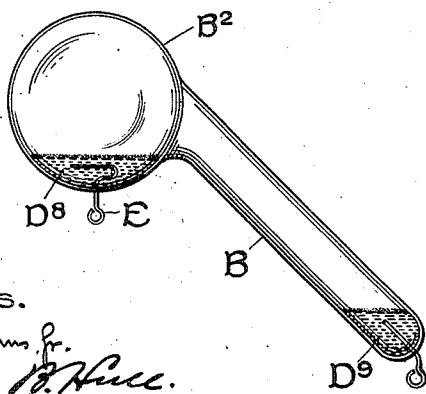


C. P. STEINMETZ.
ELECTRIC LIGHTING.
APPLICATION FILED APR. 30, 1900.

1,006,021.

Patented Oct. 17, 1911.



Witnesses.

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UNITED STATES PATENT OFFICE.

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ELECTRIC LIGHTING.

1,006,021.

Specification of Letters Patent.

Patented Oct. 17, 1911.

Application filed April 30, 1900. Serial No. 14,790.

To all whom it may concern:

Be it known that I, CHARLES P. STEINMETZ, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Lighting, of which the following is a specification.

I have discovered that the light from an electric arc, excluding that portion of the light which comes directly from the crater, is to a very large extent independent of the temperature at which the arc may exist, but depends rather on the nature of the substances constituting the arc stream. This being the case, it is advantageous to cause the arc to spring from a terminal, or between terminals, capable of giving forth vapor at comparatively low temperatures, since the temperature of the arc stream is fixed, as is the temperature of any other saturated vapor, by the boiling point of the substance vaporized. These considerations point to the advisability of replacing the carbon arc of commerce by an arc from terminals one at least of which is formed of mercury or similar substance having the property of a low vaporization temperature and producing a conducting vapor. Unfortunately however mercury is not at all suited to the commercial production of light, for the reason that its spectrum is almost entirely lacking in the yellow, orange and red lines, so that in the light from a mercury arc red substances appear black, and very few substances have their correct color values. In a former application for Letters Patent of the United States, Serial Number 7265, I have set forth and claimed a method of overcoming this very serious defect, and without attempting herein to define the scope of the said application, or to set forth in detail the disclosure made therein, it may be sufficient here to state that the said application contemplated the addition to the arc of conducting vapors of such a nature as to reinforce the spectrum. I find that non-conducting vapors have no effect in the mercury arc, from which I am led to believe that the action is in the nature of a sympathetic vibration of conducting vapors under the electrical and physical conditions existent in the arc stream. Any substances added to the stream, if capable of producing conducting vapors, give light corresponding

to the arc spectra of such substances, but carbon on the one hand and gases on the other hand, if added to the arc stream, apparently have no effect whatever, which is probably due to the extremely low temperature at which the mercury arc is maintained. I have also shown in the application above set forth, that it is, commercially speaking, essential to surround the arc by inclosing chamber or envelop, for the reason that the mercury arc is somewhat unstable, and also because of the extremely poisonous vapors which it produces. I have further shown that the color-modifying substances which fulfil the necessary conditions, as for example, potassium, sodium, lithium, rhubidium, indium and thallium, vigorously attack the transparent envelop, which, for example, may be constituted of the best hard glass, and form on the inside thereof a black deposit which destroys the usefulness of the lamp in a very short time, so that the lamp can scarcely be said to be operative if the color-modifying substances are introduced in the simple manner thus far described. In my said former application I have set forth at considerable length a method of overcoming this difficulty, which consists in causing the color-modifying substances to exist in the arc in an ionized state, which may be brought about, as described in said application, by introducing them, not in their natural condition, but rather as anhydrous iodids, or other halogen salts, with or without a neutral or diluent substance for the purpose of reducing the effect of the color-modifying substances upon the arc. In a certain other application for Letters Patent, April 21, 1900 13,718 I have shown that these same beneficial results may be attained by allowing the color-modifying substances to react upon the inner walls of the envelop, but by so managing this chemical action that the resulting products shall always be transparent or translucent. This may be effected by introducing the color-modifying substances to the mercury arc or other low-temperature arc in the form of silica salts, preferably as meta-silicates, as for example the meta-silicate of lithium, SiO_3Li_2 . Such substances have, it is true, some chemical action upon the glass, but the continual combination and recombination which takes place is such as to preserve the translucency of the envelop, for the reason that the salts

formed by such action are translucent in their nature, and the inner surface of the envelop is not blackened, but merely given an agreeable frosted appearance.

5 My present application sets forth and claims certain improvements upon the methods and apparatus described in the above-mentioned applications.

One feature of my present invention is
10 the reduction of the potential necessary to start the arc by the use of a rarefied atmosphere of hydrogen or other material of lower dielectric strength than air, as for example helium or argon, by which I am able
15 to very greatly reduce the initial voltage necessary for the starting of the lamp. Further, I find that the action of the halogen salts above mentioned is ultimately adversely affected by the use of an open tube,
20 or of any tube such that air or moisture can have access to the salts, for two reasons, first that they are more or less oxidizable, and second that they are extremely hygroscopic, and after they have absorbed moisture
25 from the atmosphere tend to boil when the arc strikes them and to be deposited on the inner surface of the tube, or to be collected in lumps of considerable size comparatively speaking, whereas they should,
30 for best results, be uniformly distributed over the terminal in order that the arc may at all times run through a layer of color-modifying substance. The silicates above
35 discussed do not share this disadvantage, but they are all open to the objection that their action takes place at a temperature slightly higher than that of the action of the iodids. Further, I find that the iodids
40 actually tend to emphasize and bring out the color of the modifying substances, imparting a warmer tinge to the light from the lamp. Therefore in lamps constructed in accordance with my present invention, I
45 wholly inclose the mercury or other light-giving substance in a hermetically-sealed glass vessel filled, say, with hydrogen, and exhausted to a fairly high vacuum, measured for example by one millimeter of mercury on the ordinary scale or less. Further,
50 I provide for an excess of iodine in the color-modifying substances, by the addition of free iodine or of iodide of mercury, or in some other equivalent manner.

My present invention further comprises a
55 new means for the initial starting of the lamp, which will be fully described and claimed below, as well as an automatic arrangement whereby the length of the arc will be regulated and maintained within
60 definite limits by the pressure generated by the arc itself.

The drawings accompanying this specification represent a simple form of lamp embodying certain features of my present invention.
65

Referring to the drawing, it will be seen that B is a tube, which may be formed of hard glass, provided with an enlargement or condensing chamber B², and so shaped
70 as to afford two depressions or receptacles D⁸, D⁹, which receptacles are filled with mercury. The terminals E, E¹ serve to conduct current to these electrodes D⁸, D⁹, and the surfaces of the electrodes are covered
75 with a color-modifying substance, in accordance with the principles above set forth. In this particular case we may assume that it is desired to produce white light, in which case the color-modifying substance may be constituted of a mixture
80 of the iodides of lithium and sodium, or lithium, sodium and potassium, which mixture is prepared by heating these iodides, the lithium iodide preponderating, in an atmosphere of hydrogen under reduced pressure
85 with the addition of some free iodine and with the exclusion of air. To this mixture of iodides may be added a diluent substance such as fluoride of calcium. This type of lamp is preferably included in a constant-
90 current circuit, in series. It is well to warm the lamp, and particularly to raise the terminals nearly to the boiling point of the mercury, by the application of a spirit lamp or other source of heat. When this result
95 has been achieved, the lamp is included in the constant-current circuit, alternating or direct, by any suitable switching apparatus, whereupon the arc strikes across from one
100 electrode to the other and fills the whole tube, or the central portion of the tube, according to the degree of the vacuum, with a beautiful white light. The mercury furnishes the violet, blue, green and yellow
105 lines of the spectrum, while the orange and red lines are furnished by the color-modifying substances sodium and lithium. As the arc plays over the surface of the mercury, it is continuously taking up small quantities
110 of the lithium and sodium iodides, which disassociate in the arc, allowing the metallic pieces to vibrate under the electrostatic stress, or otherwise as the case may be, while the disassociated atoms of iodine continuously
115 stand guard, as it were, over the atoms of sodium and lithium, and prevent them from attacking the glass. This is the result of the fact that the metallic substances exist
120 in the arc in a state in which their natural affinity for the glass is to a certain extent satisfied, as it were, by the tendency of the iodine atoms to be combined with them. Thus the glass is protected, and the additional free iodine above mentioned tends to
125 help the color-modifying substances to fulfill their functions, which I attribute to the fact that the excess increases the volatility of the lithium and potassium.

By increasing the amount of any one of the color-modifying substances, and by suit-
130

ably choosing said substances in accordance with their known arc spectra, the light may be given any desired color.

5 In conclusion, I will state that although I have particularly described my invention with reference to the use of mercury, I am not restricted to that substance, as some features of my invention are of much broader application.

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

15 1. The method of producing light of any desired color or combination of colors, which consists in drawing an arc from a terminal vaporizable at a low temperature in a suitable envelop, introducing a color-modifying substance to the arc and maintaining it in an ionized state by the addition of a protecting substance, and increas-

ing the action of the color-modifying substance by the introduction of an excess of the protecting substance.

2. The method of modifying the color of an arc light and protecting the inclosure in which the same is contained, which consists in introducing vaporous color-modifying substances in a form in which their chemical activity with reference to the envelop is neutralized, and protecting the modifying substances from the action, of moisture or of the atmosphere.

In witness whereof I have hereunto set my hand this 27th day of April, 1900.

CHARLES P. STEINMETZ.

Witnesses:

BENJAMIN B. HULL,
ALEX F. MACDONALD.