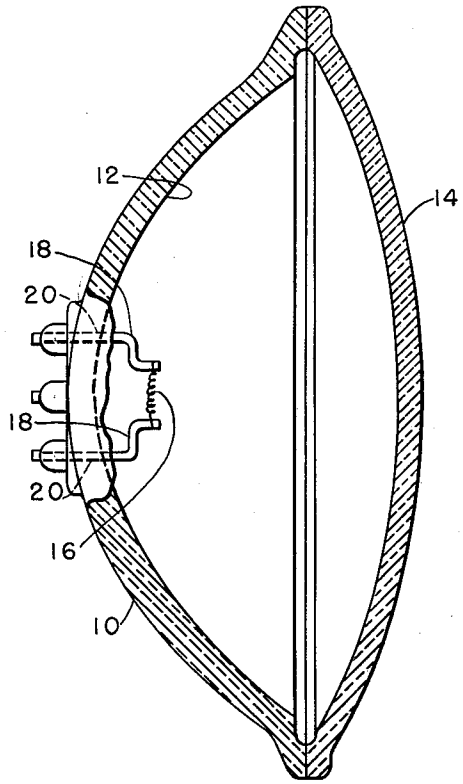
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ELECTRIC LAMPS

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ELECTRIC LAMPS

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This invention relates to electric lamps and more particularly to new and improved electric incandescent lamps adapted to be operated at relatively high temperatures and possessing relatively long, useful operating life at such high temperatures.

A principal object of the present invention is to provide in incandescent lamps of the character described at least one filament comprising tantalum carbide and at least one other refractory metal carbide selected from the group consisting of the carbides of zirconium and hafnium, and a substantially oxygen-free atmosphere comprising, at operating temperatures, hydrogen, and volatilized carbon.

Another object of the invention is to provide for use in an atmosphere of the above type a filament comprising tantalum carbide and from about 1 to about 30 percent by weight of at least one other refractory metal carbide selected from the group consisting of carbides of zirconium and hafnium.

Still another object of the invention is to provide a filament of the above type which permits the achievement of very high efficiencies.

Still another object of the invention is to provide a filament of the above type for use in an atmosphere comprising, at operating temperatures, a halogen such as chlorine, hydrogen and volatilized carbon.

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

The invention accordingly comprises the products 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 nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, which is a representation of a section through a typical automobile headlamp embodying the features of the invention.

Present-day electric incandescent lamps are generally constructed with a tungsten filament mounted in an evacuated atmosphere within the bulb or in an atmosphere comprising essentially inert gases. These inert gases may, for example, comprise a mixture of gases of which the major portion is argon, krypton or xenon. Inert gases are employed to reduce evaporation of the filament during lamp operation. Nevertheless, a common cause of lamp failure is evaporation of filament material to such an extent that the filament is gradually eaten away and fails. Since the rate of evaporation varies directly with the temperature, this kind of failure is especially prevalent in bulbs designed to operate at very high temperatures. Rapid filament evaporation has long been a serious problem in incandescent lamp manufacture, since the efficiency of the bulb as a source of illumination, measured in candle power per watt, for example, generally increases as the operating temperature of the filament is raised.

This invention accordingly contemplates the use within a lamp bulb or envelope of an essentially multi-carbide filament of the type heretofore described having improved high melting points and an atmosphere the elements of which interact with each other and with a preferred carbide filament in such a manner that the filament does not deteriorate over an extended period of operation at high

filament temperatures. The invention thus yields a lamp that has both long operating life and high efficiency.

The drawing illustrates a vehicle headlamp of the sealed-beam type which comprises a cup-shaped base member **10** having its inner surface **12** silvered or otherwise coated to provide a metallic reflector, preferably of paraboloidal shape. The base member has hermetically sealed thereto a transparent cover plate **14**, of for example, glass which may serve as a lens element for controlling the dispersion of light emitted from the lamp. Within the bulb there is mounted or suspended, for example, a tantalum carbide-zirconium carbide filament or a tantalum carbide-hafnium carbide filament **16** on lead wires **18** which, in turn, are attached to subleads **20**. The subleads may be connected to a source of electric power outside the bulb or envelope. The carbide filament is located at the focus of the reflector. After assembly, the bulb is evacuated and filled with an atmosphere which, at operating temperatures, preferably comprises hydrogen, a halogen such as chlorine and volatilized carbon, and if desired an inert gas such as argon.

In one preferred embodiment, a preferred carbide filament about 7 mils in diameter and about ½ inch in length may be mounted on 40-mil leads within a standard T–20 envelope of about 270 cc. capacity, into which about 2 cc. of carbon tetrachloride and 20 cc. of hydrogen, at atmospheric pressure and room temperature, have been introduced, along with sufficient argon to bring the total pressure within the bulb at least to slightly less than one atmosphere. The bulb and components may be cleaned and prepared in ways well known to the art. It is desirable to coat the inner surface of the envelope (preferably after formation of the reflector if such is used) with a material that will protect the envelope material, for example glass, from attack from materials such as, for example, fluorine. This may be done by evaporating calcium fluoride, for example, upon the inner surface of the envelope before the lamp is completely assembled.

The multi-carbide filaments of the present invention may comprise solid solutions or mixtures of tantalum and zirconium carbides and tantalum and hafnium carbides. Filaments comprised of all three of the above carbides may also be employed. The filaments of the present invention comprise tantalum carbide and from about 1 to about 30 percent by weight of at least one of the carbides of zirconium and hafnium. Such carbide filaments have melting points above the melting point of each of the individual carbides, the maximum melting point being at about 80 percent by weight of tantalum carbide. Thus, the preferred filaments comprise tantalum carbide and about 20 percent by weight of zirconium carbide or hafnium carbide or both zirconium carbide and hafnium carbide. Higher efficiencies are possible with the present carbide filaments since, if desired, higher operating temperatures can be employed. Moreover, such filaments permit a reduction in the amount of reactive materials in the envelope atmosphere used for stabilizing the carbide filament.

Although any convenient method of forming the preferred carbide filaments may be used, it may be convenient to convert a filament comprising an alloy of tantalum-hafnium or tantalum-zirconium, for example, to the carbide structure after the bulb has been assembled. For example, the bulb may be constructed with all elements identical with those disclosed in the embodiment described above, except that the filament (and leads if desired) may comprise an alloy of tantalum and zirconium or tantalum and hafnium. The filament may then be converted to the carbide form by passing sufficient current through the filament to yield a filament temperature of about 3100° C. In this way, the tantalum, zirconium and/or hafnium comprising the filament (and leads) will

be substantially converted to carbides. It should also be noted that many materials may be used for leads, for the leads may be similar to the filament in composition or they may be made of carbon, tungsten, platinum, palladium, rhodium or a suitable metal coated or clad with, for example, platinum, palladium or rhodium. The preferred carbide filament may be of any suitable configuration, whether straight, coiled, crimped or otherwise shaped.

The envelope atmosphere may comprise a volatile hydrocarbon and hydrogen such as disclosed in U.S. Patent 2,596,469 or preferably the envelope atmosphere may comprise, at operating temperatures, a halogen, hydrogen and volatilized carbon. The preferred envelope atmosphere may be provided by a number of materials or sources. For example, single compounds, such as ethylenediamine hydrochloride, methylamine hydrochloride and the like, are satisfactory. The necessary elements may also be provided by introducing into the envelope a combination of materials, such as ethylene or another hydrocarbon and a gaseous hydrogen halide, for example hydrogen chloride; or a combination of hydrogen, chlorine and any convenient hydrocarbon, e.g., methane, ethane, ethylene and the like; or a combination of hydrogen and any convenient halogenated hydrocarbon such as benzene hexachloride, the polyhalogen derivatives of methane, ethane, etc., e.g., carbon tetrachloride, tetrachloroethane and the like; or a combination of hydrogen and polyhalogenated organic compounds such as tetrachloroethylene and the like. It is obvious that the desired atmosphere thus may be obtained in any number of suitable ways. Other inert gases, such as xenon or krypton, may be used instead of argon.

Relatively high pressures within the bulb will lengthen lamp life; it is desirable to maintain the pressure during operation at or near the highest level that the envelope can safely withstand. If the pressure generated by the reacting gases is great enough, the need for an inert gas is reduced.

Other halogens may be used in place of chlorine without departing from the invention; members of the class of halogens having an atomic weight of less than 100 e.g., bromine and fluorine, are especially effective. If fluorine is used, however, precautions must be taken to avoid decomposition of the bulb envelope and attack upon other lamp elements. If elemental halogens are used in preparing the lamp atmosphere, precautions should be taken to avoid inhalation or contact with the skin and eyes.

In general, any combination of materials may be used that will provide, at operating temperatures, an atmosphere of volatilized carbon and hydrogen and also preferably a suitable halogen, particularly chlorine, in the area surrounding the filament. The atmosphere should be substantially free of water or oxygen; specifically, the oxygen content should be less than the order of fifty parts per million. The amount of carbon in the atmosphere should be sufficient to prevent the preferred carbide filament from decomposing into free metal and carbon. Hydrogen and halogen may be used in varying proportions; it is critical only that enough hydrogen be present to prevent halogen from attacking the bulb components, and that the total amount of hydrogen and halogen be sufficient to combine with the carbon atoms escaping from the region surrounding the filament to reduce to a minimum deposit of uncombined carbon upon the inner wall of the bulb or upon other exposed surfaces. Thus, the atmosphere, at operating temperatures, preferably comprises an excess by volume of hydrogen and halogen over vaporized carbon and an excess by volume of hydrogen over halogen. For example, the employment of benzene hexachloride produces an atmosphere comprising an atomic ratio of approximately one carbon atom to one chlorine atom to six hydrogen atoms. If the preferred atmosphere is provided by a mixture of materials, such as a hydrocarbon and gaseous hydrogen chloride, a desirable atomic ratio is one carbon to three chlorine to five hydrogen. It is to be understood that these ratios may be varied widely, within the limits previously specified, without departing from the invention.

While the drawing particularly illustrates the applicability of the present invention to vehicle lamps, it is understood that the invention may be advantageously employed generally with incandescent lamps, for example photoflood lamps, projection lamps and related structures adapted to project carefully controlled or substantially collimated light beams.

Moreover, while the drawing describes a specific lamp configuration or structure, it is understood that the incandescent lamp 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.

Since certain changes may be made in the above products 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 incandescent lamp, an atmosphere comprising, at operating temperatures, hydrogen and carbon, and a filament positioned within said atmosphere comprising tantalum carbide and about 20% by weight of at least one refractory metal carbide selected from the group consisting of the carbides of zirconium and hafnium.

2. A lamp according to claim 1, wherein the atmosphere also includes, at operating temperatures, at least one halogen.

3. A lamp according to claim 1, wherein the atmosphere also includes an inert gas of low heat conductivity.

4. In an incandescent lamp, an atmosphere comprising at least one source of hydrogen and at least one source of carbon, said atmosphere being substantially free of oxygen, and a filament positioned within said atmosphere comprising tantalum carbide and about 20% by weight of at least one refractory metal carbide selected from the group consisting of the carbides of zirconium and hafnium.

References Cited in the file of this patent

UNITED STATES PATENTS

1,655,488	Wolff et al.	Jan. 10, 1928
1,925,857	Van Liempt	Sept. 5, 1933
2,025,565	Blau	Dec. 24, 1935
2,072,788	Andrews	Mar. 2, 1937
2,596,469	Cooper	May 13, 1952