Patented Apr. 12, 1938

2,113,905

UNITED STATES PATENT OFFICE

2,113,905

FILAMENT FOR INCANDESCENT LAMPS AND METHOD OF MANUFACTURING THE SAME

Jakob Salpeter, Vienna, Austria

No Drawing. Application February 6, 1937, Serial No. 124,502. In Austria March 28, 1935

6 Claims. (Cl. 176—132)

This invention relates to the manufacture of coiled filaments of tungsten, particularly electric incandescent lamp filaments, which are stable with regard to shape i. e. tungsten filaments which do not become distorted and are practically non-sagging.

Hitherto attempts to produce a practically non-sagging filament, that is one, which will remain stable at the operating temperature of the lamp, have centred on making the filament of a wire developing comparatively large overlapping crystals. Admittedly also it has been proposed to employ filaments of a multi-crystalline structure, in which recrystallization is carried out before mounting the filament on its supports, i. e. outside the lamp; yet in this case to obtain a sag, which is less than 5%, the average size of the crystals had to lie between 0.05 and 1 mm. All previous methods have been based on the fundamental assumption that a coiled filament sags the less, the coarser its crystalline structure is, and therefore with the increase in size of the dimensions of the crystals.

Now, it has been discovered that practically non-sagging or substantially non-sagging coiled filaments can be obtained, by means of a fine grained structure with a predominating crystal size of only a few or several thousandths of a millimetre.

In carrying out this invention the filament body, which consists of drawn tungsten wire which, on heating by the known methods is inclined to develop large overlapping crystals—prior to recrystallization—is preferably subjected to a heat treatment on a mandrel or core at a temperature which is such that no change in the crystalline structure takes place. The temperature of this treatment is, of course, dependent also on the material, of which the mandrel is formed and for example in the case of iron or copper mandrels, the temperature should not exceed 800° to 900° C. After the filament on the mandrel has been cut up into the required lengths and the mandrel removed, for instance by acids, the filament supported on a solid base is advantageously subjected to a further heat treatment at a higher temperature—preferably between 1000 and 1200° C.—but which is still a temperature below the recrystallization temperature of the tungsten of which the filament is made.

It is to be understood that provided the material, of which the mandrel is made, possesses a sufficiently high melting point, such as molybdenum, both heat treatments can be carried out in one stage on the mandrel. The preliminary heat treatment just described is not essential but is preferred since it serves a dual purpose in that it relieves the filament wire of strain and renders the specific electrical resistance of the wire more uniform throughout.

After subjecting the filament to this preliminary treatment it is attached to the supporting stem of the lamp and according to this invention it is subjected for a very short time (preferably less than about $\frac{1}{10}$ of a second) to a shock heat treatment at a temperature in the neighbourhood of the melting point of the filament material.

It has been found that a tungsten wire heated in this way on the one side develops a pronounced fine grained structure, i. e. the most frequently occurring or predominating crystal size being a few or several thousandths mm., and that on the other side it has practically no sag when the lamp is in operation, that it therefore meets with all the requirements relative to the constancy of the form.

A suitable method of effecting the shock heating is to subject the filament while fixed to its supports to the action of an electric current in the circuit of a transformer having a leakage of over 25%. By employing a transformer with this leakage ensures that the voltage applied will drop by about 30% or more immediately the circuit is completed and furthermore it also obviates arc-discharges of the filament during heating.

The same purpose can be achieved by the use of a condenser, with or without an inductance placed in series. The employment of either a transformer or a condenser with inductance enables the desired shape of the temperature curve to be adjusted by the selection of the constants.

Filaments of coiled tungsten wire produced according to the method described, exhibit a fine grained structure with a predominating crystal size of a few or several thousandths mm. and possess a sag of less than 10% or even less than 5%. The percentage of sag is measured by the percentage relationship of the arrow (sagitta) to the chord of the segment, the segment being the area between the positions of the filament at the commencement and after burning.

It will be found that a filament manufactured by the method of this invention will at its ends be of a substantially fibrous structure, whereas the remainder i. e. substantially the entire filament is recrystallized. This variation in structure is due to the cooling influence of the elec-

trodes (current supply wires) during the heat treatment.

As to special kinds of coiled tungsten wire it is advisable first to ascertain the suitability of the wire by microscopic inspection of filaments subjected to the herein described shock heat treatment under varied temperatures in the neighbourhood of the melting point.

What I claim is:

1. A process for manufacturing coiled filaments from drawn tungsten wire inclined to the formation of long crystals suitable for electric incandescent lamps which consists in subjecting the coiled filament for a short time less than about $\frac{1}{10}$ second, to a shock heating at a temperature in the neighbourhood of the melting temperature of tungsten.

2. A process for manufacturing coiled filaments from drawn tungsten wire inclined to the formation of long crystals suitable for electric incandescent lamps, which includes previously subjecting the coiled filament on a mandrel of refractory metal to a heating at a temperature of about 1100° C. which lies below the recrystallization temperature and then subjecting the coiled filament for a short time less than about $\frac{1}{10}$ second, to a shock heating at a temperature which is in the neighbourhood of the melting temperature of tungsten.

3. A process for manufacturing coiled filament from drawn tungsten wire inclined to the formation of long crystals suitable for electric incandescent lamps, which includes previously subjecting the coiled filament on a mandrel of easily fusible metal to a primary heating at a temperature between 600 to 900° C., removing the mandrel, subjecting the filament to a secondary heating at a temperature of about 1100° C. which lies below the recrystallization temperature and then subjecting the coiled filament for a short time being less than about $\frac{1}{10}$ second, to a shock heating at a temperature which is in the neighbourhood of the melting temperature of tungsten.

4. A process for manufacturing coiled filaments from drawn tungsten wire inclined to the formation of long crystals suitable for electric incandescent lamps which consists in subjecting the coiled filament for a short time less than about $\frac{1}{10}$ second, to a shock heating at a temperature which is in the neighbourhood of the melting temperature of tungsten the said heating being effected by the passage of an electric current in the circuit of an electrical transformer having a leakage of more than 25%.

5. A process for manufacturing coiled filaments from drawn tungsten wire inclined to the formation of long crystals suitable for electric incandescent lamps which consists in subjecting the coiled filament for a short time less than about $\frac{1}{10}$ second, to a shock heating at a temperature which is in the neighbourhood of the melting temperature of tungsten, the said heating being effected by the passage of an electrical current in the circuit of an electrical condenser.

6. A process for manufacturing coiled filaments from drawn tungsten wire inclined to the formation of long crystals suitable for electric incandescent lamps which consists in subjecting the coiled filament for a short time less than about $\frac{1}{10}$ second, to a shock heating at a temperature which is in the neighbourhood of the melting temperature of tungsten, the said heating being effected by the passage of an electrical current in the circuit of an electrical condenser with an inductance in series therewith.

JAKOB SALPETER.