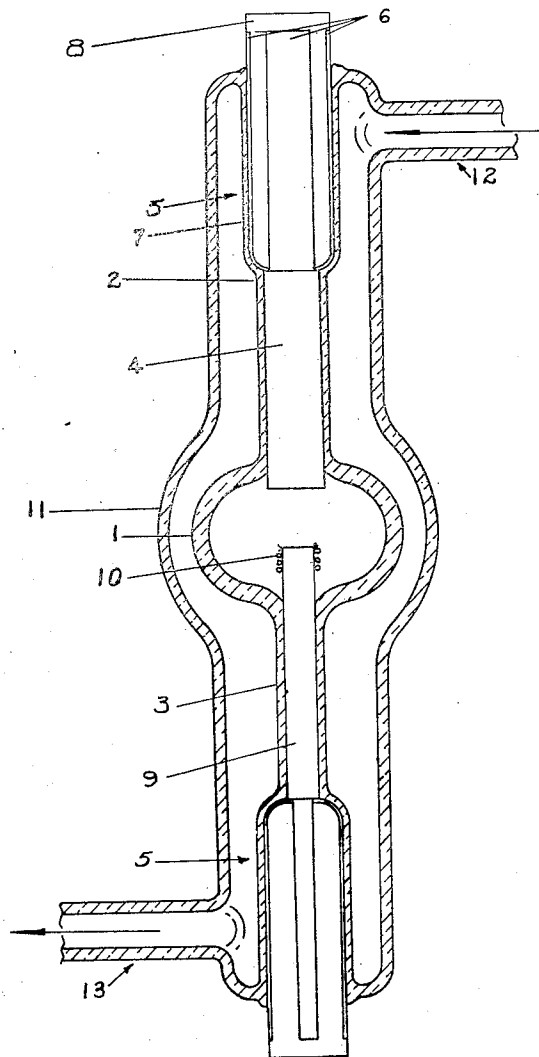


July 30, 1946.

V. J. FRANCIS ET AL
ELECTRIC DISCHARGE LAMP

2,404,953

Filed Jan. 1, 1945



Inventors
Evan H. Nelson
Victor J. Francis
By *John H. Henderson*
Their Attorney

UNITED STATES PATENT OFFICE

2,404,953

ELECTRIC DISCHARGE LAMP

Victor J. Francis, Aylesbury, and Evan H. Nelson,
Harrow Weald, England, assignors to General
Electric Company, a corporation of New York

Application January 1, 1945, Serial No. 570,892
In England July 2, 1943

2 Claims. (Cl. 176—122)

1

This invention relates to high-intensity gaseous electric discharge lamps, and especially to high pressure metal vapor (H. P. M. V.) electric lamps of the type wherein the brightness of the discharge column exceeds 10,000 candles per sq. cm. Here and hereinafter "brightness" means maximum brightness in a "cross-plane" that is to say, in a plane perpendicular to and intersecting the shortest straight line between the electrodes.

In one kind of lamp of this type the length of the envelope and the distance between the electrodes are much greater than the diameter of the envelope in a cross-plane midway between the electrodes. It is then necessary to cool the envelope with liquid applied to its outer surface. But now the difficulty arises that, if the cooling is sufficient to prevent the central part of the envelope from being damaged by heat, it is difficult to prevent the parts behind the electrodes from being so cool that the requisite high vapor pressure of the metal (usually mercury) can not be maintained. It is overcome by providing within the envelope metal so much in excess of that evaporated in full operation that the cool spaces behind the electrodes are filled with metal. The surface of this metal might actually be the electrode, but it is usual to provide tungsten electrodes, projecting slightly from the mercury. These electrodes are kept below their melting point by the conduction of heat through the mercury between them and the wall. But the presence of the excess mercury limits the operating characteristics of the lamp, and the necessity for keeping it around the electrode limits the form of the lamp.

It has heretofore been proposed to avoid the necessity for excess mercury by bringing solid electrodes into sufficiently close contact with the end wall of the envelope. It was also stated that this device made it possible to make the diameter of the central part of the envelope greater than was usual in water-cooled H. P. M. V. lamps at the date; but it was not suggested that the prevailing practice of making the distance between the electrodes much greater than the diameter of the envelope should be abandoned.

A second kind of high brightness H. P. M. V. lamp is known, in which the distance between the electrodes is less than the diameter of the envelope and indeed less than the distance of either electrode from the envelope; the envelope is approximately spherical and all the mercury is evaporated in normal operation. In such lamps, if a coolant has been applied to the ex-

2

terior of the envelope during normal operation, it has been a gas (usually air). A forced blast of air may be provided; but it is impossible or at least very inconvenient to make air cooling as efficient as water cooling. Accordingly, for the same power dissipated within the envelope, the area of the external surface of high brightness lamps of the second kind has to be larger than that of high brightness lamps of the first kind. Moreover, if the area of the envelope were reduced by water cooling, it would not always be possible to reduce the size of the electrodes so that they would still fit inside the envelope, for the electrodes are cooled mainly by radiation. For these reasons lamps of the second kind are usually bulkier than corresponding lamps of the first kind. But it is not a serious disadvantage so long as the power dissipated by the lamp is less than 2 kw., for then the diameter of the envelope need not be more than 60 mm. However when the power dissipated is greater than 5 kw., the disadvantage is serious; an object of the invention is to remove it.

We have discovered that it can be removed by using as an electrode a stout rod of refractory metal, on whose inner end the discharge terminates and whose outer part fits closely into a tube projecting from the main, approximately spherical, envelope. The whole envelope can then be water cooled. The conduction down the rod to the part within the tube, through which much of the heat developed at the electrode is abstracted, is sufficient to prevent the inner end from melting, and yet the space between the rod and the tube is kept so hot by the rod that substantially all the metal is evaporated in normal operation. If the lamp is run on A. C., both electrodes must be of this kind; but if, as is now usual with high brightness lamps, the lamp is run on D. C., it may be possible to use as a cathode an electrode of some other kind.

According to one aspect of the invention, in a high brightness H. P. M. V. electric discharge lamp, the envelope consists of a main, approximately spherical, part of external area *S*, having at least one tubular neck portion projecting therefrom; one electrode is a stout rod of refractory metal on whose inner end the discharge terminates and whose outer part fits closely within the said tube; the distance between the terminations of the discharge in normal operation is less than the diameter of the envelope in any cross-plane; and the lamp is adapted, when the whole exterior of the envelope is water-cooled, to dissipate a power *W*, where *W* is not less than 4

3

kw. and W/S is not less than 60 watts/sq. cm.

According to another aspect of the invention, a source of light, adapted to cooperate with optical projection apparatus, comprises in combination a H. P. M. V. lamp according to the first aspect of the invention and means for maintaining liquid in contact with substantially the whole of the surface of the said envelope. Preferably the said means is a jacket, of the same material as the envelope and forming part of the same vitreous body, provided with apertures for the entry and exit of the liquid.

One embodiment of a lamp comprising the invention will now be described, by way of example, with reference to the accompanying drawing which is an elevation, in section, of such a lamp.

Here 1 is the main part of the envelope, being a sphere 40 mm. in external diameter with a quartz wall 2-3 mm. thick. 2 and 3 are tubes forming tubular neck portions projecting from it at opposite ends of a diameter, the thickness of their quartz walls being $\frac{1}{2}$ -1 mm. The anode 4, is a tungsten cylinder, 40 mm. long and 12 mm. in diameter, fitting closely within tube 2 and with its inner end projecting 2-3 mm. into the sphere 1; its outer end is connected to exterior leads through the multiple strip seal 5. The seal 5 comprises a plurality of thin metallic strips 6 of molybdenum, for example, attached to the outer end of the electrode 4 and fused between an extension 7 of tube 2 and a quartz plug 8. The cathode 9 is a tungsten rod, 50 mm. long and 6 mm. in diameter, fitting closely within the tube 3 and with its inner end projecting so far within the sphere 1 that it is 10 mm. distance from the inner end of the anode. Near its inner end it carries the activated starting electrode 10; its outer end is connected to exterior leads by the lower strip seal 5. 11 is a quartz jacket surrounding the whole of the parts 1, 2, 3, and sealed at its ends to the outside of the seals 5, 5. There is 3-6 mm. clearance between the jacket and the parts 1, 2, 3. 12, 13 are respectively inlet and outlet tubes for water passing through the jacket.

The lamp is designed to burn on a D. C. supply with the axis vertical and the cathode lowermost. The amount of mercury, practically all evaporated in operation, is adjusted so that, when the discharge is in series with a suitable stabilizing resistance, the current carried by the discharge is 77 amps. and the voltage between the electrodes 65

4

volts. The brightness of the discharge exceeds 20,000 candles per sq. cm.; the power dissipated is 5 kw.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A high-pressure electric discharge lamp comprising a globular envelope of vitreous material and designed for operation under liquid cooling conditions with a power input in excess of 60 watts per square centimeter of the external surface of said envelope and a total power input in excess of 4 kw., a predetermined amount of mercury in said envelope which is completely vaporized during operation of the lamp, a thin-walled elongated tubular neck portion projecting from said envelope, an electrode in the form of an elongated stout rod of refractory metal which fits closely within but is not hermetically sealed to said neck portion and terminates, at its inner end, close to the inner wall of the envelope, current conductor means connected to the outer end of said electrode and hermetically sealed in the outer end of said envelope neck portion, a cooperating electrode sealed in the envelope at a point opposite the first-mentioned electrode, the arc gap between said electrodes being shorter than the diameter of the envelope in any plane normal to the shortest straight line between said electrodes.

2. A high-pressure electric discharge lamp comprising a globular envelope of vitreous material and designed for operation under liquid cooling conditions with a power input in excess of 60 watts per square centimeter of the external surface of said envelope and a total power input in excess of 4 kw., a predetermined amount of mercury in said envelope which is complete vaporized during operation of the lamp, a pair of thin-walled elongated tubular neck portions projecting from opposite sides of said envelope, a pair of electrodes in the form of elongated stout rods of refractory metal which fit closely within but are not hermetically sealed to said neck portions, current conductor means connected to the outer ends of said electrodes and hermetically sealed in the outer ends of said envelope neck portions, the arc gap between said electrodes being shorter than the diameter of the envelope in any plane normal to the shortest straight line between said electrodes.

VICTOR J. FRANCIS.
EVAN H. NELSON.