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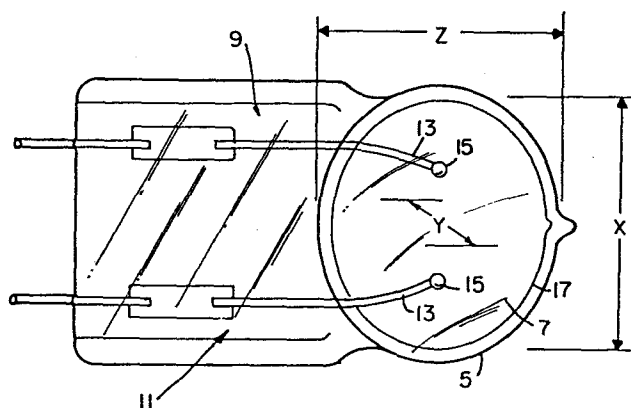
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⑧④ Designated Contracting States: **BE DE FR GB NL**

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⑤④ **Single ended metal halide discharge lamps and process of manufacture.**

⑤⑦ A single-ended metal halide discharge lamp including a fused silica elliptical-shaped envelope which is filled with a metal halide dosed high pressure mercury fill and wherein a pair of electrodes each having a metal rod with a ball on the end thereof are sealed whereby isothermal operation of the elliptical-shaped envelope is effected. A manufacturing process is also provided wherein an elliptical-shaped envelope is formed, a pair of electrodes having metal rods with a ball on the end thereof are sealed into one end of the envelope, and the envelope is filled with a metal halide dosed high pressure mercury fill.



SINGLE-ENDED METAL HALIDE DISCHARGE LAMPS AND  
PROCESS OF MANUFACTURE

CROSS REFERENCE TO OTHER APPLICATIONS

5 The following concurrently filed applications relate to  
single-ended metal halide discharge lamps and the fabrication  
thereof: Attorney's Docket No. 24,445; 24,213; 83-1-058; and  
83-1-085.

TECHNICAL FIELD

10 This invention relates to single-ended metal halide discharge  
lamps and the manufacture of such lamps and more particularly to  
single-ended metal halide discharge lamps having a stabilized arc  
and an envelope formed for isothermal operation.

BACKGROUND OF THE INVENTION

15 In the field of projectors, optical lens systems and similar  
applications requiring a relatively intense source of light, it has  
been a common practice to employ a light source in the form of a  
tungsten lamp. Although tungsten or tungsten halogen lamps do have  
certain desirable features such as low cost, desirable color  
20 features enhancing skin tones and do not require a special power  
source, several undesirable features are unfortunately also  
present. For example, structures employing a tungsten source do not  
generate enough blue light, tend to undesirably generate large  
amounts of heat which necessitates expensive and cumbersome cooling

devices located adjacent the light source, and tend to exhibit a relatively short life such as an operational period of about 10 to 20 hours. Thus, it is not uncommon to replace the light source each time the apparatus is employed. Obviously, such inconvenience and expense leaves much to be desired. Moreover, screen illumination is limited due to the inability to increase surface luminance much beyond 3400° K while the mechanical body structure is rigid leading to destruction during operation by chemical means and by vibration or shock.

10 An improvement over the above-described system is provided by the use of metal halide discharge lamps as a light source. For example, a common form of high pressure metal halide discharge lamp is disclosed in U.S. Patent No. 4,161,672. Therein, a double-ended arc tube or an arc tube having electrodes sealed into diametrically  
15 opposite ends is employed in conjunction with an evacuated or noble gas filled outer envelope. However, it has been found that such structures are relatively expensive to manufacture and are obviously not appropriate for use in projectors or other optic lens-type apparatus.

20 As to single-ended metal halide arc discharge lamps, U.S. Patent Nos. 4,302,699; 4,308,483; 4,320,322; 4,321,501 and 4,321,504 all disclose variations in structure or fill suitable to a particular application. However, any one or all of the above-mentioned patents leave something to be desired insofar as stability of the arc and  
25 isothermal uniformity of the discharge lamp are concerned.

#### OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved single-ended high intensity discharge lamp. Another object of the invention is to enhance the capabilities of single-ended high  
30 intensity discharge lamps. Still another object of the invention is

to provide a single-ended high intensity discharge lamp having an improved structural configuration. A further object of the invention is to provide an improved process for manufacturing single-ended high intensity discharge lamps.

5 - These and other objects, advantages and capabilities are achieved in one aspect of the invention by a single-ended high pressure high intensity discharge lamp having a pair of electrodes each including a metal rod with a spherical ball on the end thereof sealed into and passing through one end of an elliptical-shaped  
10 envelope of fused silica containing a metal-bearing mercury fill therein.

In another aspect of the invention, a process for manufacturing single-ended metal halide discharge lamps is provided wherein a pair of electrodes each having a spherical ball on the end of a metal rod  
15 are sealed into one end of an elliptical-shaped fused silica envelope, and the envelope is filled with unsaturated metal-bearing mercury.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of one embodiment of a  
20 single-ended high intensity discharge lamp of the invention;

FIG. 2 is a diagrammatic illustration of the discharge and convection gas flow for vertical operation of the discharge lamp of FIG. 1;

FIG. 3 is another illustration of the discharge lamp of FIG. 1  
25 showing the approximate electric field lines of force between the electrodes of the lamp; and

FIG. 4 is a photograph, 100 X enlargement, of an electrode of the embodiment of FIG. 1.

## BEST MODE FOR CARRYING OUT THE INVENTION

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the accompanying drawings.

Referring to the drawings, FIG. 1 illustrates a low wattage metal halide lamp having a body portion 5 of a material such as fused silica. This fused silica body portion 5 is formed to provide an elliptical-shaped interior portion 7 having a major and minor diametrical measurement, "X" and "Y" respectively, in a ratio of about 2:1. Moreover, the elliptical-shaped interior portion 7 preferably has a height "Z" substantially equal to the minor dimensional measurement "Y".

Sealed into one end of and passing through the body portion 5 is a pair of electrodes 9 and 11. Each of the electrodes 9 and 11 includes a metal rod 13 with a spherical ball 15 on the end thereof within the elliptical-shaped interior portion 7. Preferably, the electrodes 9 and 11 are positioned within the elliptical-shaped interior portion 7 in a manner such that the end of the spherical balls 15 of the electrodes 9 and 11 is substantially equally spaced from the interior portion 7 insofar as the major and minor axes "X" and "Y" and also substantially at the midpoint of the height "Z".

Also, a metal-bearing mercury fill is disposed within the elliptical-shaped interior portion 7. For example, mercury dosed with a metal halide such as sodium and scandium along with argon is an appropriate fill for a low wattage metal halide discharge lamp. Specifically, a 50-watt discharge lamp having an elliptical-shaped interior portion 7 with a volume of about  $.1 \text{ Cm}^3$  was filled with about 3.0 mgms of mercury, 1.9 mgms of sodium and scandium in a molar ratio of about 20:1 and argon at a pressure of about 200

torr. Operational testing provided an initial lumen output of about 3100 lumens with a lumen maintenance of about 84% after 160 hours of operational life.

Referring more specifically to the above-described  
5 elliptical-shaped interior portion 7, FIG. 2 of the drawings illustrates the electrodes 9 and 11 each having a spherical ball 15 thereon and spaced along the major axis "X" and substantially equal distance from the walls 17 of the interior portion 7. As can readily be seen, the body portion 5 is preferably vertically  
10 positioned such that the spherical balls 15 are located one above the other. As a result, a gas flow pattern is provided, as indicated by the arrows, wherein cool gas tends to flow down the outside wall 17 of the interior portion 7 and is drawn into the elliptical-shaped arc or plasma column 22 at the bottom electrode  
15 11. The spherical ball 15 of the bottom electrode 11 provides a spherical extension, which will be explained hereinafter, and, in turn, produces gas flow pinching or a venturi action 20 at the arc terminus of the spherical ball 15 of the bottom electrode 11. In this manner, arc terminus wandering is minimized. Also, the gas  
20 atoms are heated in the plasma column 22, and the upper electrode 9 acts as a deflector which spreads the hot gases reaching the top of the body portion 5 of the elliptical-shaped arc tube. Moreover, infrared measurements of the temperature of the wall 17 during operation of the arc tube indicate less than a 20% temperature  
25 variation at a wall temperature of about 1100° C. Thus, the above-described elliptical-shaped interior portion 7 and the elliptical-shaped arc 22 provide a convection current flow; 21 of FIG. 2, which is substantially uniform and free from undesired turbulence such that arc stability, which is particularly important  
30 in projectors and lens systems, is provided.

Additionally, it has been noted that the above-described arc tends to wander about the contact region of the spherical balls 15 initially. However, it has been found that the employing of a seasoning step in the manufacturing process tends to cause development of protuberances 24 of (FIG. 4) on each one of the balls 15. As a result, the protuberances 24 tend to minimize the arc gap between the spherical balls 15 of the electrodes 9 and 11 and force the arc to have centrally located termination points on each of the electrodes 9 and 11.

Although not completely understood, it is believed that the above-described protuberances 24 of (FIG. 4) are of a size which depends upon the local material properties and the field strength and gas flow properties. Moreover, the growth formation also appears to be a function of the electrode size and temperature. Thus, the lower the operating temperature the longer the seasoning time required.

As a specific example, a 0.017-inch tungsten rod having a ball 15 thereon of about 0.025-inch was operated in a 100-watt metal halide filled discharge lamp drawing about 1.6 amperes of current. After about 15 minutes of "seasoning" at normal operational conditions, it was found that the arc stabilized and one or more protuberances appeared on the surface of the spherical balls 15 of the electrodes 9 and 11. Thus, the surface breakup into platelets and formation of the protuberances on the spheroid balls 15 inhibits any wandering of the arc and enhances the light source.

Additionally, it is to be noted that an arc source, such as a metal halide discharge lamp, provides not only higher luminance but also higher efficacy than a tungsten source. Also, a metal halide discharge lamp provides a point source relative to a tungsten source. Specifically, a 100-watt metal halide discharge lamp exhibits a plasma having a minimum luminance intermediate the spherical balls 15 and a maximum luminance at or near the spherical

balls 15. Moreover, the plasma column is normally about 1 to 2 mm in diameter and about 3 mm in length. However, a tungsten source is about 2.5 mm in diameter and 8 mm in length with the luminance varying in a sinusoidal manner over the length of the tungsten source.

Following is a table, Table I, showing a comparison in luminance, efficacy and size of a tungsten source, a high pressure xenon source and a metal halide lamp source:

TABLE I

	<u>Luminance</u> (Cd/mm)	<u>Efficacy</u> (Lumens/Watt)	<u>Size</u> (Length X Diam.)	<u>Theoretical Throughput</u> (Lumens)
10 Tungsten (300 Watts)	30	33	8 X 2.5	1980
15 Xenon (150 Watts)	150	20	2.2 X 5	600
Metal Halide Lamp (100 Watts)	75	65	3 X 1	1300

20 As can readily be seen, the tungsten source at 300 watts provides about 33 lumens per watt as compared with 65 L/W for a 100-watt metal halide lamp. Also, tests in a 35 mm projection system indicate an output of about 10,000 lumens from the 300-watt tungsten source is equivalent to that of the 6,500 lumens from the 25 100-watt metal halide lamp source. The long wavelenth radiation and the misdirected visible light of the tungsten source tends to be absorbed as heat by the film of a projector. Thus, is has been found that the tungsten lamp generates about 270 watts of heat as compared to about 90 watts or about 1/3 thereof by the metal halide 30 lamp and associated power supply.



Further, the xenon source shows a relatively high luminance capability but a relatively low efficacy capability. Thus, a lumen output of the xenon source which is comparable to that provided by a 100-watt metal halide lamp would necessitate a xenon source of about 200 watts in order to compensate for a relatively poor efficacy capability. Moreover, a xenon source has a relatively small diameter, about 0.5 mm in the example, as compared with a metal halide lamp, about 1.0 mm, which greatly and undesirably reduces the tolerances or variations in positioned location of the arc source when employed with a reflector in a projection system. In other words, positional adjustment of an arc source in a xenon lamp is much more critical than in a metal halide discharge lamp system.

Accordingly, a single-ended metal halide discharge lamp has been provided wherein electrodes are disposed within an elliptical-shaped interior portion of a fused silica envelope. This elliptical-shaped envelope interior, in conjunction with an elliptical-shaped arc therein, provides a substantially isothermal operational condition of the fused silica envelope forming the discharge lamp. Moreover, it has been found possible to provide a stabilized arc which is particularly important in the operation of projector and optic lens apparatus.

While there has been shown and described what is at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention as defined by the appended claims.

## CLAIMS

## WHAT IS CLAIMED IS:

1. A single-ended metal halide discharge lamp comprising:  
a fused silica elliptical-shaped envelope having major and minor  
5 axes;

a pair of electrodes sealed into and passing through one end of  
said envelope with each of said electrodes including a metal rod  
having a spherical ball on the end thereof interior of said  
envelope, said electrodes being spaced from one another along said  
10 major axis of said envelope; and

a metal halide dosed high pressure mercury fill within said  
envelope whereby isothermal operation of said elliptical-shaped  
envelope is substantially effected.

2. The metal halide discharge lamp of Claim 1 wherein said  
15 electrodes are each spaced at a substantially uniform distance from  
said envelope.

3. The metal halide discharge lamp of Claim 1 wherein said  
elliptical-shaped envelope has major and minor axes in a ratio of  
about 2:1.

20 4. The metal halide discharge lamp of Claim 1 wherein said  
spherical ball of each one of said pair of electrodes has a  
protuberance thereon of a size which varies with the material and  
operational temperature of said spherical ball.

5. The metal halide discharge lamp of Claim 1 wherein said electrodes are positioned to provide a substantially elliptical-shaped arc within said substantially elliptical-shaped envelope.

5        6. In a metal halide discharge lamp having an envelope of fused  
silica with a fill of metal halide dosed high pressure mercury, the  
improvement wherein said envelope has an elliptical shape with a  
major and minor axes and a pair of electrodes are sealed into one  
end of said elliptical-shaped envelope with each electrode having a  
10 metal rod with a spherical ball on the end thereof interiorly of  
said envelope.

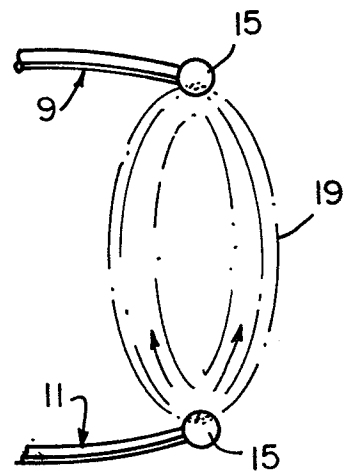
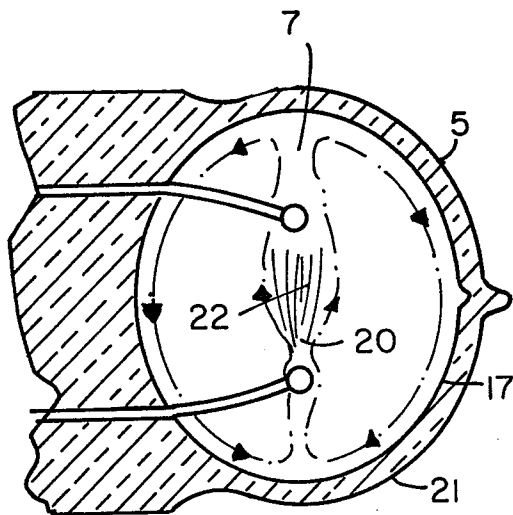
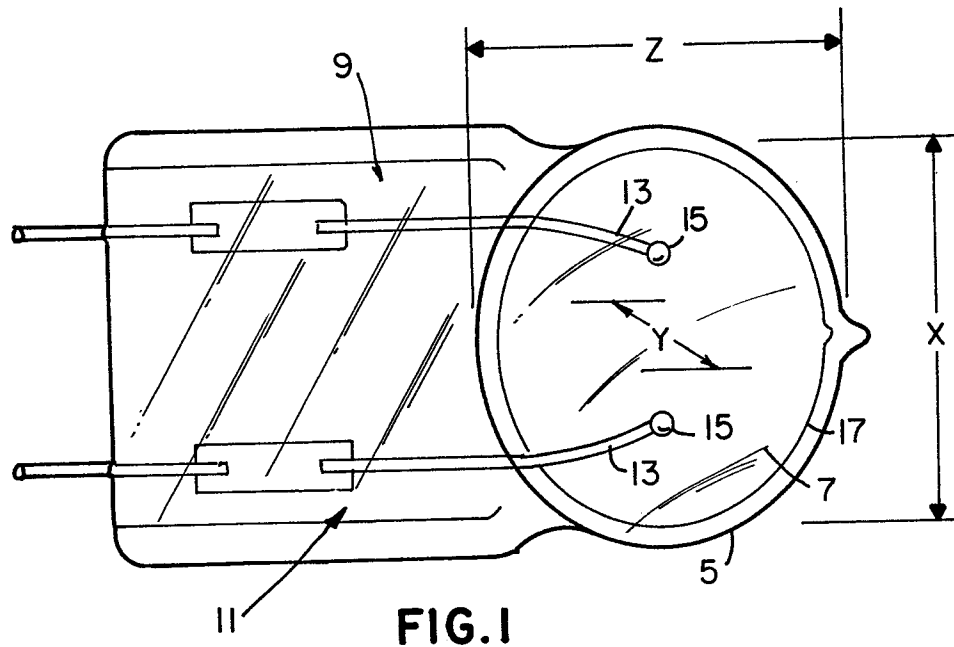
7. The improvement of Claim 6 wherein said major and minor axes  
of said elliptical-shaped envelope are in a ratio of about 2:1.

8. The improvement of Claim 6 wherein each of said electrodes  
15 is spaced substantially uniformly from said envelope.

9. The improvement of Claim 6 wherein said electrodes and fill  
combine to provide a substantially elliptical-shaped arc uniformly  
spaced from said elliptical-shaped envelope.

10. The improvement of Claim 6 wherein said discharge lamp is a  
20 50-watt lamp having a lumen maintenance of about 84% at 160 hours of  
operation.

11. The improvement of Claim 6 wherein each of said spherical  
balls of each of said electrodes has a protuberance thereon whereby  
stability of a developed arc is enhanced.



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FIG. 4

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 84106567.5
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	DE - A1 - 3 227 380 (GENERAL ELEC- TRIC)  * Fig. 5c; claims 1-3; page 11, lines 11-26 *  --	1,2,6	H 01 J 61/18 H 01 J 61/82
A	DE - A1 - 3 110 811 (GTE)  * Fig. 2; page 3 - page 4, line 13; claim 1 *  --	1,6	
A	GB - A - 2 013 394 (GENERAL ELEC- TRIC)  * Fig. 1; lines 11-53 *  ----	1,6	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
			H 01 J 61/00 H 01 J 9/00 H 01 J 1/00 H 01 J 5/00 H 01 J 7/00
The present search report has been drawn up for all claims			
Place of search  VIENNA		Date of completion of the search  10-09-1984	Examiner  BRUNNER
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			