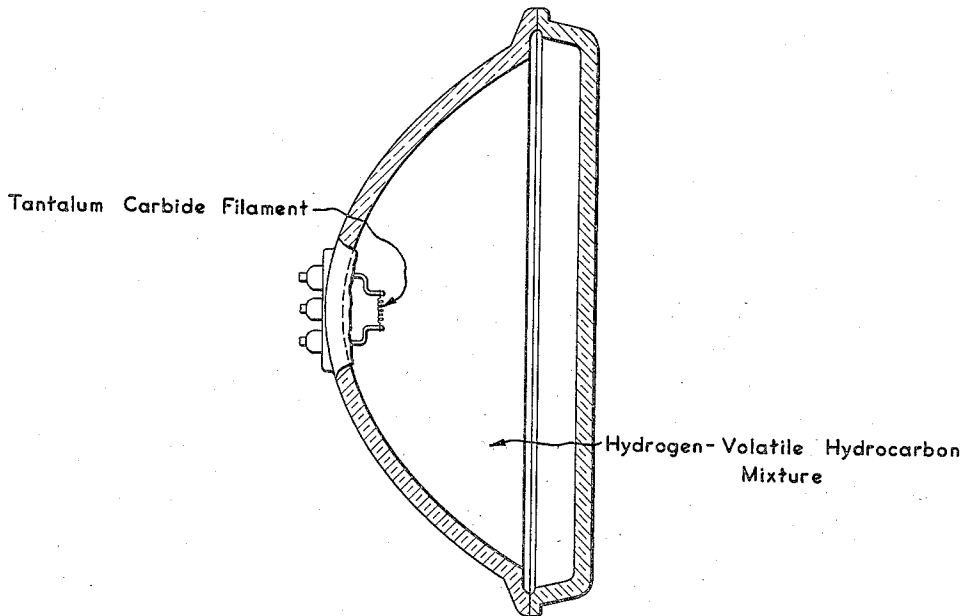


May 13, 1952

D. P. COOPER, JR

2,596,469

TANTALUM CARBIDE FILAMENT ELECTRIC LAMP CONTAINING
HYDROGEN-VOLATILE HYDROCARBON MIXTURE
Filed Feb. 27, 1951



INVENTOR

Dexter P. Cooper, Jr.

BY

Brown and Mikulka
Attorneys

UNITED STATES PATENT OFFICE

2,596,469

TANTALUM CARBIDE FILAMENT ELECTRIC
LAMP CONTAINING HYDROGEN-VOLATILE
HYDROCARBON MIXTUREDexter P. Cooper, Jr., Cambridge, Mass., assignor
to Polaroid Corporation, Cambridge, Mass., a
corporation of Delaware

Application February 27, 1951, Serial No. 212,934

9 Claims. (Cl. 313-223)

1

This invention relates to new and improved incandescent lamps adapted to be operated at relatively high filament temperatures, for example at filament temperatures of the order of 3600° to 3800° K., and possessing relatively long, useful operative life at such high temperatures, and to processes for the manufacture of such lamps.

Objects of the invention are to provide incandescent lamps of the character described wherein the filament consists essentially of tantalum carbide; wherein the envelope of the lamp is filled with a gaseous mixture comprising hydrogen, a hydrocarbon such as methane, ethylene or other volatile hydrocarbon, and an inert gas of low heat conductivity, such as argon or krypton; and to provide a process for the manufacture of lamps of the character described wherein a tantalum filament is converted to tantalum carbide within the sealed envelope of the lamp after it has been filled with gas, by controlled operation of the lamp at filament temperatures of the order of 2800° to 3600° K. for a short period and until the tantalum filament has been substantially completely converted to tantalum carbide.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the product possessing the features, properties and the relation of elements which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing which is a diagrammatic representation, in section, of one form of lamp embodying the invention.

There is a demand for incandescent electric lamps operating at relatively high filament temperature and producing substantially white light. Such lamps are used, for example, in flood lighting for photographic purposes. Those presently available which operate at filament temperatures as high as 3400° K. are of relatively short life, burning out usually within a period of from three to four hours and, moreover, showing evidence of a black deposit on the inside of the transparent envelope of the lamp after a much shorter period, for example a period of the order of five to ten minutes. The photographic lamps presently available which operate at lower temperatures,

2

for example filament temperatures of the order of 3200° K., have a somewhat longer life, for example in the neighborhood of twenty hours, but the light emitted from these lamps is less desirable in its color properties.

The product of the present invention, an incandescent lamp which operates at a filament temperature of the order of 3600° to 3800° K., gives an even more desirable and whiter light than the short-lived photoflood lamps previously mentioned and has a substantially longer life, for example in excess of twenty-five to thirty hours, than the less desirable photographic lamps operating at the lower filament temperatures. It is therefore admirably adapted for use wherever photoflood lamps are now advantageously employed, and because of its high filament temperature and relatively long life finds utility in other commercial applications.

The incandescent lamp of the present invention may take any desired shape and have any desired size. It may, for example, have an envelope which is either transparent or translucent in whole or in part, and where a portion only of the envelope is light transmitting the remainder may comprise a parabolic or other suitable reflector with the lamp filament positioned at the focus thereof.

While particular mention has been made of the applicability of the present invention to lamps of the photoflood type, it is to be understood that the invention may be advantageously employed generally with incandescent lamps, for example with such lamps as the sealed beam automobile headlight and related structures adapted to project carefully controlled or substantially collimated light beams. Such a lamp is shown diagrammatically and in section in the drawing.

The incandescent lamp of the present invention employs a filament which may be of any desired size and shape, either straight, crimped, folded or coiled, which is formed essentially of tantalum carbide and which may be mounted between any suitable electrodes, as for example electrodes of nickel. Where the envelope of the lamp is composed in part of a reflector, the filament is preferably positioned at a focus of the parabola or other surface formed by the reflector. The envelope is at least in part light transmitting and preferably transparent and may, if desired, have incorporated therein lens elements in ways well known to the art.

The envelope is exhausted of air and filled, for example, at or slightly below atmospheric pres-

sure, with an atmosphere comprising in part a volatile hydrocarbon and in part hydrogen. With these gases there may be mixed, if desired, an inert, highly transparent gas of low heat conductivity such, for example, as argon, krypton or xenon.

So much volatile hydrocarbon should be employed as will provide sufficient carbon to convert the entire heated portion of the tantalum filament to tantalum carbide and in addition will maintain an equilibrium condition preventing loss of carbon from the surface of the filament at the operating temperature. In practice, this means as a minimum three or four times the calculated amount of hydrocarbon necessary to completely convert the filament to the carbide. Preferably, a considerable excess of volatile hydrocarbon over the indicated minimum is employed.

While any volatile hydrocarbon may be employed within the lamp envelope, some preference is given to the use therein of methane or ethylene. During the operation of the lamp the reactions arising from the high temperature of the tantalum carbide filament, in an atmosphere such as has been described, probably result in the production of some ethylene. The proportion of volatile hydrocarbon to hydrogen in the gaseous mixture with the envelope is not critical. Preferably the mixture contains more than twice as much hydrogen as volatile hydrocarbon, by volume. Where a filament, approximately one-half inch in length between electrodes, and from ten to fifteen thousandths of an inch in diameter is employed, the envelope may advantageously contain at least about 20 cc. of methane or other volatile hydrocarbon and at least about 50 cc. of hydrogen. The remainder of the gaseous mixture within the envelope may be either hydrogen or in inert gas such as argon. Where the lamp is large and the volume of the envelope relatively great, for example of the order of 2800 cc., the atmosphere within the lamp envelope may preferably contain slightly more, for example 25 to 30 cc., of the volatile hydrocarbon, and the remainder of the atmosphere may be entirely hydrogen or a mixture of hydrogen and a suitable inert gas comprising at least about 150 to 200 cc. of hydrogen.

Lamps such as have been described, i. e., incandescent lamps having filaments of tantalum carbide, and an envelope containing a small amount of a volatile hydrocarbon and hydrogen with or without a suitable inert gas of low heat conductivity, can be satisfactorily operated at voltages to give filament temperatures of the order of 3600° to 3800° K. and can be operated continuously under these conditions for relatively long periods, for example in excess of twenty-five hours, without blackening or smoking up, i. e., without the formation of a dark deposit on the interior surface of the envelope and without appreciable alteration in the chemical composition of the filament. Moreover, the lamps of the present invention operate at substantially higher efficiency (candlepower output per watt input) than do conventional tungsten filament lamps. Tests of lamps such as those previously described indicate efficiencies of the order of three times those of conventional lamps.

While it is to be understood that the filament of the lamp of the present invention may be converted from tantalum to tantalum carbide by any conventional process, and before insertion in the lamp envelope, if desired, a preferred process for the manufacture of the lamps, one which avoids

the necessity of handling and shaping tantalum carbide, is one wherein the filament is converted from tantalum to tantalum carbide within the lamp after the lamp has been filled with the preferred operating atmosphere and the envelope sealed. This is accomplished in the following manner:

A lamp is constructed with a filament of metallic tantalum but otherwise in every way substantially identical to the lamp previously described, i. e., its envelope may be exhausted of air and filled with a suitable mixture of a volatile hydrocarbon and hydrogen, with or without added inert gas of low heat conductivity. A voltage is then impressed upon the lamp filament sufficient to raise its temperature to about 2800° K. and this temperature is maintained for approximately one minute after which it is gradually raised by increasing the voltage until a filament temperature of approximately 3600° K. is reached. This temperature increase may, for example, be reached where the filament is of the length and diameter previously mentioned in about eight or nine minutes. This heated portion of the filament is then substantially completely converted to tantalum carbide, as X-ray analysis has demonstrated, but to insure complete conversion the lamp may be operated with a filament temperature of approximately 3600° K. for an additional five to ten minutes, during which time the color temperature of the filament is frequently checked to insure that conversion has ceased. The lamp is now in condition for commercial use and may be operated for extended periods at filament temperatures of the order of 3600° to 3800° K.

Throughout the specification and claims reference to the lamp filament is to be understood as including the heated illuminant within the lamp envelope, whatever its size and shape and whether it be wirelike or ribbonlike, flat, coiled, looped or corrugated.

Since certain changes may be made in the above product and process without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In an electric lamp, a filament comprising essentially tantalum carbide positioned within an atmosphere comprising a volatile hydrocarbon and hydrogen.

2. A lamp according to claim 1 wherein the atmosphere comprises a substantial excess of hydrogen over volatile hydrocarbon.

3. A lamp according to claim 1 wherein the atmosphere also comprises a transparent, inert gas of low heat conductivity.

4. A lamp according to claim 1 wherein the volatile hydrocarbon is present in quantity at least three times that sufficient to convert metallic tantalum of the filament to tantalum carbide at the filament temperature at which the lamp is operated.

5. A lamp according to claim 4 wherein the hydrogen is present in quantity at least twice that of the hydrocarbon.

6. A lamp according to claim 1 wherein the hydrocarbon comprises ethylene.

7. In a process of manufacturing tantalum carbide filament electric lamps, the steps comprising positioning a filament formed essentially

5

of metallic tantalum in a lamp envelope containing an atmosphere comprising a volatile hydrocarbon and hydrogen, operating said filament within said atmosphere at a filament temperature of the order of 2800°K . for a short period, and gradually increasing said filament temperature to approximately 3600°K ., whereby said filament is converted to tantalum carbide.

8. A process according to claim 7 wherein the atmosphere within said envelope comprises at

6

least twice as much hydrogen as hydrocarbon by volume.

9. A process according to claim 8 wherein the atmosphere comprises at least three times the volume of volatile hydrocarbon necessary to provide the calculated quantity of carbon to effect conversion of the tantalum to tantalum carbide.

DEXTER P. COOPER, JR.

No references cited.