Jan. 23, 1940. V. J. FRANCIS 2,187,774

ELECTRIC DISCHARGE LAMP ADAPTED FOR USE AS SOURCE IN OPTICAL PROJECTION APPARATUS

Filed Oct. 20, 1938

Fig. 1

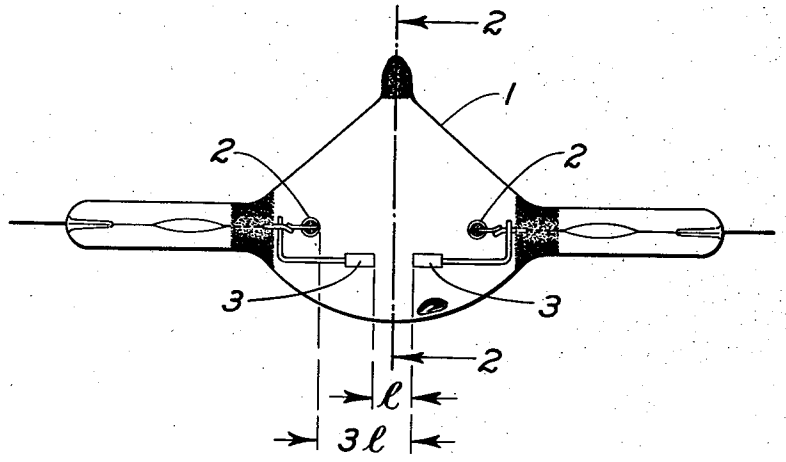
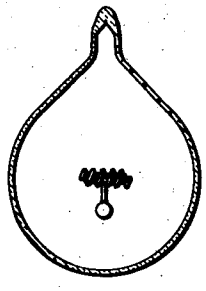


Fig. 2



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Patented Jan. 23, 1940 2,187,774

UNITED STATES PATENT OFFICE

2,187,774

ELECTRIC DISCHARGE LAMP ADAPTED FOR USE AS SOURCE IN OPTICAL PROJECTION APPARATUS

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Application October 20, 1938, Serial No. 236,110
In Great Britain October 8, 1937

1 Claim. (Cl. 176—122)

This invention relates to electric discharge lamps of the type, adapted to operate so that the discharge consumes in full operation a prescribed power W, in which the electrodes, heated by the discharge so as to emit thermionically, are contained in a large envelope filled in operation with metal vapour (mainly if not entirely mercury) at a pressure greaty exceeding atmospheric and are so near together that W/*l*, where *l* is the distance between the electrodes, greatly exceeds 100 watts/cm. "Large" means that a sphere, drawn around an electrode as centre and having a radius equal to the distance between the electrodes intersects the envelope (if at all) only over a part of its surface much less than the whole. Electrodes here means the surfaces on which the discharge terminates in full operation. The envelope normally contains, in addition to the metal vapour, rare gas to facilitate starting.

Lamps of this type are well suited as sources in optical projection apparatus, because the discharge column is small and very bright. Examples have been described in which the distance between the electrodes is about 5 mm., and W is about 600 watts, so that W/*l* is about 1200 watts/cm., the pressure of the vapour being some 50 atmospheres or more. It has been said that the brightness of the discharge column in such lamps may be as high as 60,000 candles per sq. cm. It is generally recognised that still higher brightness could be obtained if W/*l* were still further increased, the pressure in operation being maintained or increased still further. But no proposal appears to have been made to increase W/*l* much above 1200 watts/cm. One reason is probably the difficulty of running up the discharge after starting; if the electrodes are so near together, either the current during the run up would have to be so large that there would be great difficulty in generating it and leading it to the electrodes, or the time occupied by the run up would be prohibitively long, or both. Another reason is that the thermionically active material, which must be provided on the electrode to start the discharge, would rapidly evaporate or sputter away.

These obstacles to further increase of brightness can be removed by the use of starting and running electrodes as described in British Patent No. 472,658. If the distance between the starting electrodes is made sufficiently great, the current that has to flow during the run up, in order that the energy dissipated in the discharge shall be sufficient to start and continue to run up, becomes practicably small; and since the discharge terminates in full operation on the refractory running electrodes evaporation and sputtering can be reduced within practicable limits.

According to the invention in an electric discharge lamp of the type specified, comprising at least one starting electrode associated with a running electrode as described in British Patent No. 472,658, the distance between the running electrodes is so small that the said W/*l* exceeds 1200 watt/cm. and the brightness of the discharge column in full operation is at least 60,000 candles per cm.^{2}, and the distance of the starting electrode from the electrode with which it cooperates during the first part of the run up is so great that, when the lamp is supplied by a suitable circuit (unaltered between starting and full operation), the current carried by the discharge during the run up never exceeds twice the current carried by the discharge in full operation. The usual circuit, wherein impedance, chosen according to known principles, is in series with the lamp is suitable, and so are other known alternatives.

The discharge column is not generally of uniform brightness. It generally has a central part of maximum brightness and terminal parts whose brightness decreases as the electrodes are approached; these may be terminated in turn by spots immediately in front of the electrodes whose brightness may equal or exceed that of the central part. The brightness of the discharge column in the foregoing statement and the appended claim means the brightness of the central part.

Again, in order that the maximum current during the run up shall be definite it is necessary that the cooling conditions should be specified. If cooling conditions are prescribed by the maker of the lamp, these conditions are to obtain during the determination of the maximum current. If no cooling conditions are prescribed by the maker, the lamp as made or sold is to be exposed in free air at 20° C., shielded from draughts.

If the lamp is to be operated on D. C., there need be only one pair of a running and associated starting electrodes; the same electrode, being the anode, may then be the other running electrode and the electrode with which the starting electrode cooperates during the first part of the run up. But if the lamp is to be operated on A. C., there are preferably two pairs, each of a running and associated starting electrode, and the electrode cooperating with each starting electrode will be the other starting electrode.

The said lower limit for W/*l* is not generally the preferred value. For I have found that the brightness of the discharge continues to increase

rapidly with W/l, even when W/l exceeds 1200 watt/cm. Thus if W is 500 watts, it will generally be desirable to make l as small as 3 mms. and even as small as 1 mm. An upper limit to W/l is set mainly by the refractoriness of the electrodes.

The distance between the starting electrode and the electrode with which it cooperates as aforesaid will generally need to be at least 3 times that between the running electrodes. The prescribed values of W/l and of the brightness will set a lower limit to the vapour pressure in operation which will generally be at least 10 atmospheres. It is generally desirable that this pressure should be as high as possible. For this purpose the envelope should be no larger than is necessary to keep its temperature below that at which it deteriorates rapidly. Quartz is at present the best available material for the envelope; it will usually have to be as much as 2 mm. thick even if the wattage is as low as 250. The surfaces of the envelope in the direction of projection may have to be very perfect in order that there shall be no optical distortion.

Lamps according to the invention have advantages other than that of brightness. One is an increased stability of the discharge. When the lamp is operated with the line between the electrodes horizontal, there is hardly any bowing upwards; when it is operated with this line vertical, the irregular wandering about the mean position is much less. Another is that, for a given brightness, the power dissipated is less than in lamps with the electrodes further apart.

For the purpose of illustrating the invention I have shown a preferred embodiment thereof (which is identical with the lamp disclosed in the aforesaid British Patent No. 472,658 except for the dimensions thereof) in the accompanying drawing, in which

Fig. 1 is an elevational view of the lamp, and

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1.

In these figures there is shown a lamp having a more or less spherical envelope 1 having starting electrodes 2 and running electrodes 3, wherein at starting the discharge operates between either of the electrodes 2 as a cathode and the electrode 3 at the other side of the envelope 1 as an anode, and then later shifts to a path between the electrodes 3 which then serve alternately as anode and cathode when the device is operated on alternating current.

Since all of the embodiments of the invention are identical, save for dimensions, which are critical, these figures will suffice to illustrate each of the lamps hereinafter described.

Thus in one embodiment the diameter of the envelope 1 is 30 mms. The running electrodes 3 are cylindrical tungsten blocks 3 mms. in diameter and 4 mms. long, separated by 1.25 mms. The starting electrodes 2 are tungsten helices enclosing oxide rods separated by 18 mms. In full operation the discharge consumes 250 watts with 25 volts between the electrodes. The brightness of the discharge is then 100,000 candles per sq. cm.

In a second embodiment, the diameter of the envelope is 37 mms. The running and starting electrodes are as in the first embodiment. In full operation the discharge consumes 500 watts with 30 volts between the electrodes. The brightness is 100,000 candles per sq. cm.

In a third embodiment the diameter of the envelope is 50 mms. The running electrodes 3 are cylindrical tungsten blocks 4 mms. in diameter and 5 mms. long separated by 3 mms. The starting electrodes 2 are tungsten helices enclosing oxide rods separated by 22 mms. In full operation the discharge consumes 1000 watts with 54 volts between the electrodes; the brightness is 80,000 candles per sq. cm.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

An electric discharge lamp of the type adapted to operate with relatively high pressure comprising a sealed envelope containing a rare gas and a vaporizable metal, a pair of running electrodes therein separated by a distance of the order of a few millimeters, and an activated thermionic starting electrode associated with at least one of said running electrodes and so located with respect thereto that the distance between said starting electrode and the opposite running electrode is more than three times the distance between said running electrodes.

VICTOR JAMES FRANCIS.