UNITED STATES PATENT OFFICE.

ALEXANDRE DE LODYGUINE, OF PARIS, FRANCE, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, OF PITTSBURG, PENNSYLVANIA.

PROCESS OF MANUFACTURING FILAMENTS FOR INCANDESCENT LAMPS.

SPECIFICATION forming part of Letters Patent No. 494,150, dated March 28, 1893.

Application filed September 14, 1888. Serial No. 285,434. (No specimens.)

To all whom it may concern:

Be it known that I, ALEXANDRE DE LODYGUINE, a citizen of Russia, residing at Paris, France, have invented a certain new and useful Improvement in the Manufacture of Incandescents for Electric Lamps, (Case No. 222,) of which the following is a specification.

The invention relates particularly to a process of manufacturing the incandescents or filaments of incandescent electric lamps. I make use of any suitable organic substance, such as silk, bamboo, paper, thread, piassava, or other organic material capable of receiving the treatment hereinafter mentioned. The organic material used is reduced to the required shape and size in any of the usual ways employed in making blanks from which such incandescents are generally formed. These blanks, having the required dimensions, are treated in the following manner. They are first carbonized in any usual, well known manner, and then the occluded gases are driven off from the carbonized filament. This is accomplished conveniently by placing the filament in a closed chamber and exhausting the air therefrom. The filament is then connected in an electric circuit in any convenient manner, and a current of sufficient strength is sent through the filament to drive off the occluded gases contained therein. The vacuum pump employed for exhausting the air from the chamber may be kept in operation during this step of the process, if desired. After the filament has been thoroughly freed from the occluded gases, a current is passed through it of sufficient strength to change the molecular structure into the form of coke. This step is carried on *in vacuo*, and in practice it is found that it can be conveniently accomplished in about eight seconds. The strength of the current used is as great as the filament will practically bear without breaking. It is found that by thus coking the filament its resistance changes, being gradually reduced until its cold or permanent resistance has become approximately the same as the hot resistance of the filament before it was coked. The coking may be stopped at this point or before it has been reached, if desired, and for certain purposes it is found advantageous to arrest the operation at an intermediate point. When the resistance, has reached its lowest point it is found that it tends to rise again if this step of the treatment is continued.

For convenience of description I have spoken of the operation of freeing the filament from occluded gases and the coking of the filament as separate steps, but the two steps are in practice accomplished by the one operation, the occluded gases being driven off during the first stage of the coking operation. After the filament has been coked, the resistance is rendered uniform by the deposition of carbon. This is accomplished by placing the filament in a closed vessel charged with hydrocarbon or other carbonaceous gas, and passing a current of electricity through it sufficient to heat it to such a temperature that the gas will be decomposed and carbon deposited upon the coked core. This step of the process may be carried on in the same chamber as the freeing from occluded gases and coking, the hydrocarbon gas being admitted to the chamber after the coking process has terminated. After the deposition of carbon has been completed the filament is removed from the chamber and placed in the bulb and the lamp finished and made ready for use in the usual way.

In the manufacture of incandescents from organic substances as heretofore practiced, it has been customary to carbonize the substance in a closed chamber by the external application of heat, and to then render the resistance uniform by the deposition of carbon by passing an electric current through the incandescent in the presence of a carbonaceous liquid or gas, and finally to drive off the occluded gases by the passage of an electric current through the incandescent after it has been placed in the bulb and the air is being exhausted therefrom. Such incandescents are found to deteriorate when put in use, such deterioration being evidenced by the gradual diminishing of the candle-power, and the short life of the filament. This reduction of candle-power is due in part to a molecular change which takes place in the filament. It is difficult to determine exactly

what change occurs in the structure of the filament, and whether or not it gradually becomes coked by the current employed in actual use; but it is found that its resistance becomes greater after long continued use, and therefore less current passes through it and the efficiency is diminished. The more or less amorphous condition of the filament renders it subject to more rapid disintegration and destruction, as its particles are more rapidly detached. By changing the filament into a hard carbon or coke, in which form the resistance has been reduced to approximately its lowest point, the molecules become more fixed and permanent and less change in structure and resistance takes place during the use of the lamp. The increased durability of the filament thus obtained may be availed of either by giving it a greater length of life without increasing the efficiency, or by increasing the efficiency without increasing the life, or both the efficiency and the life may be increased.

In another application of even date herewith (Case No. 221), I have claimed the driving off of the occluded gases before building up the carbon by deposition. This can be done without coking the filament, and hence this case is distinguished from such other application by claiming the coking operation both *per se* and in combination.

An incidental result of the coking operation is that the occluded gases are driven off thereby. If the filament thus made is subsequently covered by a deposit of carbon as described, the previous driving off of the occluded gases is an advantage, because the hard shell of deposited carbon has a tendency to prevent the escape of occluded gases. Moreover the coking of the filament renders the core more homogeneous with the hard deposited shell, and the change in the density and hardness of the carbon renders the filament less liable to occlude gases in subsequent manipulations in the manufacture of the lamp.

While in the first claim of this application I claim the coking as a step in a complete process, I do not limit myself to its use in such process, but in the other claims I claim it broadly without reference to any particular order of steps or any particular process of making incandescents.

In another application of even date herewith (Case No. 223) I have claimed as an article of manufacture an incandescent of the character here described.

I claim as my invention—

1. The method of making incandescents for incandescent electric lamps, which consists: first, in carbonizing a filament of organic material; second, in driving off the occluded gases contained in the carbonized filament and coking the same by passing therethrough an electric current *in vacuo* whereby the resistance of the filament is reduced to approximately that of the hot resistance of the original carbonized filament; and lastly, rendering the resistance of the filament uniform by the deposition of carbon thereon; substantially as described.

2. A step in the manufacture of incandescents for incandescent electric lamps, which consists in heating a carbonized organic filament by a current of electricity *in vacuo* until the filament is changed into a hard carbon and its permanent or cold resistance is reduced to approximately the hot resistance of the original carbonized filament.

3. The method of treating carbonized filaments for incandescent electric lamps, which consists in heating the same *in vacuo*, by the passage of an electric current, to a temperature at which its permanent resistance gradually decreases and in interrupting the current when the resistance has reached approximately a minimum.

In testimony whereof I have hereunto subscribed my name this 9th day of August, A. D. 1888.

ALEXANDRE DE LODYGUINE.

Witnesses:

W. D. UPTEGRAFF,

CHARLES A. TERRY.