UNITED STATES PATENT OFFICE.

WILLIAM D. COOLIDGE, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

FILAMENT.

1,008,588. Specification of Letters Patent. Patented Nov. 14, 1911.

No Drawing. Application filed August 1, 1906. Serial No. 328,727.

To all whom it may concern:

Be it known that I, WILLIAM D. COOLIDGE, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Filaments, of which the following is a specification.

This invention relates to incandescent lamp filaments and particularly to filaments operative at exceedingly high temperatures.

Incandescent lamp filaments now in common use are substantially circular in cross-section, and consequently possess a relatively small surface area per unit of volume. On the other hand, flat filaments may be given a surface area varying between wide limits and this variation may be made without altering the resistance of the filament, provided its length remains constant. These principles have a direct bearing on the new filament hereinafter described, for the filament has a relatively large radiating surface per unit of volume. Such a disposition of the conductive material has particular value when the material is one of the more refractory metals such as tungsten, molybdenum, titanium, tantulum, niobium, etc. These metals have a comparatively good conductivity, and filaments made therefrom must be of considerable length when of circular cross-section and arranged for operation on commercial voltages of say 110 or 220 volts. The length and size of a cylindrical filament of any refractory material are definitely fixed by three determining factors, namely, candle power of the lamp, its voltage, and its efficiency. With these three factors fixed, the resistance is fixed, and the latter determines the particular length and cross-section of the filament which gives just sufficient area to dissipate the rated input at the selected watts per candle.

By making the filaments of the shape hereinafter described, I am able to vary the length by varying the surface area, and am thereby enabled to decrease the quantity of material necessary and utilize the material of the filament to good advantage.

In order that my invention may be better understood, I have hereinafter described a process for making this improved form of filament from tungsten powder, but it should be understood that other refractory materials are applicable to the process and useful in the product. This present application is however, limited to the final refractory filament of the form referred to, and no claim is herein made to the procedure by which the filament is produced or any of the steps comprised therein, or to any of the various matters necessarily referred to or described in the description of such procedure. This process and other matters not claimed herein are claimed in certain of my pending applications, among which I may particularly mention No. 316,006, filed May 9, 1906, and No. 377,781, filed June 7, 1907.

The metal tungsten is typical of the general class of refractory metals and elements, and will be used for illustrative purposes. This material is obtainable in the form of a fine powder by the reduction of tungsten trioxid with hydrogen, or with finely divided carbon or graphite. The powder so obtained is relatively non-coherent, and in general, cannot be worked into lamp filaments without the application of some special treatment or process for shaping the refractory powder into coherent wires. Such a process is disclosed in my application No. 316,006, filed May 9, 1906. According to that process, the refractory tungsten powder is rubbed into a warm plastic amalgam consisting of equal parts of cadmium and mercury, the tungsten being added in the proportion of 40 per cent. or more by weight. The product thus obtained may be squirted warm through a die or may be otherwise manipulated. So much of the process there described may be used in the production of filaments non-circular in cross-section, but subsequent steps may be different, as hereinafter set forth.

After obtaining ductile wires as above described, I roll them out into strips having a relatively large surface area. These flat strips may be drawn through a steel, sapphire, or diamond die of the proper size to curl them up into tubes. The edges of the strip may be overlapped to strengthen the finished filament, or I may leave a gap or slit between the opposing edges of the tube.

To remove the volatile components above mentioned, I mount suitable lengths of the strip or tube in treating bulbs and there subject them *in vacuo* or an inert atmosphere, to the heating action of current passed therethrough. The current distils or vaporizes

the cadmium and mercury of the binding material and consolidates and sinters together the particles of tungsten.

The relatively large surface of the flattened wire or tube brings a large proportion of the filament within a very short distance of either the front or back surface of the strip, so that when the strip is heated by current, volatile material can pass out without difficulty and without disturbing the arrangement of the refractory particles of the conductor.

The finished filaments may be straight or looped and are operative on higher voltages than could be used with the same material disposed in a cylindrical wire. I consider this feature of great advantage when the filaments consist of tungsten or of other refractory material having a conductivity so high that a relatively long wire would be necessary if of circular cross-section.

I have described the squirtable mixture of tungsten, cadmium and mercury as consisting of equal parts of cadmium and mercury and 40 or so per cent. of tungsten, but I conceive that this mixture may be varied through considerable limits, and that I may use a mixture containing as low as 32.5 parts by weight of cadmium to 50 parts of mercury.

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

1. A tubular filament of refractory material having a slit along one side of the filament.

2. A tubular filament of tungsten having a slit along one side of the filament.

In witness whereof, I have hereunto set my hand this 30th day of July, 1906.

WILLIAM D. COOLIDGE.

Witnesses:
BENJAMIN B. HULL,
GRACE M. HANIGAN.