

UNITED STATES PATENT OFFICE.

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PROCESS OF PRODUCING ALUMINIUM.

SPECIFICATION forming part of Letters Patent No. 410,568, dated September 3, 1889.

Application filed August 8, 1888. Serial No. 282,236. (No specimens.)

To all whom it may concern:

Be it known that I, MARTIN WANNER, a citizen of the United States of America, residing at Robinson, in the county of Summit and State of Colorado, have invented a certain new and useful Process of Producing Aluminum, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to a new and useful process for the production of metallic aluminum, either in condition sufficiently pure for ordinary uses or as alloyed with any desired metal or metals.

Its object is to furnish for such production a simple, readily and easily practiced, efficient, and reliable method, one adapted to produce the metal aluminum from aluminous ores, as a commercial product, so economically as to warrant its practical use in many relations in the arts and manufactures where now cheaper metals not possessing its merits, advantages, and adaptabilities are used.

To these ends my invention consists in a process of treating any of the aluminous fluorides while fused with a compound readily disassociating at a temperature below the fusing-point of the aluminous fluoride, and having an element or elements of such high affinity for fluorine that it or they at the moment of disassociation, or while *statu nascendi*, unite immediately with such element or elements of the aluminous fluorides as are in combination with the aluminum, displacing and leaving the latter free, a "process for the production of the metal by substitution," as it may be termed, as hereinafter described and claimed.

In practicing my process the aluminous base used may be the ordinary fluoride of aluminum, either that found as a natural product—such as fluolite—or that formed from the oxide or hydroxide or other aluminous compound, or such base may be a double fluoride of aluminum and an alkaline metal—

such as cryolite or $\text{Al}_2\text{F}_6\text{NaFl}$. While either may be used as the base, it is preferable to mix them and use as the base a mixture of one part of the single fluoride to two parts of the double fluoride of aluminum and an al-

kaline metal, for the reason that the sodium or other alkaline metal in the double fluoride forms a suitable fluxing material, enabling the reduction process to be carried on without the addition of extraneous fluxes, while in such compound the other elements are present in the combining proportions proper for the reagents to be used, as hereinafter specified.

The base used is fed into or placed within any suitable furnace or crucible containing a bath of fused metal, and is then itself fused upon or over such bath or in such relation thereto that the fused material may flow into or upon such bath. The base thus fused and in the bath is then treated with a reagent whose elements disassociate at a temperature lower than that of the fused base, and having an element of greater affinity for fluorine than has the aluminum. Among such reagents are the sulphides of silicon and of boron and the hydrides of the same and the carbonyl-hydrides thereof. The mode of the application of these reagents will vary somewhat with the furnace or crucible used and the particular reagent employed. The application may be by passing the reagent through the fused mass in a gaseous state, when it assumes or can be made to assume such state, or it may be by forcing the reagent finely comminuted through the fused mass by a jet of hydrogen or nitrogen or other fluid not containing oxygen, or by a jet of fluid which, while containing oxygen, does not part there-with to or in the presence of the other elements—as carbon monoxide, for instance—or the reagent may have been mingled with the aluminous fluoride while the latter was still in a solid state, the essential thing being that the aluminous base and the reagent should be in relation to each other for the operation of their affinities and changes of combination at the moment of disassociation of the elements of the reagent. In the reactions that follow all the original combinations are broken up, and the elements, excepting aluminum, enter into new ones, the aluminum being replaced in its former combinations by other elements and left in a free metallic state. For instance, if silicon sulphide were the reagent employed, its silicon

at the moment of disassociation attacks the fluorine and combines therewith, to the exclusion of the aluminum, there being as resultants, besides other elements or compounds, silicon fluoride and free aluminum, the silicon being substituted for the aluminum in the fluorine compounds. The same reaction and results follow the use of either of the sulphides, hydrides, or carbo-hydrides of silicon or boron, they being generic equivalents in the process noted.

While in the fused condition the freed aluminum should be protected from contact with air or other oxygen-yielding material. While in the bath the slag formed, in part at least, of the sodium from the double fluoride does this, but it is also preferable that the process should be carried on in a furnace from which air is excluded as thoroughly as possible.

When it is desired to obtain the aluminum in a practically or commercially pure state, the metallic bath referred to should be of fused aluminum. Otherwise it should be of such metal as it is desired to alloy the aluminum with.

As giving a practical illustration of the use of this process, I will now describe it as carried on with the furnace illustrated in the accompanying drawings—a furnace which I have designed with especial reference to the needs of this process, and for which I have made a separate application for Letters Patent contemporaneous herewith.

In such drawings, Figure 1 is a section of such furnace on the line xx , Fig. 3; Fig. 2, a front elevation thereof; Fig. 3, an end elevation thereof.

In these figures the reference-numeral 1 indicates the chamber of the furnace, from which, over a bridge-wall 3, leads a flue 4 to the flue 2, the latter being connected to any suitable stack or chimney-pipe.

In the base of what may be termed the "front" of the chamber is a depression 5, forming a crucible or pot, the floor 6 of the remainder of the base of the chamber sloping thereto and draining thereinto. A tuyere 7 leads into such crucible 5, while therefrom proceeds the draw-off passage 8.

In the top of the chamber is arranged a water-jacketed inlet 9, for the material to be treated, the inlet being so situated that the material shall fall therethrough upon the upper end of sloping floor 6. A fuel-inlet is arranged at 10 for the admission of the gaseous fuel—as mingled air and hydrocarbon, oxyhydrogen, &c.—intended to be used.

In order that the condition of the material under treatment may be noted, a peep-hole 11 is arranged, having its outer limit covered with glass to shut out access of air thereby to the interior of the furnace.

In the flue 2 are located one or more retorts 12 for the preparation of the reagents to be used, the retorts being so located that the heat of the waste and escaping products of combustion may be utilized for such prepa-

ration. If two or more retorts 12 are used, they are connected at their rears by a pipe 16, that the vapors arising may freely pass from one to another. From the upper part of the lower retort a pipe 17 is arranged to connect with the tuyere 7, so that if the reagent is in gaseous form, and it is so desired, the reagent may be passed directly from the retorts to the interior of the furnace.

It is to be understood that all the pipes herein noted may be provided with suitable dampers or valves, so that their action may be permitted or interdicted, as may be desirable.

Into the upper retort leads a pipe 15, by which sulphur or other necessary vapors or gases may be passed thereinto, while from the lower part of the front of the lower retort leads a pipe 18. As when the retorts are used to prepare the reagents used, such may be prepared more rapidly than they are consumed, this pipe 18 may lead to any convenient tank or receptacle for the reception and storage of the surplus or prepared reagents.

Supposing now a mixture of fluoride and a double fluoride, as noted, is to be used as the aluminum-yielding material and silicon sulphide as the reagent; the metallic bath in kettle or crucible 5 is made ready, filling the kettle to about the tuyere-line, and the material to be reduced is introduced through the feed-hole 9 upon the sloping floor 6. The heat from the gaseous fuel entering through fuel-inlet 10 fuses the material, which flows upon the metal bath in crucible 5, and when such crucible is about full the introduction of material is stopped. Thereupon the silicon sulphide is passed into and through the fused mass from the tuyere 7, causing the reactions before noted. Through the peep-hole 11 the progress of the operation is noted, and when it is seen that no more vapors of silicon fluoride and sodium sulphide rise from the fused mass (which is indicated by the changed color of the rising vapors) the supply of silicon sulphide is cut off, the reduction being then complete. Any foreign matters collect upon the top of the mass—as scoriæ or slag—and are drawn off through slag-passage 13, while a portion of the reduced metal is drawn off by spout 8, enough being left in the crucible 5 to form the metallic bath for the next charge. In the meantime a batch of the reagent sulphide has been in course of preparation in the retorts 12. Therein was placed silicon dioxide and carbon, the same being heated by the products of combustion passing around them in the flue 2. Thereinto has been admitted through pipe 15 the vapors or fumes of sulphur sublimed in a separate vessel, carbon oxide and the needed disulphide being the results, as before recited.

This process enables aluminous ores to be reduced and the metal extracted very speedily, the process being a very effective one and reducing also the cost of production of aluminum

to a very low figure, so low, indeed, as to warrant its commercial and economic competition in practical use with copper, and even with cheaper much-used metals.

5 Having thus described my invention, what I claim is—

10 1. The process of producing the metal aluminum herein described, consisting in treating a fused aluminous fluoride or fluorides, while in a molten-metallic bath and protected from oxidizing agents, with a reagent whose elements disassociate at a temperature below the fusing-point of the aluminous fluoride or flu-
15 ties that it displaces the aluminum in the flu-

oride or fluorides, but having no element capable of uniting with the aluminum, substantially as set forth.

2. The process of obtaining aluminum by treating a base of fused aluminous fluoride 20 or fluorides, while in a bath of molten metal and protected from oxidizing agents, with a sulphide of silicon or equivalent reagent, substantially as set forth and described.

In testimony whereof I affix my signature in 25 presence of two witnesses.

MARTIN WANNER.

Witnesses:

Z. F. WILBER,

A. H. WEBER.