

No. 676,577.

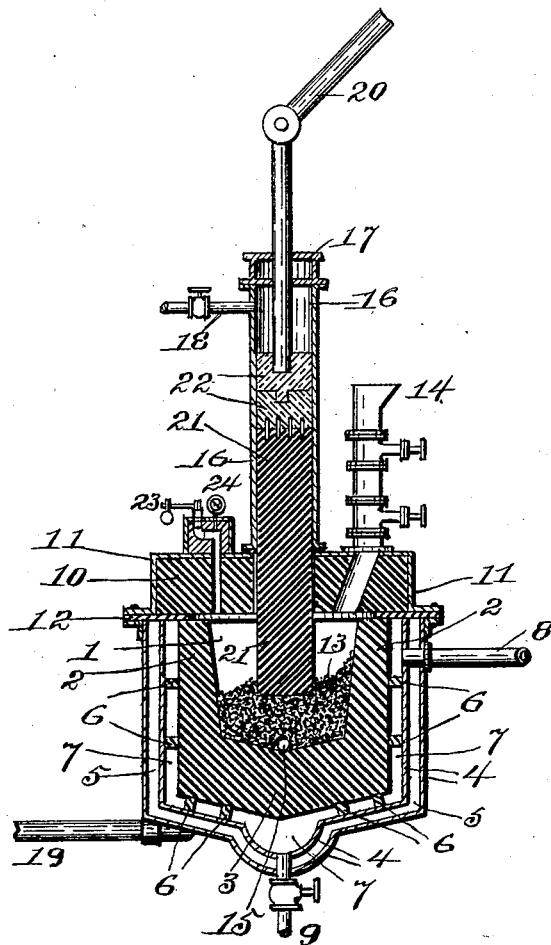
Patented June 18, 1901.

A. H. COWLES.

ELECTRIC SMELTING PROCESS OF REDUCING SODIUM COMPOUNDS.

(Application filed Sept. 27, 1900.)

(No Model.)



Witnesses:

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UNITED STATES PATENT OFFICE.

ALFRED H. COWLES, OF CLEVELAND, OHIO, ASSIGNOR TO THE ELECTRIC SMELTING AND ALUMINUM CO., OF SAME PLACE.

ELECTRIC SMELTING PROCESS OF REDUCING SODIUM COMPOUNDS.

SPECIFICATION forming part of Letters Patent No. 676,577, dated June 18, 1901.

Original application filed July 20, 1895, Serial No. 557,172. Divided and this application filed September 27, 1900. Serial No. 31,284. (No specimens.)

To all whom it may concern:

Be it known that I, ALFRED H. COWLES, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Electric Smelting Processes of Reducing Sodium Compounds, of which the following is a specification.

This invention relates to electric smelting, and particularly to an electric smelting process of reducing sodium compounds and for the manufacture of metallic sodium and aluminium products from aluminate of soda.

This application is a division of my application filed July 20, 1895, Serial No. 557,172, and the apparatus herein shown and described for carrying out this process is covered by my applications filed November 24, 1899, Serial No. 738,201, and August 30, 1900, Serial No. 28,606.

The object of the invention is to provide a process to simultaneously reduce sodium compounds of refractory oxids non-reducible practically by ordinary fiery processes with carbon, the purpose of the process being to obtain separately the sodium and the base of the oxid either as metal, carbid, or alloy.

In the accompanying drawing, forming part of this application, the figure is a central vertical section.

The same numeral references denote the same parts in the drawing.

The furnace-chamber 1 has walls 2 and a hearth 3, all of which are composed of compacted but porous carbon or hard compacted carbon in which are arranged blocks or masses of porous carbon or charcoal permeable to the gases and vapors evolved during the operation of the furnace, so as to permit the gases or vapors to pass through said walls and hearth from the furnace-chamber, but which is non-permeable to floating solids. Inclosing the walls and hearth is a metallic double-walled jacket or casing 4, which forms a water or cooling chamber 5, provided with suitable water inlet and outlet pipes, (not shown,) and the inner wall of the casing is held away from the carbon walls 2 and hearth 3 by metallic blocks or stays 6 to prevent the said inner

wall of the casing from becoming heated to too great a temperature and to form a space or receptacle 7 between the casing and the walls 2 and hearth 3 into which the gases and vapors are discharged through the numerous pores or openings in the walls 2 and hearth 3 for condensation therein. The office of the cooling jacket or casing is to maintain the temperature of the condensing-space 7 at the proper temperature to effect condensation of the fumes or vapor discharged thereinto, as above noted. An exhaust-pipe 8 extends from the upper part of the condensing-space 7, through which the carbonic oxid generated in the operation of the furnace is passed off, assisted, if need be, by a suction-blower or equivalent device. (Not shown, but which may be attached to the pipe 8.) The bottom of the casing is provided with a suitable discharge-pipe 9 for drawing off the condensed sodium from the condensing-space 7. The top or cover 10 of the furnace is preferably made separable from the furnace and is composed of compacted carbon covered by an iron shell 11, and a suitable layer of insulating material 12 is placed between the body of the furnace and its cover. The ore charge 13 is fed from a hopper 14 through the furnace top or cover, and a tap-hole 15 is formed in the bottom of the furnace. A pipe 16 is secured to the furnace-top, but insulated therefrom, and the top of the pipe has a stuffing-box 17, making the pipe practically gas-tight. Just below the stuffing-box is a pipe 18, discharging into the pipe 16 for the purpose hereinafter described. One of the electrode-terminals 19 is attached to the casing 4, and the other terminal 20 is connected to an electrode 21 by means of metallic plugs 22, permitting the electrode 21 to play in the pipe 16 through the top of the furnace and in the furnace-chamber. The function of the pipe 18 is to discharge into the pipe 16 a small quantity of hydrocarbon, neutral, or reducing gas or gas-forming liquid, which will prevent any small amount of sodium from passing up as vapor around the electrode 21. A sufficient amount of the hydrocarbon gas can be admitted to maintain a

slight escape thereof down around the said electrode. The top of the furnace is provided with a safety-valve 23 and a pressure-gage 24. The course of the current is from the circuit-cable connected to the electrode 21 through the ore charge, the walls and furnace-hearth, the stay-blocks, and the casing to the other circuit-terminal. As hereinbefore stated, this furnace is especially applicable to the reduction of the class of compounds of which aluminate of soda ($\text{Na}_2\text{Al}_2\text{O}_4$) is a type, yet it is quite as applicable to other classes of reductions where salts are to be electrolyzed, and I wish it to be distinctly understood that its application is unlimited.

Taking aluminate of soda as a typical compound, the operation is as follows: Take a mixture of aluminate of soda with coke or carbon in any form, forming such mixture either by mixing the crushed, ground, or granulated material or by forming a mass of sodic aluminate saturated with a hydrocarbon and baked, and, if need be, crushed, or by mixing the aluminate of soda with carbon and coal-tar or pitch or equivalent carbonaceous matter, it being desirable that the ore charge should not be too powdery in consistence and it being also preferable, except when carbonates are being formed, that no excess of carbon above the amount necessary for the reduction should be employed, since such excess will accumulate in the furnace and may need to be removed. The charge mixture is fed through the hopper into the furnace in successive portions, regulated according to the judgment of the operator by the temperature and pressure of the furnace. If the ore charge is fed too slowly, the furnace will become too hot, which will be indicated to the operator not only by the noticeable increase of temperature of the furnace and the water discharging from the water-jacket, but also by the diminished amount of carbonic acid passing off. If the charge is fed too fast, there will accumulate in the furnace a mass of fused unreduced alumina, which will be observed in tapping off from time to time the contents of the furnace. As the ore charge is fed to the furnace the high temperature causes the sodium to distil off rapidly along with the carbonic acid produced by the reduction of the acid of aluminium. These gaseous products passing through the porous carbon walls of the furnace into the condenser formed between the said walls and the water-jacket, being perfectly strained from dust in their passage through said carbon walls, the vapor of sodium is condensed in the condensing chamber or space 7, whence it is drawn off in liquid form at proper intervals through the pipe 9, while the carbonic acid, being condensed, passes off through the outlet-pipe 8. The space or condensing-chamber 7 is kept at a temperature above 96° centigrade, at which temperature sodium is liquefied, but by means of the water-jacket it is

kept below the temperature (red heat) at which sodium is volatile. The interior of the furnace is maintained at a very high temperature, reaching incandescence on the inner surface of the carbon walls and decreasing to a dull-red heat at the iron casing. By this means sodium is prevented from condensing in the furnace and any possibility of short-circuiting arising from condensed sodium condensing on the inner walls of the furnace at the junction of the cover and body-wall or elsewhere is prevented, although such short-circuiting could not occur to an extent to materially affect the operation, since the sodium in such case would be instantly volatilized by the heat of the current shunted through it.

The gases evolved in the furnace during the operation create a pressure within the furnace which will be indicated to the operator by the pressure-gage 24, and although there is very little, if any, danger of the pressure reaching a point where any injury to the apparatus could occur therefrom yet possibility thereof is fully obviated by providing the safety-valve 23. This pressure in the furnace materially assists in driving through the porous carbon wall of the furnace the volatilized sodium vapor and the gases evolved in the operation. The acid of aluminium left by driving off the sodium from the aluminate is acted upon and reduced by the carbon, the reaction yielding carbonic acid, which passes through the walls of the furnace.

By adding through the ore charge or otherwise in reducing it in the furnace a metal less volatile than sodium—as, for instance, iron, copper, or tin—an alloy of the reduced aluminium with such metal is obtained. Further, by adding in the same manner a volatile metal, such as zinc, there will be obtained in the condenser an alloy of sodium with such other volatile metal, all of such operations, reactions, and reductions being successfully carried out by this furnace.

It is advisable to heat up the furnace to a high temperature before adding the ore to be reduced, which is readily done by putting a quantity of granular carbon in the bottom of the furnace to save the carbon lining of the furnace and allowing the arc to play thereon, one advantage of which is that by previously raising the furnace temperature so high that the ore will reduce rapidly a more perfect operation is secured at more economical expense. The charge fed into the furnace should be proportionate to the electrical energy delivered to the furnace, the best results being obtained when the electric current and the feed of ore are so proportioned that ore is reduced as fast as fed in and the process of reduction conducted in a substantially continuous manner.

By mixing sodium compounds with calcium compounds and the proper portion of carbon there may be obtained sodium volatilized and condensed in the condenser and calcium carbide remaining in the furnace.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The herein-described electric smelting process for manufacturing metallic sodium and aluminium from aluminate of soda, which consists in forming a mixture, of sodic aluminate with carbon in a granular, broken or intimately-associated condition, heating said mixture in a tightly-closed chamber by heat generated from an electric current, whereby the sodium is reduced, vaporized and passed out of the furnace and the oxid of aluminium is reduced by the carbon and metallic aluminium set free, collecting and condensing the sodium vapors, and tapping or removing from the furnace the reduced aluminium, substantially as set forth.

2. The herein-described electric smelting process for reducing aluminate of soda, which consists in forming a mixture of sodic aluminate with carbon and a compound of a non-volatile metal, heating said mixture in a tightly-closed carbon-lined chamber by heat from an electric current, whereby the sodium is reduced, volatilized and passed out of the chamber, the oxid of aluminium is reduced and an alloy of the aluminium with the non-volatile metal of the charge is produced, collecting and condensing the sodium vapors, and tapping or removing from the furnace the reduced aluminium alloy, substantially as set forth.

3. The herein-described electric smelting process for manufacturing sodium alloys and aluminium from aluminate of soda, which consists in forming a mixture of sodic aluminate

with carbon in a granular, broken or intimately-associated condition and a volatile metal, heating said mixture in a tightly-closed chamber by heat generated from an electric current, whereby the sodium is reduced and with the other volatile metal volatilized and passed out of the chamber and the oxid of aluminium is reduced by the carbon, collecting and condensing the mingled vapors of the sodium and other volatile metal as an alloy, and tapping or removing from the furnace the reduced aluminium, substantially as set forth.

4. The herein-described electric smelting process for manufacturing alloys of sodium and aluminium, which consists in mixing sodic aluminate with carbon in a granular, broken or intimately-associated condition, charging the said mixture with a volatile and non-volatile metal into an electric furnace and heating the same therein by heat generated from an electric current, whereby the sodium of the aluminium is reduced and with the volatile metal is volatilized and passed out of the furnace, the oxid of aluminium is reduced by the carbon and the aluminium alloyed with non-volatile metal, collecting and condensing the volatilized sodium and other metal as an alloy, and tapping or removing from the furnace the aluminium alloy, substantially as set forth.

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

ALFRED H. COWLES.

Witnesses:

NELLIE J. WILLS,
J. H. PIERONG.