

UNITED STATES PATENT OFFICE.

THEODORE MACE, OF NEW YORK, N. Y.

MANUFACTURE OF INCANDESCENT ELECTRIC LIGHTS.

SPECIFICATION forming part of Letters Patent No. 378,258, dated February 21, 1888.

Application filed February 15, 1887. Serial No. 227,715. (No specimens.) Patented in England July 27, 1886, No. 9,694.

To all whom it may concern:

Be it known that I, THEODORE MACE, merchant, a citizen of the United States of America, and residing at 14 Dey street, New York, in the said United States, but at present residing at the First Avenue Hotel, in the county of Middlesex, England, have invented certain new and useful Improvements in the Manufacture of the Incandescing Portion or Luminant of Incandescent Electric Lamps, (for which I have applied for a patent in Great Britain on the 27th of July, 1886, No. 9,694,) of which the following is a specification.

This invention relates to the manufacture of a material for use as the incandescing medium or luminant of incandescent electric lamps.

The inventor has discovered that with a certain proportion or mixture of carbon and alumina an incandescent is produced having new and remarkable properties.

It has hitherto been attempted to incorporate metallic oxide with carbon filaments so as to produce a homogeneous structure by saturating a suitable carbonizable thread with a salt of aluminium and then precipitating by saturating with ammonia or other suitable chemical solution. I have found that such a process is not practicable commercially on account of the difficulty of obtaining a uniform result, which may be said to be due to several causes. The texture of the thread varies. The action of the precipitating solution varies also, and a mechanical washing takes place which carries away the precipitate almost as readily as it is formed; and this last fact becomes emphasized by the subsequent washing rendered necessary to remove the soluble salts formed in the reaction. My invention, on the contrary, effects the incorporation of the oxide with absolute uniformity and in any desired proportion. The product is commercially uniform and very readily obtained without the necessity for washing out soluble salts.

Briefly, my invention consists in the various steps and in the complete process, as herein-after more fully described and claimed.

I take a filamentous carbonizable material—such as an ordinary cotton thread, which is always more or less porous and capable of absorbing liquids. As the absorbent quality of any given thread will vary throughout its

length, (owing to many causes incident to its manufacture,) I first submit the thread to a bath of boiling water or steam, and in a suitable length of time it will be found that a large amount of sedimentary matter has been removed from the thread. The result is that the thread so treated has a perfectly uniform absorbent power. I then take such thread, either after drying or just in the last stages of drying, and submit it to a bath of an oxygen-bearing compound of aluminium—such as the ethylate, or methylate, or acetate, or the sulphate or other compound capable of being decomposed, and forming the oxide of aluminium by the simple application of heat. This bath may be applied one or more times according to the particular salt or compound used and according to the percentage of oxide desired to finally become a part of the incandescent, and where several applications of the bath are found desirable it is best, though not essential, to dry the thread after each bath. The body or thread may be still further treated directly with and enveloped in alumina, which can be formed into a pasty condition by admixture with a small quantity of starch, dextrine, or other binding agents, and may then with good effect be drawn through one or more draw-plates, or between smoothing-rolls, for the purpose of rendering the diameter and cross section uniform throughout and for laying down any irregularities on the surface. The product when now dried is smooth and polished and perfectly pliable, and can be handled in any manner without losing the oxide with which it has been impregnated, and it may then be conveniently wound upon forms preparatory to the decomposition by heat, which will set it permanently in whatever shape it may occupy at the time of the application of such heat.

The next step in my process is the decomposition of the aluminium salt or compound, resulting in thorough impregnation of the thread with oxide of aluminium or alumina. For this purpose I take the thread, (which I have preferred to wind on blocks of hard carbon,) and after placing it in a crucible or muffle submit it to a high temperature, preferably for a period of several hours. This baking at high temperature effects two results: first, carbonizing the thread itself, and,

second, decomposing the salt or compound which has been impregnated; but a further result is obtained by the decomposition of the salt contemporaneously with the carbonization, namely, that the latter effects a mechanical shrinkage of the particles and a resulting consolidation of the mass. The body is now allowed to cool, and is then removed for subsequent treatment. At this stage, if a piece of the treated thread be held in an oxidizing flame, the carbon will be gradually but with great difficulty consumed, while the oxide of aluminium remains in the form of a thread, showing the perfect uniformity with which impregnation, decomposition, and consolidation have taken place. The next step in the process is to effect two objects: first, to produce a more thorough bond between the carbon particles and the oxide of aluminium, and to assist in rendering uniform the electrical resistance of the product and to regulate the same. I effect this by dipping the product into a liquid of an organo-metallic nature, capable of contributing oxide of aluminium upon decomposition, which is effected by passing the electric current through the body after such dipping and removal from the liquid. A suitable liquid for this purpose is the ethylate or methylate of aluminium. The dipping absorbs a part of such liquid, and the body is then removed from the liquid and submitted to the action of any suitable exhausting apparatus or vacuum-pump, which dries it and practically removes the free oxygen, which might tend to produce combustion in the next step. The apparatus required is very simple, being merely a saucer or other vessel containing the liquid for dipping or soaking, and any of the well-known forms of "treating-flasks," which can be connected to a vacuum-pump, and is provided with means of holding the incandescent and supplying it with current. After removing from the dipping-bath, the incandescent is placed in the treating-flask, and the latter is partially exhausted, thus drying out the incandescent. Then current is sent through the incandescent. The vacuum completes the drying of the liquid soaked up by the incandescent in the dipping-bath, and the current, at about red heat, decomposes the residue from the dipping operation and leaves the oxide. The current is now increased until the particles of oxide are fused and cause them to coat the particles of carbon after the manner of a glaze, and thereby produce a perfect bond throughout the mass. The result is an incandescent or luminant for electric lamps which possesses some very remarkable properties. It is exceedingly strong, highly elastic, and is not subject to the so-called "bombardment" when in use in an exhausted globe, for the reason that the carbon particles are imprisoned by the alumina and cannot become detached; hence the globe does not (even after long-continued use) show the well-known deposit of carbon unless it has

been overdriven, so as to reach or exceed the temperature heretofore mentioned, after which a fusion of the alumina takes place, and thereby frees the carbon to a greater or less extent. The character of the light produced is remarkably different from that produced by an ordinary carbon filament, being perfectly white, and exhibiting the characteristic which is so marked in the incandescence of alumina. The specific resistance is much higher than that of carbon alone, and therefore the electrical efficiency is higher. A further and very marked characteristic is in the fact that while a general rule is recognized by electricians concerning carbon filaments—namely, that their resistance at red heat is about one-half their resistance when cool—an incandescent, after my process, falls in resistance very much less than fifty per cent. In fact, I have produced incandescents whose resistance at red heat was seventy-five per cent. of the resistance cold. This is a result entirely new, and makes a decided departure in the character of behavior under current.

As above stated, the percentage of alumina present in the completed incandescent may be varied at will according to the number of baths given it and according to the number of times it is dipped in the solution preparatory to sending a current through it. I have, however, determined that the very peculiar characteristics as to specific resistance and percentage of reduction at red heat are not discernible unless the proportion of alumina is at least five per cent. of the whole, and that the specific resistance increases in very nearly exact proportion with the relative amount of alumina present, while the percentage of reduction of resistance between cold measurement and red heat is about in inverse proportion to the percentage of alumina present.

What I claim as my invention is as follows:

1. The process of preparing thread for the manufacture of incandescents, consisting in saturating a carbonizable thread with an oxygen-bearing compound of aluminium capable of being decomposed by the application of heat and yielding thereby alumina, and then applying heat and by it alone decomposing said compound and leaving alumina, substantially as described.

2. The process of making an aluminous carbon incandescent, consisting in first saturating a carbonizable thread with an oxygen-bearing compound of aluminium and then heating and thereby carbonizing the thread and at the same time reducing said compound to alumina, substantially as set forth.

3. In the manufacture of incandescents by the impregnation of a carbonizable thread with alumina, the method of effecting thorough incorporation of the materials by first submitting the thread to a bath of hot water or steam and then to a bath of an aluminium compound capable of forming the oxide by the application of heat, substantially as de-

scribed, whereby the impurities of the thread are expelled and its pores opened for the absorption of the salt.

- 5 4. In the manufacture of incandescents, the method of finishing consisting in dipping the carbonized incandescent into a liquid containing alumina, then drying the same, and finally consolidating the structure by heating with an electric current, substantially as described.
- 10 5. In the manufacture of carbonaceous incandescents containing alumina, the method of regulating the resistance and compacting the bond between the alumina and the carbon, consisting in dipping the incandescents into a liquid containing alumina in solution and combination, drying the same, and then, by means of the electric current, heating the incandescent to a temperature beyond that at which it is to be used, substantially as described.
- 15 6. In the manufacture of carbonaceous incandescents containing alumina, the method of regulating the resistance and compacting the bond between the alumina and the carbon, consisting in dipping the incandescent into a liquid containing alumina in solution or com-
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bination, drying the same, and then, by means of the electric current and with the exclusion of free oxygen, heating the incandescent to a temperature beyond that at which it is to be used, substantially as described.

30 7. In the manufacture of carbonaceous incandescents containing alumina, the method of regulating the resistance and compacting the bond between the alumina and the carbon, consisting in dipping the incandescent into a liquid containing alumina in solution or combination, drying the same, and then, by means of the electric current and with the exclusion of free oxygen and in partial vacuum, heating the incandescent to a temperature beyond that at which it is to be used, substantially as described.

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In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THEODORE MACE.

Witnesses:

CHAS. JAS. JONES,

EDWD. GEO. DAVIES,

Both of 47 Lincoln's Inn Fields, London.