∅ n of the first and second electrodes (20) is equal to or smaller than 0.25 mm.

2. A double end type metal halide lamp according to claim 1,
characterized in that a diameter ∅ P of the electrode tip portion (5, 23) projecting into the arc chamber (6) is equal to or larger than a diameter ∅ S of the remaining electrode portion (22).

3. A double end type metal halide lamp according to claim 1,
characterized in that the electrode tip portion (5, 23) projecting into the arc chamber (6) is spherical.

4. A double end type metal halide lamp according to claim 1,
characterized in that the electrode tip portion (5, 23) projecting into the arc chamber (6) is a cylinder.

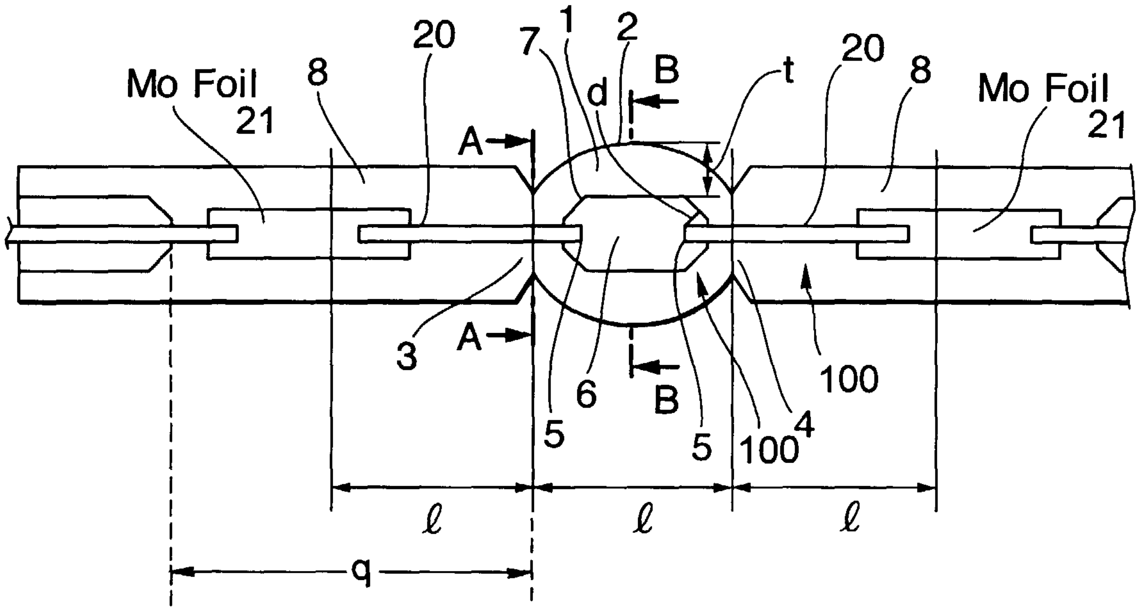
5. A double end type metal halide lamp according to claim 1,
characterized in that the cross section areas of the first and second electrodes (20) increase as the cross section moves toward a projecting end (5, 23) of the electrode (20).

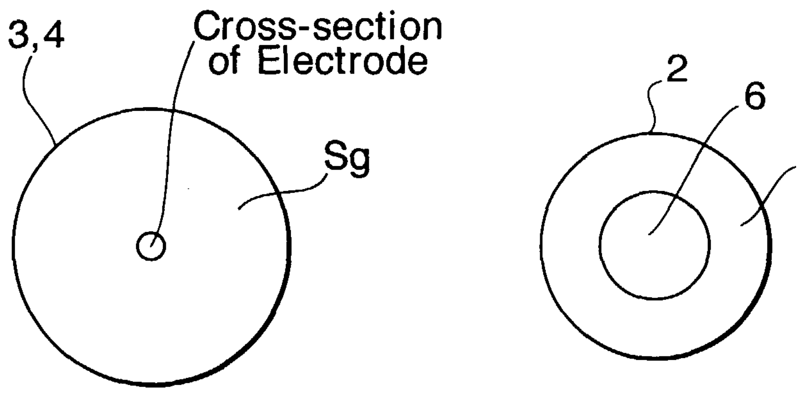
6. A double end type metal halide lamp according to claim 1,
characterized in that the metal halide included in the arc chamber (6) comprises ScI_3 and NaI.

7. A double end type metal halide lamp according to claim 1,
characterized in that a rated power range is 20-30 W.

8. A double end type metal halide lamp according to claim 6 and 7,
characterized in that instant lumen output is achieved by sealing rare gas at high pressure and applying excessive current at start-up of the lamp.

F I G. 1





Along A-A line

Along B-B line

FIG.2(a)

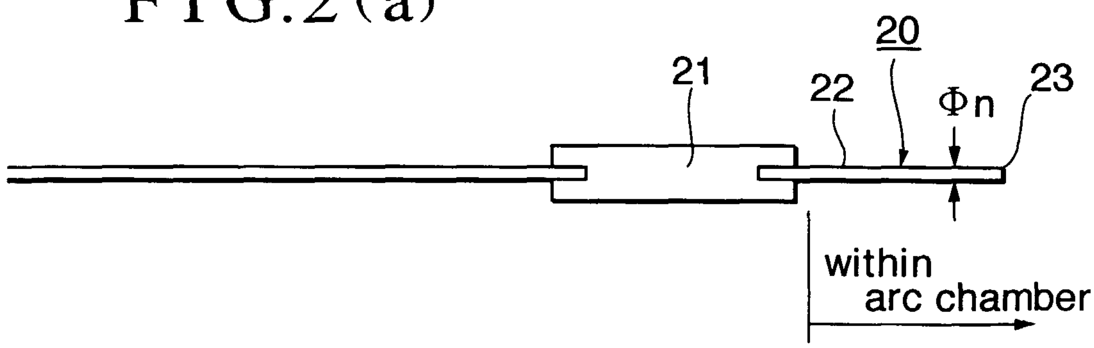


FIG.2(b)

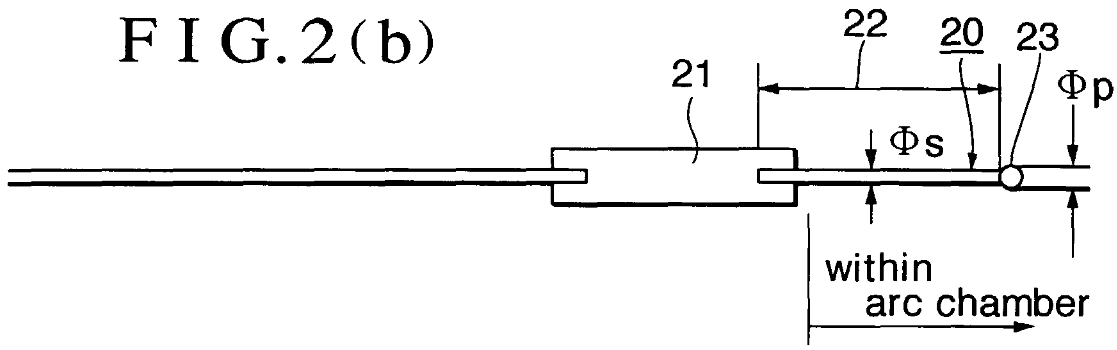


FIG.2(c)

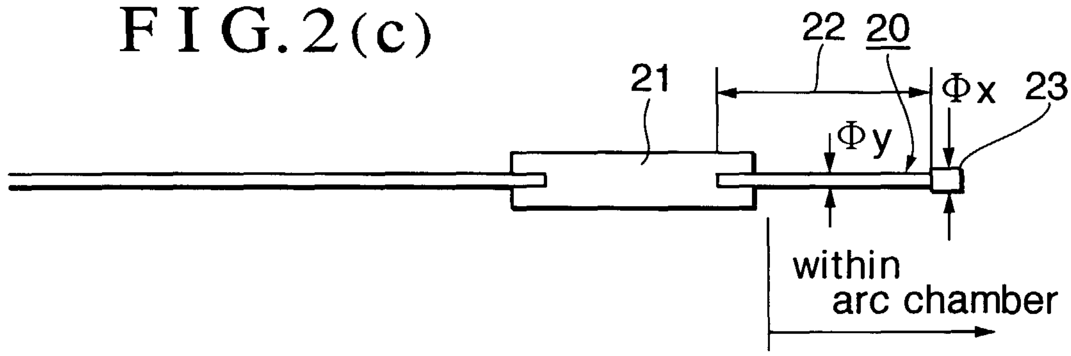
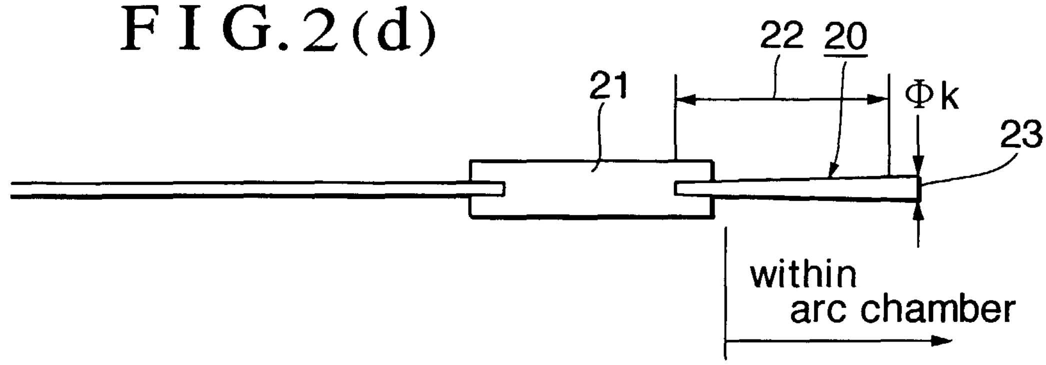
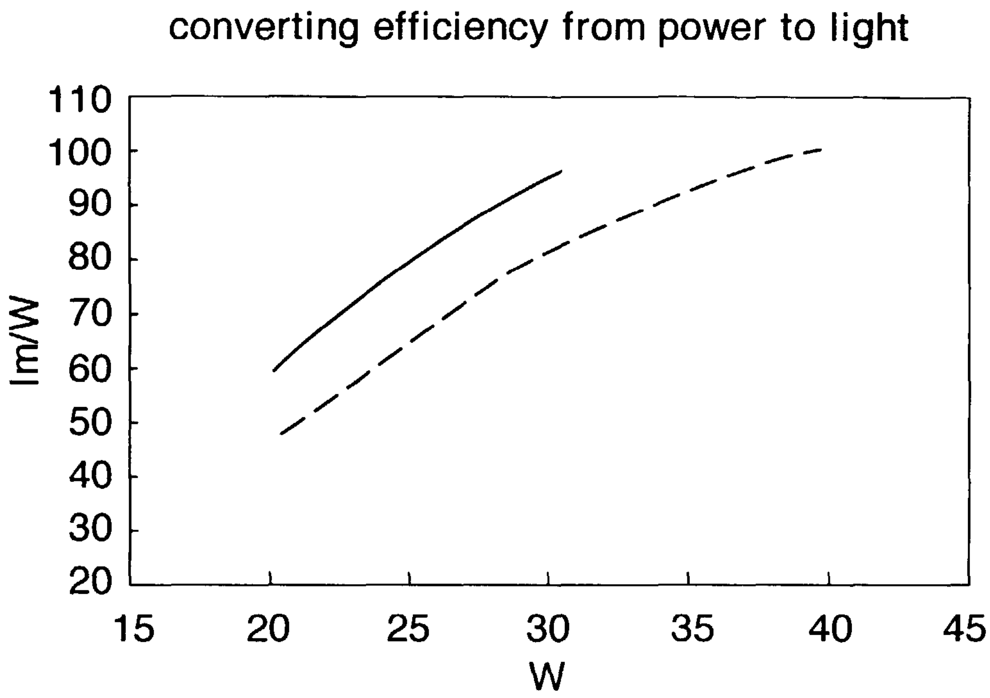


FIG.2(d)



F I G. 3


converting efficiency from power to light
110
100
90
80
70
60
50
40
30
20
lm/W
15
20
25
30
35
40
45
W

F I G. 4

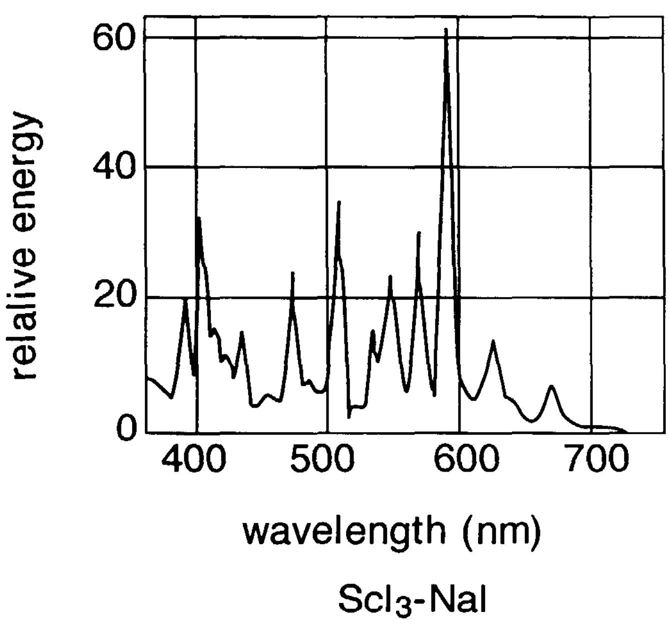

60
40
20
0
relative energy
400
500
600
700
wavelength (nm)
Scl3-Nal

FIG. 5

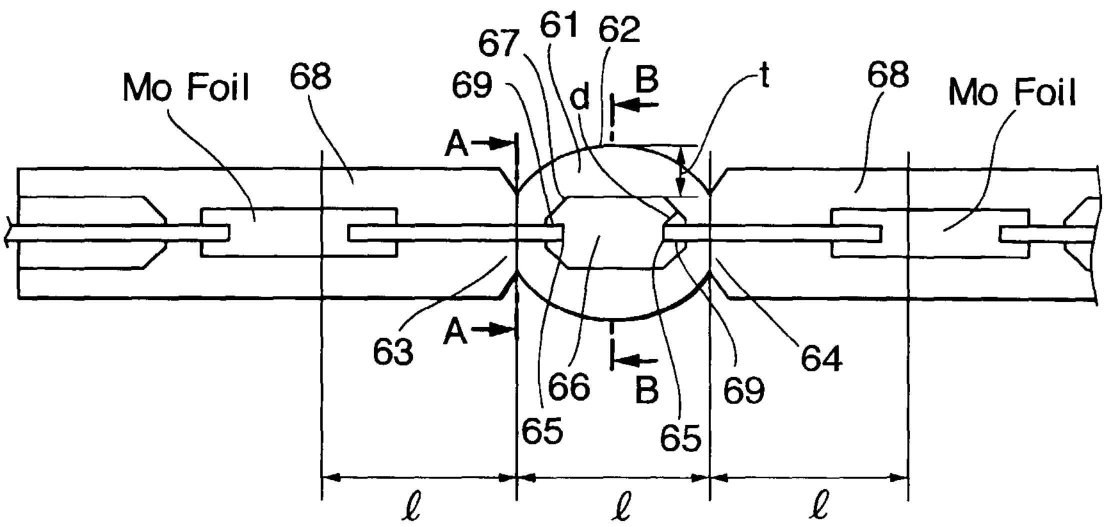
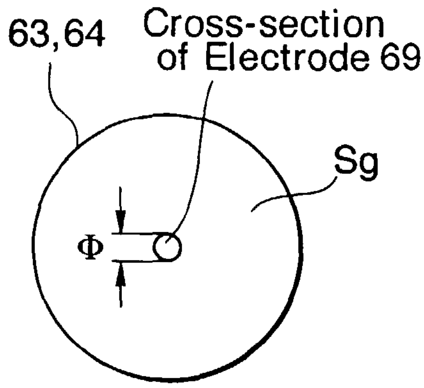
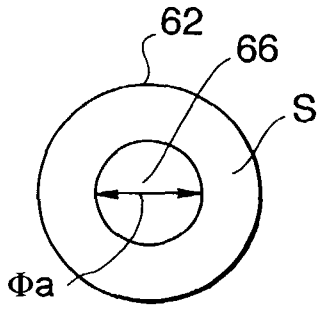


FIG. 6(a)



Along A-A line

FIG. 6(b)



Along B-B line