UNITED STATES PATENT OFFICE.

WILLIAM LAWRENCE VOELKER, OF LONDON, ENGLAND, ASSIGNOR TO THERON CLARK CRAWFORD, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LIGHT AND PROCESS OF MAKING SAME.

SPECIFICATION forming part of Letters Patent No. 637,979, dated November 28, 1899.

Application filed February 28, 1898. Serial No. 672,473. (No specimens.)

To all whom it may concern:

Be it known that I, WILLIAM LAWRENCE VOELKER, a citizen of the United States, residing at No. 38 Bernard street, Russell Square, London, England, have invented certain new and useful Improvements in Incandescent Electric Lights and Processes of Making the Same, of which the following is a specification.

The materials which can be employed for my purposes are the carbids of the earth metals uranium and thorium. In preparing the carbids I proceed as follows: I take, for instance, two parts, by weight, of chemically-pure nitrate of the earth metal selected and one part, by weight, of pure cane-sugar and dissolve the same in distilled water, taking care to use very little excess of water in dissolving the nitrate and sugar. I then heat the solution in a suitable porcelain evaporating-dish until the boiling-point is reached, whereupon the application of heat is discontinued. In a few moments the mass will swell to a porous body largely increased in bulk and presenting, if uranium nitrate be employed, a yellow color. This body spontaneously ignites and while burning gives off great volumes of nitrous fumes. When the fumes cease to be evolved, the vessel is covered with a porcelain lid, and the mass is allowed to cool slowly. When cold, the mass has a brownish-black color and is soft and porous. This mass is then ground to a fine powder in a suitable mill, and having been transferred to a mortar and sufficient syrup of cane-sugar added the mass is worked until it has the consistency of putty. The mass is then pressed into cakes, slowly dried, and baked hard in covered crucibles. The next operation consists in melting these cakes in a suitable electric furnace. A cake of a size adapted to fit the hearth of the furnace is placed therein, and the arc having been struck the electrodes are drawn apart until the arc covers the entire width of the cake. The current required to reduce from six to eight ounces of the compressed mass to a perfectly fluid body in about fifteen minutes should be approximately one thousand amperes at from seventy-five to one hundred volts. The current is cut off when the whole mass is in a perfectly fluid state and the furnace allowed to cool down. If sufficient care has been taken in all the operations described and perfect fluidity has been obtained, a reaction will have taken place in the furnace, resulting in a carbid which when fractured will present a crystalline appearance. If the heavy crystalline body resulting is to be kept for any length of time, it should be covered with benzol to preserve it from contact with a moist atmosphere.

To produce filaments from the carbid obtained as heretofore described, I proceed as follows: The carbid is reduced with benzol or naphtha in a suitable air-tight mill to an impalpable powder. The grinding-surfaces, being carbid of the earth metal employed in the preceding process, are so adjusted that the material to be ground only comes into contact with the said grinding-surfaces. The shaft that actuates the upper grinding-surface works through a stuffing-box in the top of the mill. The impalpable powder rises to the top of the benzol or naphtha as the grinding proceeds and from time to time is drawn off through a suitable opening in the side of the mill, fresh benzol or naphtha being added through an opening in the top of the machine. When the grinding is complete, the impalpable powder is freed from the benzol or naphtha, dried in a warm dry chamber, such as a drying-oven, and then mixed with a viscous compound composed of guncotton and oil of cassia. This binding compound is prepared, by the aid of gentle heat, from one part, by weight, of guncotton to four parts, by weight, of oil of cassia, sufficient time being allowed to secure the thorough decomposition of the guncotton. The impalpable powder is mixed in a mortar or suitable mixing-machine with the guncotton and cassia compound and then rolled for about an hour between hard and polished steel rolls. Upon the completion of the rolling the mass should be smooth, glossy, and tough. It is now transferred to a strong steel cylinder provided with a tight-fitting piston and having at the bottom a jewel with a polished orifice of the size required for the filaments desired. The piston, worked by hydraulic power, a screw, or other convenient means, is started, and the filament is expressed or squirted through the jewel-die and

wound on suitable forms made of gas-carbon, the surfaces of the latter being polished and well rubbed with graphite. The size and shape of the form should be adapted to the length and shape of filament desired. The electrical resistance of the finished filaments is so great that it is only necessary to have them U-shaped and with legs much shorter than those of carbon filaments. When the filaments wound on the form or forms are perfectly dry, they are, either singly or several together, placed in electrically-connected spring-clips attached to wire conductors which pass through and are sealed air-tight in a ground-glass stopper, the latter fitting a glass cylinder having connections to an air-pump for exhausting the air and to a source of supply of a purified and attenuated gas. The stopper, with the clips holding the filament or filaments, having been fitted air-tight into the open end of the cylinder, the air is exhausted from the cylinder and a fairly-good vacuum created. By means of a stop-cock the connection with the air-pump is then closed, the gas is admitted, and the electric current turned on at a sufficiently high voltage to cause the filament or filaments to glow bright red. The pressure required to effect this with filaments for one-hundred-volt lamps will be from one thousand to twelve hundred volts. The carbon deposited on the filament or filaments from the attenuated gas forms a slight coating on the surface and aids conductivity, and the carboniferous matter of the binder forms in a few seconds a partial union with the particles of the carbid. When the bright-red glow appears, the current is shut off, the remaining gas is allowed to escape from the cylinder, and connection with the source of the gas-supply is closed. The filament or filaments are now removed, are joined to platinum wires by forming suitable joints, and replaced in the glass cylinder. This is then partially exhausted, and the current again turned on until intense incandescence results. Any uncombined carbon on the surface is thereby volatilized, and the partial union of the carbon and carbid of the core is completed, a homogeneous structure remaining. If it be deemed desirable to standardize the filaments, they are flashed in a good vacuum in a vapor of hydrocarbon and of the earth metal employed in a filament in a manner similar to that ordinarily pursued in normalizing carbon filaments. The mounted and standardized filaments are now sealed into glass bulbs from which the air is exhausted in the usual way. The resulting finished lamps give in comparision with the best carbon-filament lamps a much higher candle-power with a greatly-reduced consumption of current, the electrical resistance of the carbid filaments being so much higher. The carbid filaments having also greater stability at the resulting high temperature, the economic life of the lamps is greatly lengthened. I do not, however, restrict myself to the particular process I have described of forming the filaments from the carbids, as they can be obtained by mixing the powdered carbid with triturated carbon and adding a viscous mixture, such as described above, with purified benzol, with coal-tar, or with pure caoutchouc. They may also be formed by electrically heating an unbaked carbon filament prepared from pure powdered carbon and a suitable binding mixture in a vapor of the respective metal, the said vapor being produced by vaporizing the metal in my improved electric furnace, there being connected to the latter a suitable exhausted vessel wherein the filaments are set up without contact with each other. I prefer, however, the methods hereinbefore particularly described.

For producing incandescing electric lamps which yield a peculiar characteristic light I prefer to employ uranium carbid filaments. The light emanating therefrom has the appearance of sunlight reflected from a polished metallic surface, throwing off golden rays. The whiteness of the light can, however, be increased by adding thorium nitrate to the uranium-nitrate and cane-sugar solution prepared as above described, or, if it be desired to increase the electrical resistance, titanium nitrate may be added in a similar manner preparatory to melting in the electric furnace.

I am aware that carbids of nearly all the earth and alkaline-earth metals have been produced by the electric furnace. I am also aware that attempts have been made to produce filaments for incandescing electric lamps from compounds of carbon and one or another of the earth metals; but

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In the manufacture of filaments for incandescing electric lamps, the herein-described method of producing carbids of the earth metals uranium or thorium; same consisting in taking two parts by weight of chemically-pure nitrate of the earth metal, and one part by weight of pure cane-sugar, dissolving the same in a minimum quantity of distilled water and heating the solution in a suitable evaporating-dish to boiling-point, then withdrawing the source of heat and allowing the mass to assume the condition at which spontaneous combustion takes place, and then, the evolution of nitrous fumes having ceased and the resulting black porous mass having cooled, compressing the same into cakes of a size to fit the hearth of an electric furnace, and there reducing the same to a molten fluid by a large volume of current at a relatively low pressure, substantially as set forth.

2. The herein-described method of producing filaments for incandescing electric lamps, consisting in reducing to impalpable powder the carbid of one of the earth metals, uranium or thorium, by grinding in a suitable mill under benzol or naphtha, between grinding-

surfaces of the like carbid, separating the powder from the benzol or naphtha, mixing the former with a viscous compound of gun-cotton and oil of cassia, rolling the mass between hard polished rollers, squirting the same through jewel-dies, drying the filaments so formed, heating the latter to a bright-red color, by means of an electric current of high voltage, in an atmosphere of a purified and attenuated gas, then volatilizing at a very high temperature and *in vacuo* the surface carbon deposited from the gas, and finally completing the union of any uncombined carbon with the carbid in the core of the filaments by bringing them to their highest degree of incandescence, substantially as set forth.

3. In the manufacture of filaments for incandescing electric lamps from carbid of uranium, the herein-described means for increasing the whiteness of the light emitted by the filament; same consisting in adding to the uranium-nitrate and cane-sugar solution a suitable proportion of thorium nitrate, the mass being ultimately reduced in the electric furnace, substantially as set forth.

4. In the manufacture of filaments for incandescing electric lamps from carbid of uranium, the herein-described means for increasing the electrical resistance consisting in adding to the uranium-nitrate and cane-sugar solution a suitable proportion of titanium nitrate, the mass being ultimately reduced in the electric furnace, substantially as set forth.

5. The herein-described method of producing filaments for incandescing electric lamps, consisting in forming carbid by heating an oxid of one of the earth metals uranium or thorium, to a high temperature in the presence of carbon, producing a viscous mass of the resultant carbid and an agglutinating agent, forming filaments from the mass, and exposing the same to a high temperature, substantially as set forth.

In witness whereof I have hereunto set my hand in presence of two witnesses.

WILLIAM LAWRENCE VOELKER.

Witnesses:

THOMAS WILSON,

GEO. J. B. FRANKLIN.