(No Model.)

P. HÉROULT.

APPARATUS FOR PRODUCING ALUMINIUM OR OTHER METALS.

No. 473,118. Patented Apr. 19, 1892.

Fig: I

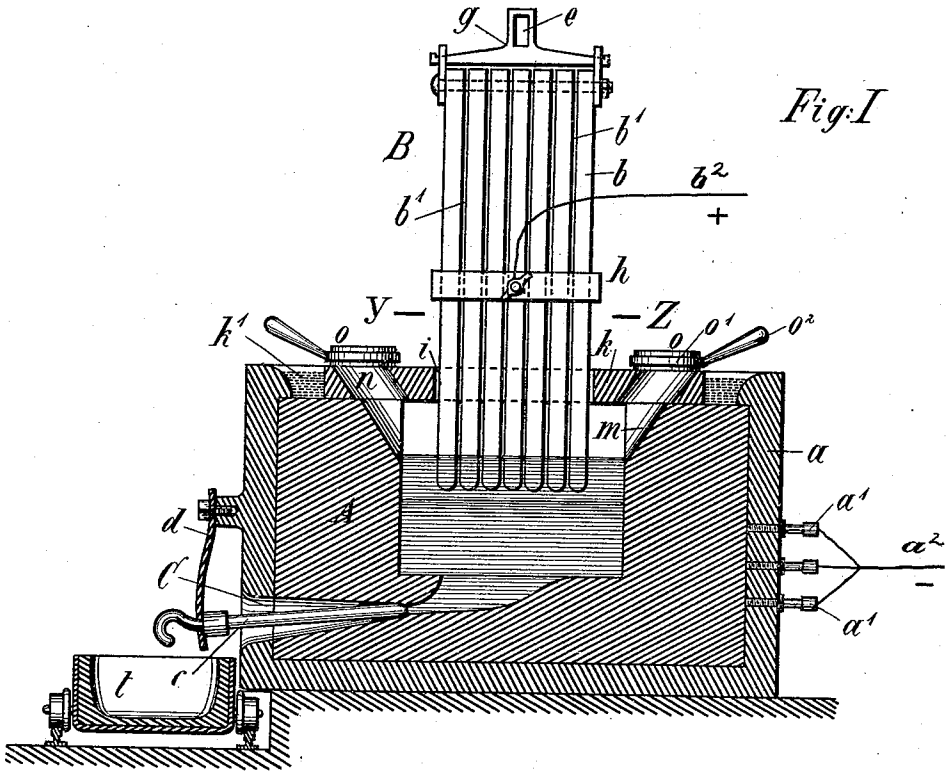
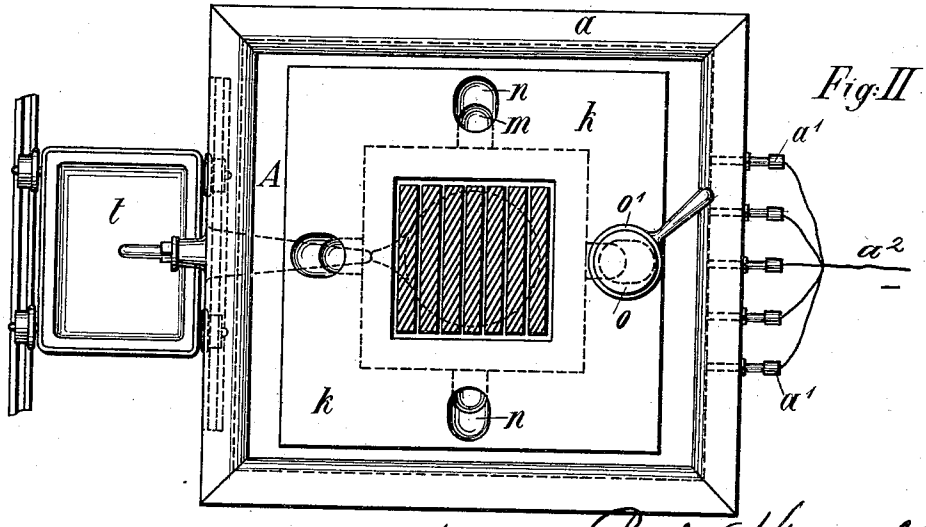


Fig: II



A.

Witnesses:
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UNITED STATES PATENT OFFICE.

PAUL HÉROULT, OF LAUFFEN, SWITZERLAND, ASSIGNOR TO THE UNITED STATES ALUMINIUM METAL COMPANY, OF NEW YORK.

APPARATUS FOR PRODUCING ALUMINIUM OR OTHER METALS.

SPECIFICATION forming part of Letters Patent No. 473,118, dated April 19, 1892.

Application filed December 27, 1887. Serial No. 259,042. (No model.) Patented in England December 7, 1887, No. 16,853, and in Germany June 3, 1889, No. 47,165.

To all whom it may concern:

Be it known that I, PAUL HÉROULT, a citizen of the Republic of France, residing at Lauffen, in the Republic of Switzerland, have invented certain new and useful Improvements in Continuous Apparatus for Producing Aluminium or other Metals in their Alloys by Electrolysis and Operating the Same, (for which Letters Patent have been granted with my consent in the following countries: in Great Britain, No. 16,853, dated December 7, 1887, and in Germany, No. 47,165, dated June 3, 1889,) of which the following is a specification.

This invention relates to apparatus for the electrolytical production of aluminium and other such metals which are difficult to separate from their ores or compounds; and it consists in the improved construction and combination of parts of such an apparatus by means of which such metals may be continuously produced in a practical manner, and more especially the alloys of such metals, as hereinafter more fully described, and particularly pointed out in the claims.

In the accompanying drawings, in which the same letters of reference indicate the same or corresponding parts in both figures, Figure I is a vertical sectional view of the crucible, showing the movable electrode in side elevation; and Fig. II is a plan view of the same, showing the movable electrode in horizontal section, taken on the line Y Z, Fig. 1.

The crucible or receiver consists of an outside shell *a*, suitably insulated from its support and made of iron or other suitable metal, and a thick interior lining A of carbon, forming the body of the crucible, which renders the walls of the crucible comparatively non-heat-conducting, so that while it is adapted to retain heat it cannot well be heated up by an external furnace. The carbon lining A must be in perfect contact with the inner sides of the surrounding shell *a*, and for the purpose of providing such perfect contact it is first built up to correspond with the shape of the desired crucible, whereupon a mold is formed around the same, so as to leave a surrounding space into which the molten iron or other metal may be poured, and when the metal thus cast around the carbon body of the receiver cools the contact between the shell and the lining will be, as far as practicable, perfect. The wire a^2, leading from the negative pole of a suitable generator of electricity, is secured by numerous branch wires to posts *a'*, of brass or copper, secured in the casing and passed through the same, so that the current through the wire may pass into the electrode formed by the carbon receiver or crucible with the least possible resistance.

The bottom of the receiver or crucible is formed at its lowest point with a laterally-extending channel or tap-hole C, which may be closed by a removable carbon stopper *c*, having the lower end of a spring *d* bearing against its outer end and holding it in the tap-hole.

The positive electrode B projects into the receiver or crucible and is formed by a number of carbon plates or bars *b*, each of the same length and breadth as the electrode and having their upper ends suitably secured in a yoke or clamp *g*, provided with an eye *e*, by which it is suspended vertically over the crucible by a chain or other suitable means. The plates or bars of carbon are bound together at their middles by a clamp *h*, to which the wire b^2 from the positive pole of the generator is connected, and the carbon plates or bars are preferably secured with narrow spaces *b'* between them, which are filled with metal to lower the electrical resistance of the electrode.

The top of the receiver or crucible is closed by a cover *k*, made from plates or bricks of graphite, (plumbago,) and this cover is formed with a central aperture, which will leave narrow spaces *i* between its edges and the sides of the movable electrode, which slides adjustably through the opening in the cover. The cover is formed with feed-apertures *n*, which register with inclined recesses or chutes *m*, formed in the upper edges of the sides of the crucible, and these feed-apertures are closed by removable graphite covers *o*, provided with frames *o'*, having handles o^2, by

means of which they may be manipulated. The spaces between the edges of the cover and the upper edges of the casing of the receiver are filled with a filling k' of graphite powder.

A suitable movable receptacle or ladle t is provided to be brought under the tap-hole for receiving the molten metal when the receiver is tapped, the receptacle being shown in the drawings as a box mounted on wheels and traveling upon a track.

In the operation of the apparatus the crucible is first fed with copper or other alloying metal through the feed-apertures, the said copper being preferably in a broken or comminuted state, and the movable postive electrode is thereupon lowered down upon the copper, so that the heat generated by the current passing through it will melt the same. This molten copper collects at the bottom of the crucible and forms the negative electrode. The compound to be decomposed—for example, alumina—is then introduced through the feed-apertures and the movable electrode is slightly raised, so that the electric current may be passed through the clay, which will melt and be decomposed. The oxygen freed from the compound decomposed comes in contact with the carbon of the positive electrode and forms carbonic oxide, which passes out through the feed-apertures, and the aluminium will thus be separated from its combinations with the oxygen, and will enter into an alloy with the copper, forming aluminium bronze. The crucible is fed with copper and alumina, either continuously or at intervals, during the electrolytical production of the metal; but special care must be taken to feed sufficient copper, as otherwise the molten aluminium or alloy will be specifically too light and float on top of the bath, short-circuiting the current and stopping the production. During the process it is necessary to raise or lower the movable positive electrode, according to the resistance of the mass in the receiver or crucible, and this may be automatically performed by connecting a suitable dynamo-electric motor to the chain or other means for suspending the electrode, the said motor being regulated in its operation by an ampère-meter. When a sufficient quantity of alloy has been produced, the receiver or crucible is tapped through the tap-hole by removing the carbon plug and allowing the molten alloy to run into the receptacle or ladle, from which the alloy may be disposed of in any desirable manner, and the movable positive electrode, which during the tapping has been raised, may again be lowered and the receiver filled with copper and clay, the operation continuing without interruption as long as the receiver is fed. The intensity of the current found most satisfactory and practical is from twelve thousand to thirteen thousand ampères, with a tension of about twelve to fifteen volts.

Various alloys of aluminium or like metals may be made in this apparatus, the copper being substituted by the desired metal for the alloy, such metals, however, which will evaporate at the melting-point of alumina being excepted, and direct combinations may be formed—as, for example, a combination of copper with silicium and aluminium, silicate of alumina being used instead of simple alumina in the process.

The copper bath first melted in the receiver may be dispensed with and pure aluminium may be produced in the apparatus.

Having thus described my invention, I claim and desire to secure by Letters Patent of the United States—

1. The apparatus for the production of metals from their refractory compounds, consisting of the crucible connected with the negative pole of a generator of electricity and provided with a thick lining of non-heat-conducting material, whereby it is adapted to retain heat within it but not to be heated up externally, an electrode of carbon connected with the positive pole of the generator and extending through an opening in the cover of the crucible, means for suspending the said positive electrode above the crucible, and means for adjusting it up and down, as described.

2. The herein-described apparatus for the production of metals from their refractory compounds, consisting of a crucible comprising a metal shell and a thick lining of non-heat-conducting material, whereby it is adapted to retain heat within it but not to be heated up externally, and a carbon electrode extending within the crucible when in normal operation, the said electrode and crucible connected, respectively, to the positive and negative poles of a generator of electricity, as set forth.

3. The herein-described apparatus for the production of metals from their refractory compounds, consisting of a crucible connected with the negative pole of a generator of electricity and provided with a thick lining of non-heat-conducting material, whereby it is adapted to retain heat but not to be heated up externally, an alloying metal maintained molten therein and thereby also connected with the said generator-pole, a carbon electrode projecting within the crucible and connected with the positive pole of the generator, and means for adjusting the latter electrode toward or away from the alloying metal.

4. The herein-described apparatus for the production of metals from their refractory compounds, consisting of a carbon electrode connected with the positive pole of a generator of electricity and a crucible into which the electrode projects connected with the negative pole of the generator and provided with, first, a thick lining of non-heat-conducting material, whereby it is adapted to retain heat within it but not to be heated up exter-

nally, and, second, a tap-hole at the lower end of the crucible and a feed-opening at its upper end, as set forth.

5. The herein-described apparatus for the production of metals from their refractory compounds, consisting of a crucible for containing the compound to be reduced and an electrode connected to one pole of a generator of electricity for passing a current of electricity through the said compound, the electrode consisting of plates or bars of carbon, with intervening spaces filled with relatively good conducting material extending substantially the entire length of the electrode, and a clamp or clamps binding the parts together, as described.

6. In an apparatus for the electrolytical production of metal, a receiver or crucible consisting of a thick heat-retaining lining of carbon and a metallic casing cast around the lining as a core, as set forth.

7. In an apparatus for the electrolytical production of metals, the combination of a carbon receiver or crucible, the positive electrode B, and the graphite cover having a central aperture for the passage of the electrode and having the feed-aperture for the introduction of material to be treated into the crucible.

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

PAUL HÉROULT.

Witnesses:
EMIL BLUM,
GEORGE L. CATLIN.