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METHOD OF TREATING TUNGSTEN FILAMENTS

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This invention relates to the manufacture of tungsten filaments and more particularly to a method of treating tungsten wire which has been coiled into a single or multiple helix for use in electric incandescent lamps or as electrodes for gas pressure discharge lamps.

The object of my invention is to produce tungsten filaments having increased efficiency and longer life than heretofore by treating the wire in such a manner that it is rendered more resistant to distortion and sag during the life of the lamp.

The method of manufacturing coiled tungsten filaments for use in electric incandescent lamps is well known and usually consists in first winding the wire into a helix on a core wire and then winding the helix and its core onto a second core. In order to remove the strains caused by coiling, the filament is subjected to heat treatment in an atmosphere of hydrogen or hydrogen-containing gas. This heat treatment may be carried out while the tungsten filament is still on the mandrel wire or after the latter has been removed, quite frequently the treatment is given before and after the removal of the wire mandrel but the important point is that with these heat treatments the tungsten filaments have hitherto been cooled in hydrogen or in an atmosphere containing that gas.

I have found that the surface layer of tungsten wire, after it has been subjected to heat treatment in a hydrogenous atmosphere and cooled in hydrogen, when exposed to air consists of oxide or contains adsorbed oxygen even when apparently clean and bright. It would appear that when exposed to high temperature in hydrogen the outer layer is reduced and the active metal so produced reverts to oxide on exposure to air; filaments which have gone through this cycle act as oxygen carriers, and as the oxygen is combined, "getters" are probably ineffective. Repeated hydrogen furnacing and exposure to air results in a deepening of the oxide layer, the removal of which increases the amount of gas adsorbed, as would also any moisture content in the gas. The metal is penetrated by the atomic hydrogen probably mainly along the partially developed grain boundaries but also by way of slip planes, surface inclusions or even into "dislocations." In this way a grain growth barrier is formed by the molecular hydrogen, which traps the gas and develops sufficient pressure to affect cohesion between grains. There is some evidence that the metal becomes contaminated by the running of dislocations carrying atoms of any contaminant surface into the metal. All such contingencies cause or induce sagging, even in the case of filaments made from metal which possesses the properties necessary for the rapid grain growth associated with non-sag behavior.

In accordance with my invention, instead of allowing the filaments to cool in hydrogen or a hydrogen-containing atmosphere, the cooling takes place in an atmosphere of inert gas such as argon after the filaments have been subjected to heat treatment in a vacuum or in hydrogen or a hydrogen-containing gas.

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In carrying my invention into effect, the tungsten filament is heated in hydrogen for a period and at a temperature which is considered to be optima, it is then cooled in an atmosphere of argon, nitrogen or other gas which is inert with respect to the tungsten filament. If the heat treatment takes place in a vacuum, the dry argon, nitrogen or other inert gas can be admitted into the vessel in which the vacuum furnacing operation is performed, thus breaking down the vacuum.

By way of specific example, a preferred method of practicing my invention is to heat the tungsten filaments, either single or coiled-coil, at 1500° C. for 10 to 15 minutes in a controlled atmosphere of wet hydrogen and immediately thereafter, without exposure to air, to cool the filaments to room temperature in dry argon in the case of filaments to be used in gas-filled lamps or dry nitrogen in the case of filaments to be used in vacuum lamps. Best results are obtained by heat-treating the filaments in a vacuum at 1500° C. for about 10 to 15 minutes and breaking the vacuum at the end of the heat-treating cycle by the admission of argon or nitrogen into the furnace.

Since subjecting coiled filaments to the process covered by this invention, I have found a remarkable improvement in the condition of the filaments after a length of life greater than the generally accepted normal life of a lamp. Moreover, the efficiency measured in terms of lumens per watt has been improved. It is believed that this improvement is due to the reduction or elimination of those chemical agents which, acting at grain boundaries and on the surface, hinder the grain growth thus causing sag and low efficiency.

Although a preferred embodiment of my invention has been disclosed, it is recognized that variations and changes may be made therein within the spirit and scope of the invention as defined by the appended claims. It is understood particularly that the heat-treating atmosphere, the cooling media and also the time and temperature can be varied, independently and in relation to each other, within fairly wide limits to obtain the desired result.

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

1. The method of treating coiled tungsten wire filaments for electric lamps and the like said method comprising winding the wire into a helix on a mandrel wire, heat-treating the coiled filament to remove the strain induced by the coiling operation in a controlled reducing atmosphere of hydrogen at about 1500° C. for about 10 to 15 minutes and immediately thereafter, without exposure to air, cooling the filaments in an atmosphere of nitrogen.

2. The method of treating coiled tungsten wire filaments for electric lamps and the like said method comprising winding the wire into a helix on a mandrel wire, heat-treating the coiled filament to remove the strain induced by the coiling operation in a controlled reducing atmosphere of hydrogen at about 1500° C. for about 10 to 15 minutes and immediately thereafter, without exposure to air, cooling the filaments in an atmosphere of argon.

3. The method of treating coiled tungsten wire filaments for electric lamps and the like said method comprising winding the wire into a helix on a mandrel wire, heat-treatment of the coiled filaments to remove the strain induced by the coiling operation in a vacuum at about 1500° C. for about 10 to 15 minutes and immediately thereafter, without exposure to air, cooling the filaments in an atmosphere of nitrogen.

4. The method of treating coiled tungsten wire filaments for electric lamps and the like said method

comprising winding the wire into a helix on a mandrel wire, heat-treatment of the coiled filaments to remove the strain induced by the coiling operation in a vacuum at about 1500° C. for about 10 to 15 minutes and immediately thereafter, without exposure to air, cooling the filaments in an atmosphere of argon.

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