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METHOD OF FORMING CARBIDE COATED COILED FILAMENTS FOR LAMPS

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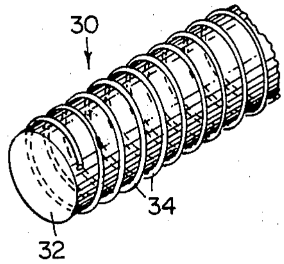

FIG. 2

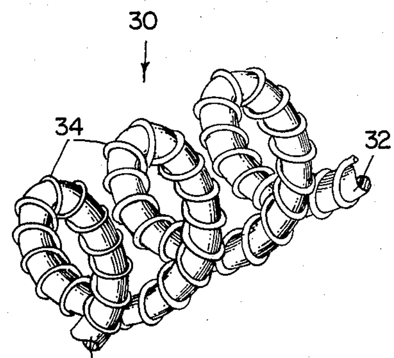

FIG. 3

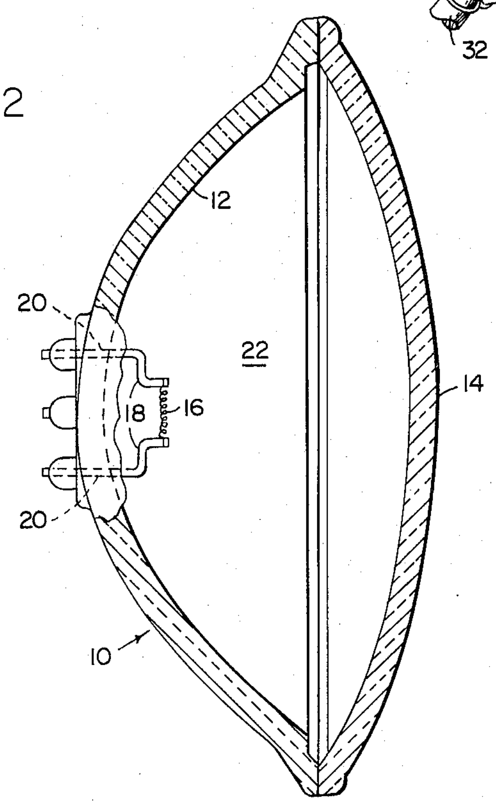

FIG. 1

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METHOD OF FORMING CARBIDE COATED COILED FILAMENTS FOR LAMPS

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1 Claim. (Cl. 29—155.5)

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 a coiled wire filament comprising a major percentage of tantalum carbide with excellent emissivity characteristics.

Another object of the invention is to provide a filament comprising a coiled wire comprising a major percentage of tantalum carbide, said coiled wire having a wire of smaller diameter wound and secured therearound, said wound wire also comprising a major percentage of tantalum carbide.

Still another object of the invention is to provide a method for producing filaments of the above type.

Still another object of the invention is to provide an incandescent lamp comprising a filament of the above type and an atmosphere comprising at least one source of 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, and the method comprising the several steps and the relation of one or more of such steps with respect to each of the others 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 this invention, reference should be had to the following detailed description taken in connection with the accompanying drawing wherein:

FIGURE 1 is a representation of a section through a typical vehicle headlamp of the sealed-beam type; and

FIGS. 2 and 3 are enlarged views of the filament of the present invention.

There is a demand for incandescent lamps adapted to be operated at relatively high filament temperatures and possessing relatively long, useful operating life as well as, for example, high emissivity. Such lamps would be desirable, for example, in vehicle headlighting, floodlighting, picture projection and the like.

This invention accordingly contemplates the use within a lamp bulb or envelope of a compound coil filament comprising a major percentage of tantalum carbide, and having improved brightness, and an atmosphere the elements of which interact with each other and with the 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 provides a lamp adapted for long operating life and excellent brightness.

FIGURE 1 illustrates a vehicle headlamp of the sealed-beam type which comprises a cup-shaped base member **10** having its inner surface **12** silvered, aluminized or otherwise coated to provide a reflecting surface. The base member **10** 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 the preferred compound coil, 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 filament is located at the focus of the reflector. After assembly, the bulb is evacuated and filled with a regenerative atmosphere **22** which, for example, may comprise a source of carbon, a source of hydrogen and a source of at least one halogen, e.g., chlorine, and, if desired, an inert gas of low heat conductivity such as argon. The components of the regenerative atmosphere may be provided by introducing one or more suitable materials as hereinafter disclosed before the bulb is sealed.

While FIGURE 1 particularly describes a vehicle headlamp, it is to be understood that the invention is applicable to incandescent lamps generally, for example, photoflood lamps and other related structures adapted to project carefully controlled or substantially collimated light beams. Moreover, it is not essential that the collimating reflector be formed integrally with the lamp envelope as shown in FIGURE 1. The reflector may not only be positioned within the lamp envelope but it may be positioned outside the lamp envelope and either affixed thereto or wholly separated therefrom. Furthermore, while FIGURE 1 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.

Referring now to FIGS. 2 and 3, there is illustrated the filament of the present invention which may be employed in the incandescent lamps described herein. In FIG. 2 there is shown the preferred wire filament **30**, in uncoiled form. The filament **30** comprises a core wire **32** of suitable diameter, for example, 5 to 7 mils, and a fine wire **34** of a diameter considerably smaller than the core wire **32** helically wound about and adhered to the core wire. The fine wire helix **34** extends along the length of the core wire **32**. The turns of the fine wire **34** around the core wire **32** are uniformly spaced apart by a distance no greater than twice the diameter of the fine wire **34**. The spacing between the turns of the fine helix is adjusted empirically to give maximum emissivity to the finished compound coil filament. Thus it may vary for different optical applications. The space between the edges of adjacent fine wires will be greater than zero, and less than two of the fine wire diameters. Both the core wire **32** and the helically wound fine wire **34** comprises a major percentage of tantalum carbide when utilized in incandescent lamps as described herein.

The diameter of the fine wire **34** is substantially smaller than the diameter of the core wire **32**. For example, a fine wire having a diameter of 1 mil or smaller (e.g., 0.25 mil) may be suitably employed as a helix about a core wire having a diameter of, for example, 7 mil. Preferably the diameter of the fine wire **34** is at least three times smaller than the diameter of the larger core wire **32**.

The fine wire helix is preferably attached or cemented to the large wire. The securing or adhering of the fine wire helix **34** to the core wire **32** may be achieved through the use of a carbonaceous material, such as a small quantity of carbon powder, at the line of contact between the two wires or through the use of an organic polymeric material which on charring decomposition produces carbon to form the desired carbonaceous bond. Among the many suitable organic polymeric materials which may be used to adhere the two wires, mention may be made of such hydrocarbon thermoplastics as polyalkylenes such as polyethylene, polypropylene, etc., vinyls such as polyvinyl chloride, and the like. In practice, a solution of the organic polymeric adhesive in a volatile solvent is employed, the solvent thereafter being removed so that the plastic binds the metallic wires together in subsequent handling, coiling, and shaping. Then upon charring decomposition of the preferred polymeric adhesives, the carbon obtained firmly bonds or secures the two wires by causing a very localized melting of Ta and C to the peritectic Ta–Ta_2C along the line of contact. As carburization proceeds, the entire structure is converted to TaC.

The construction of a compound coil, as described above, may be readily and simply achieved. For example, as a fine tantalum wire, having a diameter of say 1 mil, is about to be helically wound about a tantalum core wire of larger diameter, say 7 mils, the larger tantalum core wire is wetted with a dilute solution of a suitable polymeric plastic in a volatile solvent so as to result in the adherence of the fine wire thereto. The solvent is then removed by hot air or heat lamps, thus drying the plastic adhesive and firmly securing the fine wire helix to the larger wire. For high brightness, the pitch of the fine wire is carefully controlled during winding. The resultant composite or compound wire structure is then wound on a coil and carburized to convert the tantalum wires to tantalum carbide.

The use of filaments comprising a major percentage or portion of tantalum carbide in the presence of a regenerative atmosphere comprising a source of carbon has heretofore been suggested. The filaments of the present invention may consist essentially of tantalum carbide such as disclosed in U.S. Patent 2,596,469, or they may comprise a solid solution or mixture of a major percentage of tantalum carbide and a minor percentage of at least one other refractory metal carbide such as disclosed in copending applications Serial Nos. 5,524 and 5,525, both filed January 29, 1960 and both issued on February 20, 1962 as U.S. Patents 3,022,436 and 3,022,437, respectively. In the former application, there is disclosed and claimed the use of a carbide filament comprising tantalum carbide and from about 1 to about 30 percent by weight of at least one metal carbide selected from the group consisting of the carbides of zirconium and hafnium. In the latter-mentioned application, there is disclosed and claimed the use of a carbide filament comprising tantalum carbide and between 1 and 10 percent by weight of at least one refractory metal carbide selected from the group consisting of the carbides of titanium, thorium, vanadium, niobium, molybdenum, tungsten and uranium.

One convenient method of forming a preferred carbide filament comprises converting a tantalum or suitable tantalum alloy filament to the carbide structure after it has been shaped into the desired configuration or geometry. This conversion may be readily achieved by passing sufficient current through the filament to yield a filament temperature above 2000° K. and 3200° K., and maintaining the filament at this temperature in the presence of a carburizing atmosphere and a volatile hydrocarbon, e.g., ethylene, xylene and the like, until the desired carbide structure is obtained. Carburizing techniques such as described above are more fully set forth, for example, in U.S. Patent No. 2,596,469. Other carburizing methods such as, for example, zone carburization may also be employed to carry out the conversion.

Many materials may be used for leads. For example, the leads may have a composition similar to the filament or they may be made of rods of carbon, tungsten, platinum, paladium, rhodium and the like.

The regenerative atmosphere enclosed within the lamp bulb or envelope may comprise a volatile hydrocarbon and hydrogen such as disclosed in U.S. Patent 2,596,469, or the envelope atmosphere may comprise at least one source of carbon, at least one source of hydrogen and at least one source of halogen such as disclosed in copending applications Serial No. 14,254, filed March 11, 1960 and Serial No. 840,495, filed September 10, 1959 and both issued on February 20, 1962 as U.S. Patents 3,022,439 and 3,022,438, respectively. Other suitable envelope

atmospheres comprising at least one source of carbon and at least one source of nitrogen are disclosed in copending applications Serial Nos. 43,054 and 43,055, both filed July 15, 1960. In addition to carbon and nitrogen, the disclosed lamp atmospheres may also contain at least one source of hydrogen and at least one source of halogen. Suitable carbon nitrogen-comprising atmospheres may be provided from materials which contain or which form a cyanide radical such as, for example, hydrogen cyanide. Atmospheres comprising at least one source of carbon and at least one source of sulfur such as disclosed in copending application Serial No. 134,225, filed August 28, 1961 and which is now abandoned, may also be utilized. The envelope filling thus may comprise one or more sources of: carbon and hydrogen; or carbon, hydrogen and at least one halogen; or carbon and nitrogen; or carbon, nitrogen and hydrogen; or carbon, nitrogen, hydrogen and at least one halogen; or carbon and sulfur. Inert gases of low heat conductivity, such as argon, xenon and krypton may also be included in the envelope atmosphere.

The envelope atmosphere may be provided by a number of materials. For example, single compounds, such as ethylene diamine hydrochloride, methylamine hydrochloride and hydrogen cyanide, are satisfactory. The necessary elements may also be provided by introducing into the atmosphere a combination of materials, such as ethylene or another hydrocarbon, and a gas such as a hydrogen halide, e.g., hydrogen chloride; or a combination of hydrogen, halogen, e.g., chlorine, bromine, iodine or fluorine, 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, tetrachlorethane and the like; or a combination of hydrogen and a polyhalogenated organic compound such as tetrachloroethylene and the like. The envelope atmosphere may also comprise, at operating temperature, hydrogen, volatilized carbon and at least two halogens, e.g., chlorine and iodine. The carbon and halogens may be provided, for example, from compounds such as trichloroiodomethane and trichlorobromomethane. It is obvious that the desired atmosphere thus may be obtained in any number of suitable ways.

Since relatively high pressure 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.

If elemental halogens are used in preparing the lamp atmosphere, precautions should be taken to avoid inhalation or contact with skin and eyes. If fluorine is used, however, precautions must be taken to avoid decomposition of the bulk envelope and attack upon other lamp elements.

In general, any combination of materials may be used that will preferably provide an atmosphere comprising at least one source of carbon and at least one source of hydrogen in the area surrounding the filament. Preferably it also includes at least one halogen. The atmosphere may also include nitrogen. 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 carbide filament from decomposing into free metal and carbon. The other components such as hydrogen, nitrogen 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 these components be sufficient to combine with 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.

Since certain changes may be made in the above method and 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:

A method of forming an incandescent lamp filament of high emissivity which comprises the steps of wetting a core wire with a dilute solution of an organic polymeric bonding material in a volatile solvent, winding a fine wire about said wetted core wire to form a compound wire structure, said fine wire being of substantially smaller diameter than said core wire, said wires comprising a major percentage of tantalum, removing said solvent to dry said organic polymeric material whereby said wires are firmly bonded together, shaping said compound wire structure, and carburizing said shaped compound wire structure in the presence of heat so that said wires comprise a major percentage of tantalum carbide, said organic polymeric material charring to carbon during heating to thereby provide localized melting of tantalum and carbon to the peritectic Ta–Ta_2C along the line of contact between said wires and said organic polymeric material, said wires being fused together upon completion of carburization.

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3,022,437	2/1962	Cooper	313—218

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