UNITED STATES PATENT OFFICE.

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MANUFACTURE OF ELECTRIC FILAMENTS.

976,616. Specification of Letters Patent. Patented Nov. 22, 1910.

No Drawing. Application filed August 9, 1898. Serial No. 688,207.

To all whom it may concern:

Be it known that I, CARL AUER VON WELSBACH, a subject of the Emperor of Austria-Hungary, residing at Vienna, Austria-Hungary, have invented or discovered a certain new and useful Improvement in the Manufacture of Electric Filaments, of which the following is a specification.

The present invention relates to a thin, hair-like thread or filament of metallic osmium, of a dense or compact structure or consistency, and adapted for use as the incandescent filament in an electric lamp.

The object of the invention is to provide an osmium filament which shall have the qualities requisite for such an incandescent filament, and also to provide a method or process by which it can be readily manufactured on a commercial scale.

Heretofore, so far as I am aware, no method was known for producing osmium filaments of the kind referred to. It has long been known that osmium possessed many characteristics which were of great value for the purpose; but it is a metal of such a peculiar character, and is so difficult to obtain and treat, that attempts to utilize it in the manufacture of filaments have been attended with no success. I have succeeded in making osmium filaments and in devising several methods for producing them, in a commercial form, at a moderate cost.

I will describe one of the processes which may be followed in obtaining the article that I have produced.

I place a very thin platinum wire in a reducing atmosphere of the "water gas" class, that is to say, one in which I have water vapor together with hydrocarbon, and I then subject the wire to heat, preferably by passing an electric current therethrough. I then introduce into the chamber containing such atmosphere, fumes or vapors from a volatile osmium compound, such as osmium tetroxid. Osmium is deposited upon the wire. But there are several conditions which must be complied with in taking these steps. The osmium is (even among those of its own group of highly infusible metals) characterized by its strong chemical affinity for a number of other bodies, such as oxygen, etc. Therefore, in the reducing atmosphere, no free oxygen must be present. A hydrocarbon atmosphere would meet this particular requisite; but in turn would be subject to objections of its own, as for instance, it would readily deposit carbon upon the osmium. Hence I employ an atmosphere of a mixture of hydrocarbon and water vapor as mutual correctives, the one to prevent the formation of oxids, and the other to avoid the deposit of carbon. Furthermore, I find it also highly necessary that the osmium coating be deposited very slowly and very uniformly so that it shall be of the proper density and cross section at all points.

I deliver the osmium vapor intermittently or at intervals, preventing the saturating or surcharging of the reduction chamber, and allowing the volumes of vapor to readily disperse themselves throughout the region of the wire and permit a slow and uniform deposit. The result is the formation of a layer of uniform thickness of osmium or osmium compound which under the action of the heat is made coherent, dense and uniform. This stage of the process is carried on at a comparatively low temperature to prevent the formation of oxids, but, if too low, the osmium deposited will contain oxids of osmium, which, however, are not especially objectionable, as they are subsequently decomposed in the treatment which follows. I then place the wire carrier or fillet and its coating in an atmosphere of reducing gases such as the mixture of gases and vapors incident to the incomplete combustion of illuminating gas produced by the ignition thereof at the base of the air feed openings of a Bunsen burner, the said mixture of gases (consisting of hydrogen, carbon monoxid, carbon dioxid and hydrocarbons and which also contains water vapor) and vapors being collected from the burner tube, and I gradually increase the heat passing through the filament or wire finally carrying it up to and above the temperature at which platinum volatilizes. The osmium compounds, such as the lower oxids above referred to, are completely reduced. But the final, intensely high heat is such as to withdraw even from the alloy the greater part of the platinum which may have united with the osmium. At the high temperature, the osmium, especially when in a protecting atmosphere or *in vacuo*, has a

tendency to assume a partially fused or cinderlike condition, and it will not liquefy or volatilize even up to a temperature much higher than that at which the volatilization of platinum occurs. The effect of this high temperature is, furthermore, to drive out from the filament all or substantially all of the gases which would otherwise be occluded therein.

As above stated, the layer must be dense and uniform, and these characteristics can be attained to the extent desired by slowly and uniformly depositing the osmium in the way described by intermittently bringing charges of the osmium vapor into the region of the wire, the deposit or layer thus being under control.

The diameter of the filament is to be governed by the conditions presented in each case, but the end aimed at is to ultimately obtain a self-sustaining filament as thin as possible to have proper resistance to the current, and yet thick enough to endure the necessary current and to withstand the unavoidable shocks and jars to which the lamp is subjected when in use; but the quantity of osmium deposited upon the platinum wire should exceed the quantity of the platinum as otherwise the filament will be destroyed by the melting of the platinum. Not only can these successive coatings or laminæ of osmium thus be produced, but also by a modified method, to wit, by dipping the carrier or fillet in a suitable solution of an osmium compound and heating the fillet and its coating after each dipping to the proper point, and finally subjecting it to higher and higher temperature successively in the manner above described.

From the article resulting from this treatment, the carrier or fillet being removed by the action of the electric current, there will remain a self-supporting, hollow, thread-like or hair-like filament of osmium of the proper electrical resistance and with the required mechanical sustaining power. In either case the coating becomes transformed into a unitary coherent, compact structure of such nature that there is no disintegration due to differences of expansion and contraction or from other causes.

Instead of a platinum wire core there may be used other metals or alloys which are ductile enough to be formed into wire, which can withstand the temperature at which the oxids of osmium are deoxidized in reducing gases into metallic osmium.

The completed filament is to be mounted in a lamp bulb *in vacuo* or portective gas and is connected to the leading-in wires through the medium of an osmium cement as set forth in an application of even date herewith.

What I claim is:—

1. A flexible, elastic, incandescent filament for an electric lamp, formed of metallic osmium arranged in a plurality of superimposed minute layers or laminæ all rendered compact and coherent, substantially as set forth.

2. A flexible, elastic, incandescent filament for an electric lamp, formed of metallic osmium arranged in several superimposed self-supporting layers or laminæ formed into a unitary, compact structure, substantially as set forth.

3. A flexible, elastic, incandescent filament for an electric lamp, consisting of a hollow or tube-like thread of metallic osmium formed of osmium particles arranged in a plurality of superimposed minute layers or laminæ rendered coherent and compact, substantially as set forth.

4. A flexible, elastic, incandescent filament for an electric lamp, formed of metal infusible at the temperature at which platinum volatilizes and arranged in a plurality of superimposed minute layers or laminæ all rendered compact and coherent, substantially as set forth.

5. The herein described process of forming an incandescent filament for an electric lamp, consisting in depositing upon a carrier or fillet wire of metal infusible at ordinary temperatures and fusible only at high temperatures, a coating of metallic osmium, and heating the said coating to form a coherent, condensed structure by the action of the electric current until it is brought to the temperature of volatilization of the carrier or fillet metal, substantially as set forth.

6. The herein described process of making an incandescent filament for an electric lamp, consisting in depositing upon a carrier or fillet wire of metal infusible at ordinary temperatures and fusible only at high temperatures, a coating of osmium, then subjecting the osmium to the high heat of the electric current for the purpose of assuring the reduction to the metallic state of all of the osmium present, and raising the heat generated by the current to the temperature of volatilization of the carrier or fillet, thus finally leaving the filament in a dense coherent form substantially as set forth.

7. The herein described process of making an incandescent filament for an electric lamp, consisting in depositing upon a carrier or fillet wire of metal infusible at ordinary temperatures, a coating of osmium, then subjecting the carrier and the layer of osmium to the heat and action of an electric current in a reducing atmosphere, and subsequently raising the heat generated by the current to the temperature of volatilization of the fillet metal and thus finally leaving the filament

in a dense coherent form substantially as set forth.

8. The herein described process of forming an incandescent filament for an electric lamp, consisting in depositing intermittently upon a fillet a series of layers of a metal infusible at the temperature at which platinum volatilizes, and uniting the several layers into a compact and coherent, flexible, elastic filament by raising it above said temperature, substantially as set forth.

Signed this 27th day of July, 1898.

CARL AUER VON WELSBACH.

Witnesses:

LUDWIG HAITINGE,

ADOLF GALLIA.