(No Model.)

A. DE LODYGUINE.

ILLUMINANT FOR INCANDESCENT LAMPS.

No. 575,002. Patented Jan. 12, 1897.

Fig. 1.

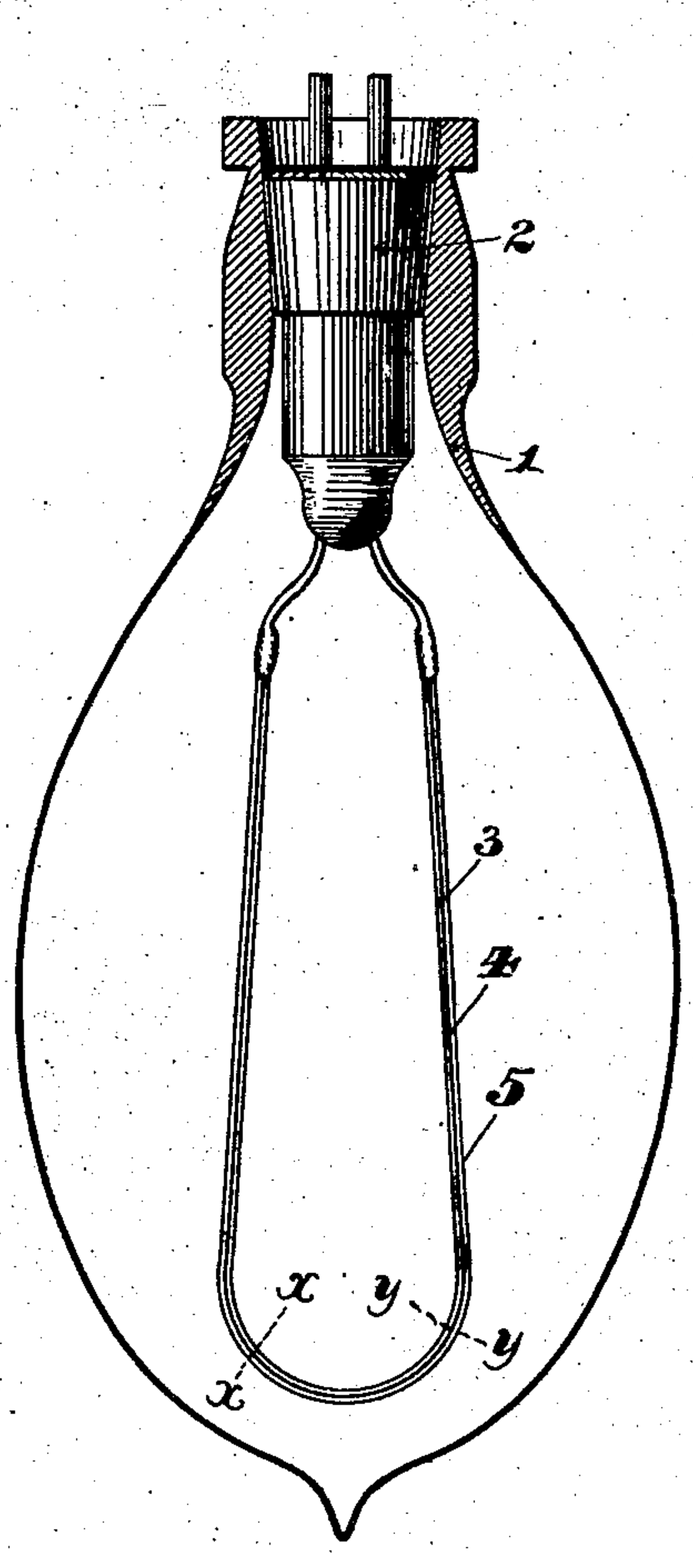
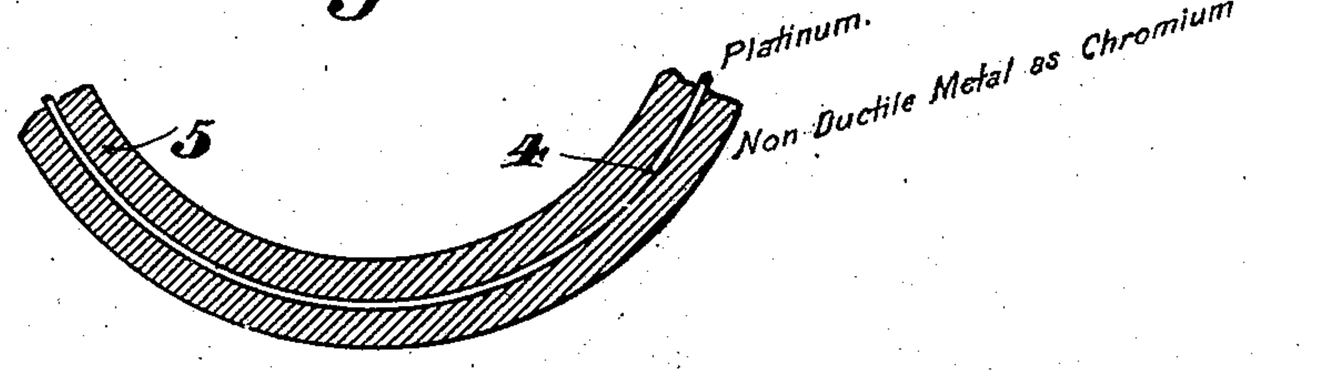


Fig. 2.



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ALEXANDER DE LODYGUINE, OF PITTSBURG, PENNSYLVANIA.

ILLUMINANT FOR INCANDESCENT LAMPS.

SPECIFICATION forming part of Letters Patent No. 575,002, dated January 12, 1897.

Application filed January 4, 1893. Serial No. 457,227. (No specimens.)

To all whom it may concern:

Be it known that I, ALEXANDER DE LODYGUINE, a citizen of Russia, residing in the city of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Illuminants for Incandescent Lamps and Methods of Making the Same, (Case No. 535,) of which the following is a specification.

My invention relates to the construction of incandescent conductors or burners for incandescent electric lamps. In the commercial lamps now in use filaments of carbon are invariably employed as the illuminant. In the early experiments with incandescent lamps it was attempted to employ metals having high fusing-points. Platinum in particular was experimented with, but it was found that for various reasons a commercial lamp could not be made with any metal filament produced by any of the processes then known.

In practice it is necessary that the illuminant should be capable of enduring a very high temperature, especially because the energy consumed per candle-power decreases very rapidly with increase of temperature. It was found that platinum fused at a temperature lower than that which is required to produce a commercially-efficient lamp. Metal possesses inherent qualities which render it more desirable material for forming an illuminant than carbon. Thus the loss of heat by radiation at a given temperature is found to vary considerably with the character of the surface. A carbon filament loses a large amount of heat by radiation, and this detracts materially from the amount of light emitted. A metallic illuminant affords a surface of a much brighter and better character for light radiation and a less opportunity for heat radiation than is usually obtainable from a carbon filament. For this reason a metallic illuminant has advantages over a carbon filament.

I have discovered that the following metals possess all the essential qualities for forming a practical, commercially-efficient metallic illuminant for incandescent electric lamps, namely, molybdenum and tungsten, rhodium and iridium, ruthenium and osmium, and chromium, and I have also discovered means whereby they may be formed into an attenuated thread-like wire in an economical and successful manner. All these metals are infusible at such temperatures as are necessary to render them brilliantly incandescent, and are very efficient as light-producing mediums. They are, however, almost absolutely non-ductile, and are extremely hard and brittle. They therefore cannot be drawn out into wires in the manner employed in operating upon ductile metals. While there are other metals known to science having fusing points sufficiently high for use in this art, and processes are known whereby they may be separated from their compounds, yet those above enumerated are found particularly desirable for the purposes of my invention, although such other metals, when prepared in the manner herein described by me, will fall within the scope of this patent.

My method of illuminant-manufacturing, expressed in general terms, is as follows:

I first form an exceedingly fine wire or thread-like base out of any desired conducting material, but preferably out of platinum. This wire should have in ordinary cases a diameter not greater than one-thousandth of an inch and usually less than this. Such wires are made from platinum, gold, and silver without great difficulty. They may also be made from other metals and even from carbon. The diameter of this base is preferably insignificant as compared to that of the completed illuminant, although in some cases it may be desirable to employ a base of appreciable size. In this specification I shall use the term "fillet" to express the idea of an inner base or temporary support forming no part of the illuminant itself and preferably bearing an insignificant dimensional relation to said illuminant. Upon this fillet then I deposit the illuminant proper, which contains the fillet as an accident of manufacture and not as a portion of itself. As understood by me and as the term is used in this specification the illuminant is of annular cross-section and is of a single homogeneous metallic structure as opposed to a composite structure. In other words, the fillet is not a portion of the illuminant, is not necessary to its permanence, and may, indeed, be removed without detriment to the illuminant or incandescent and light-giving body.

I have illustrated my illuminant and the relation of the fillet thereto in the accompanying drawings, wherein—

Figure 1 is a longitudinal central section of a preferred form of lamp provided with my illuminant, shown therein in section; and Fig. 2 is a sectional view, on a larger scale, of my illuminant and fillet broken off at *xx* and *yy*.

The lamp 1, preferably provided with a stopper 2, contains a thread 3, composed of a light-giving body or illuminant 5, containing, as I usually make it, a fillet 4. As before stated, this fillet may be removed without detriment to the illuminant itself. The relation of the fillet and illuminant as usually made is best shown in Fig. 2.

The fillet 4 is formed, preferably, of platinum, as this is most easily worked into wire; but any conducting substance may be employed which is capable of bearing the temperature needed for the decomposing process as usually practiced by me, although where the galvano-plastic process is employed this refractory character is not necessarily present.

The first step in my method of manufacture is to give to my conducting-fillet the form to be imparted to the illuminant. The next step is to deposit upon the surface of this previously-formed fillet the body which is to serve as an incandescent or illuminant. Numerous processes may be followed in pursuing this method of manufacture, and I desire it to be understood that in pointing out one process or class of processes I do not desire to limit myself to anything less than the broad method of forming metallic illuminants as set out in my method-claims following this description.

As before stated, the metals which I have used in preference to others thus far may be divided into four groups with relation to the various processes applicable to each in carrying out my method of manufacture.

The first group given by me above is molybdenum and tungsten or wolfram. There exist a number of processes whereby the method of deposition of a filament made of one of these materials upon a conducting-fillet may be carried out. The two principal ones whereby I have been successful with metals of this group are as follows: If a chlorid or chlorate of a member of this group be volatilized by heating and the resulting vapor mingled with hydrogen, the mixed gases will deposit metallic molybdenum or tungsten, as the case may be, upon the fillet when the same is heated in the mixture by the electric current or otherwise. Again, if the chlorid of these metals be fused and employed as an electrolyte, the fillet being immersed in the same as one of the poles, the metal will be galvanically deposited thereon.

The second group, rhodium and iridium, admits of the following treatment: If solutions of oxids, oxysalts, or haloid salts of this group are treated as electrolytes and the fillet is placed at one of the poles, less soluble oxids or salts may be deposited upon the fillet, and in some cases even the metal itself will be deposited. When oxids or salts are deposited, however, they may be reduced to metal in some cases by simply heating away from air, and in others by the action of hydrogen upon the heated oxid. This heating is preferably accomplished by means of the electric current.

The third group, ruthenium and osmium, admits of the following treatment: When acids having this group as a radical are heated, they form a vapor. Upon mixing hydrogen with this vapor and heating the fillet, preferably by electricity, in the resulting mixture the metal is deposited upon the fillet, thus producing the desired filament. Again, these acids in a fused condition are found to deposit metal upon a fillet placed at one of the poles, and deposition may also be accomplished from solutions of the same acids.

The above processes have been set forth thus briefly in order to give some idea of the number of processes whereby my method may be carried out; but it is the treatment of the fourth group, which I propose to describe more at length, to which my more specific claims will be directed. In this group there is only one metal which I have practically employed hitherto for making incandescent illuminants, and that is chromium. In depositing this metal upon the fillet I may make a solution of a salt thereof and deposit chromium oxid upon the fillet therefrom galvanically; but I have hitherto found the following methods more certain and economical: The oxychlorid of chromium $CrCl_6$, $2CrO_3$ or CrO_2Cl_2 is a dark-red liquid fuming strongly at ordinary temperatures. If the conducting-fillet while surrounded by the fumes of this compound be heated by a current, decomposition of the oxychlorid will result and the following reaction will take place: $2CrO_2Cl_2 = Cr_2O_3 + 2Cl_2 + O$. As this decomposition takes place only in immediate proximity to the fillet the chromium oxid thus produced is deposited upon the fillet in an even layer. This layer is black and is made up of extremely minute crystals.

As above stated, molybdenum, tungsten, ruthenium, and osmium may be deposited in metallic form from vapors of their compounds mingled with hydrogen; but with the oxychlorid of chromium this process should not be followed, as the mixture of oxychlorid and hydrogen explodes on mere contact. In order, therefore, to obtain a layer of metallic chromium, the fillet, covered with a chromic oxid resulting from the above-described treatment, is heated in an atmosphere of hydrogen. It is highly desirable that this hydrogen should be chemically pure and as dry as possible. The usual chemical means for securing these conditions may be employed. I prefer, in practice, to heat my fillet by means of the electric current. Upon thus treating with hy-

drogen the following reduction takes place: $2Cr_2O_3+6H=4Cr+3H_2O$. The water is carried off with the hydrogen, which I prefer to use as a stream, and the metallic chromium is left upon the fillet. By repeated incasings and reductions an illuminant of proper cross-section is built up. Of course I might leave the fillet in the oxychlorid long enough to build up an oxid illuminant of sufficient cross-section at one operation, and then reduce the whole at once; but in this case, as the oxid is a non-conductor, the fillet would be the only source of heat, and a much thicker illuminant would take a very long time to reduce. The thickness of the oxid illuminant would be a great objection where the heating was carried on by means other than by the electric current.

Another method whereby chromium may be deposited upon the fillet is as follows: I first dip the fillet into the liquid oxychlorid. After thus dipping the fillet I subject the same while heated, preferably by the electric current, to the action of moist air or of steam. The reaction then taking place is as follows: $CrO_2Cl_2+H_2O=2HCl+CrO_3$. The resulting hydrochloric acid is carried off and the chromic acid is left on the fillet. The same coating of chromic acid may be obtained by passing a mixture of moist air and the fumes of oxychlorid of chromium over the heated fillet. Upon subjecting the fillet thus incased with CrO_3 to the action of pure hydrogen the following double reaction takes place: $2CrO_3+6H=3H_2O+Cr_2O_3$. The Cr_2O_3 remains on the fillet and is of a green color, having the same composition as the black oxid above described, but being an allotropic form of the same. The second half of the reaction is as follows: $2Cr_2O_3+6H=4Cr+3H_2O$. These two reactions take place together and in theory successively. The whole operation of dipping and reduction should of course be repeated as often as is necessary to produce the desired cross-section of illuminant. The layer of oxid may also be obtained, if desired, by dipping the fillet into a solution of Cr_2O_3 and drying the same.

I fully appreciate the fact that other processes than those above mentioned and detailed may be employed in carrying out my method of making metallic illuminants, and I do not limit myself to any one or all of those enumerated herein. I look upon it as a novel method of making metallic illuminants to build them up around a fillet having no permanent function, but merely serving as a support during manufacture, much as a mold supports a casting.

I claim as my invention—

1. An incandescing illuminant for electric lamps composed of an incandescing metallic body and containing a conducting-fillet of different material, substantially as described.

2. An illuminant for electric lamps composed of an incandescing body of practically non-ductile metal and containing a fillet of different material.

3. An illuminant for electric lamps composed of an incandescing body of practically non-ductile metal and containing a fillet of ductile metal.

4. An illuminant for electric lamps composed of an incandescing body of practically non-ductile and infusible metal and containing a fillet of platinum.

5. An illuminant for electric lamps composed of an incandescing body of chromium and containing a fillet of conducting material.

6. An illuminant for electric lamps composed of an incandescing body of chromium and containing a fillet of platinum.

7. The method of making illuminants for electric-lamps which consists in imparting to a conducting-fillet the shape desired, depositing thereon a metallic oxid and subjecting the same to the action of hydrogen gas, substantially as described.

8. The process of making illuminants for electric lamps which consists in imparting the shape desired to a conducting-fillet, passing a heating-current through the fillet and subjecting the heated fillet to the action of a metallic oxid and of hydrogen gas.

9. A process of making illuminants for electric lamps which consists in imparting the desired shape to a conducting-fillet, passing a heating-current through the fillet in an atmosphere of vaporized chromium oxid and subsequently heating the resulting illuminant in an atmosphere of hydrogen.

10. The method of making illuminants for electric lamps which consists in imparting the shape desired to a conducting-fillet, passing a heating-current through the fillet in an atmosphere of chlorochromic acid and subsequently heating the resulting illuminant in an atmosphere of hydrogen.

11. The method of making illuminants for electric lamps which consists in bending a platinum fillet to the shape desired, passing a heating-current through said fillet in an atmosphere of chlorochromic acid and then passing a heating-current through the resulting illuminant in an atmosphere of hydrogen.

12. The method of making illuminants for electric lamps which consists in imparting the shape desired to a conducting-fillet, dipping said fillet into liquid chlorochromic acid, and subjecting the dipped fillet to the action of heat, moist air and hydrogen.

In testimony whereof I have hereunto subscribed my name this 19th day of December, A. D. 1892.

A. DE LODYGUINE.

Witnesses:

JAMES WM. SMITH,

HAROLD S. MACKAYE.