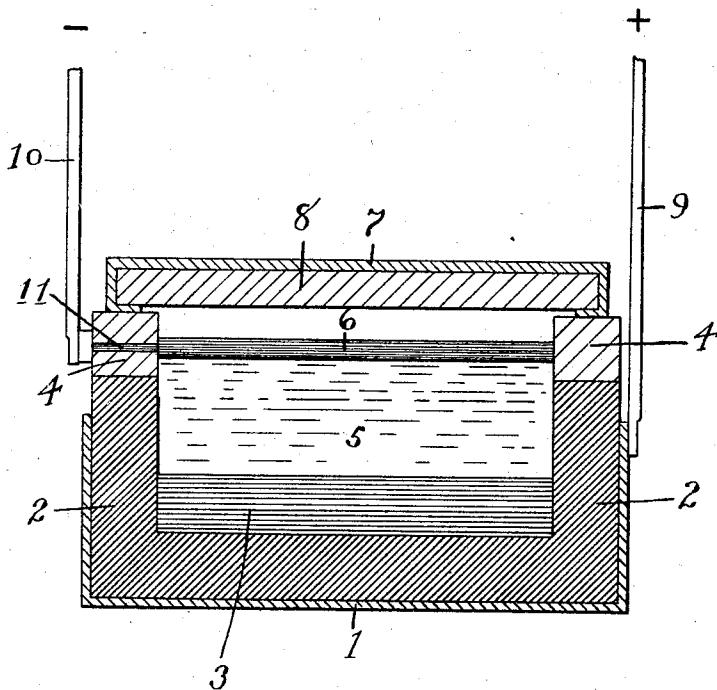


No. 795,886.

PATENTED AUG. 1, 1905.

A. G. BETTS.
MAKING ALUMINIUM.
APPLICATION FILED APR. 1, 1905.



Witnesses

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MAKING ALUMINIUM.

No. 795,886.

Specification of Letters Patent.

Patented Aug. 1, 1905.

Application filed April 1, 1905. Serial No. 253,348.

To all whom it may concern:

Be it known that I, ANSON GARDNER BETTS, a citizen of the United States, residing at Troy, in the county of Rensselaer and State of New York, have invented certain new and useful Improvements in Making Aluminium, of which the following is a specification accompanied by a drawing.

The single figure of the drawing is a view in vertical section of electrolytic apparatus I use in carrying out my invention.

This invention relates to the preparation of pure aluminium from ores without necessitating the purification of the ore before the metal is reduced from its oxid.

The principal object of my invention is to prepare aluminium of high purity at a low cost.

Other objects and features of the invention will appear in connection with the following description of my method.

Aluminium oxid occurs in nature for the most part associated with other oxids, notably with those of iron and silicon in clay and with those of iron, silicon, and titanium in bauxite. All these oxids are more easily reducible than alumina, so that it is not possible to prepare pure aluminium by first reducing the ore to an alloy and then slag off the impurities by oxidation analogously to the purification of pig-iron and most other metals. Consequently at the present time the alumina is freed chemically from the impurities before it is reduced to metal, and a moderately pure metal is thus obtained.

To carry out my process, I reduce the crude ore directly to a metallic state with or without diluting the aluminium further by the addition of another metal, as copper, iron, zinc, or tin, which I may do in numerous ways, of which I will later give examples. The product of aluminium combined or mixed with other elements, as carbon, iron, silicon, titanium, copper, zinc, tin, &c., I then place, preferably but not necessarily, in the fused state at the bottom of an electrolyzing-cell containing an aluminium-depositing electrolyte specifically lighter than the aluminium-containing product and floating on the electrolyte, which is also specifically heavier than fused pure aluminium, a layer of fused substantially pure aluminium electrically connected as cathode, while the aluminium-containing product is electrically connected as anode. The property of aluminium of being the most easily oxidized of

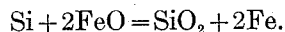
the metals present in the mixture insures that aluminium only dissolves from the anode, so that the result of passing the electric current is that pure aluminium is deposited at or in the cathode, while the deficiency of aluminium caused thereby to occur in the electrolyte is made up by solution from the anode.

As electrolytes I may use cryolite saturated with alumina, cryolite, and barium chlorid, &c.

I give a few examples of the application of my process.

Reduction of bauxite electrolytically similarly to the Hall process for aluminium from a bath of fluorids, in which the bauxite is dissolved or reduction by carbon at a high temperature by well-known methods and subsequent extraction of the aluminium electrolytically, followed by the utilization of the residue of iron, carbon, silicon, and titanium in any desired way.

Reduction of bauxite, clay, or other aluminous material for the elimination of oxygen, alloying the product with liquid iron, copper, zinc, tin, &c., and extraction of the contained aluminium electrolytically, leaving the iron, silicon, &c., still alloyed with the heavy metal. The iron, copper, or tin can be recovered in substantially pure condition by oxidation and slagging, and the zinc can be recovered by distillation. For example, the iron containing silicon resulting from the reduction of red clay, alloying with iron, and extraction of the aluminium can be smelted with iron and lime, giving a slag of calcium silicate and reduction of iron oxid to iron.



Clay or other aluminous material can be smelted with iron ore or with metallic iron or copper to alloys of copper or iron with silicon and aluminium, the aluminium electrolytically extracted, and the resulting ferrosilicon or silicon-bronze utilized in any desired manner.

In the electrolytic reduction of aluminium oxid, pure or native, now that it is easily possible to extract aluminium from alloys, a cathode of zinc, tin, or aluminium-bronze may be used to receive the deposited aluminium, making a liquid alloy therewith at a temperature below the melting-point of pure aluminium, so that other baths than the fluid bath of the Hall process may be

used—for example, the well-known electrolyte of fused sodium-aluminium chlorid. I can also use solid cathodes of iron or copper, &c., in the electrolytic reduction, for the aluminium alloy formed on the surface of the cathode being more easily fusible continually trickles off to the bottom of the electrolytic cell.

Aluminium can be extracted by my present method from such materials as aluminium silicid and carbid and similar non-oxygen-containing compounds of aluminium.

Having reference to the accompanying drawing, 1 is a cast-iron box lined with carbon 2, containing the fused aluminium alloy 3. On top of the carbon lining is a layer of non-conducting refractory material 4—for example, of alumina. The electrolyte 5 of cryolite, saturated with alumina, for example, rests on the specifically heavier alloy 3 and supports the specifically lighter fused pure aluminium 6. A cover of cast-iron 7, lined with fire-brick 8, protects the aluminium from oxidation.

Electric connection is made by the positive bus-bar 9 to the iron box 1 and by the negative bus-bar 10 to the aluminium cathode by means of the aluminium in the channel 11 in the refractory material 4.

The carbon lining being a conductor, the alloy at the bottom of the cell becomes the anode.

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

1. The process of extracting aluminium from materials containing aluminium in the unoxidized condition which consists in electrolyzing a fused aluminium-depositing electrolyte of greater specific gravity than pure aluminium and of less specific gravity than the said aluminium-containing material used, with the alloy as anode, and a suitable cathode.

2. The process of extracting aluminium from materials containing aluminium in the unoxidized condition which consists in electrolyzing a fused aluminium-depositing electrolyte of greater specific gravity than pure aluminium and of less specific gravity than the said aluminium-containing material used, with the alloy as anode, and a cathode of fused aluminium floating on the electrolyte.

3. The process of extracting aluminium from a fused aluminium alloy, which consists in electrolyzing a fused aluminium-depositing electrolyte of greater specific gravity than

pure aluminium and of less specific gravity than the alloy, with the alloy as anode beneath the electrolyte, and a cathode of aluminium floating on the electrolyte.

4. The process of producing substantially pure aluminium which consists in alloying impure aluminium with a heavier metal, and then extracting aluminium from the alloy by electrolyzing a fused aluminium-depositing electrolyte of greater specific gravity than pure aluminium, and of less specific gravity than the alloy, with the alloy as anode beneath the electrolyte, and a suitable cathode above the anode.

5. The process of producing substantially pure aluminium which consists in reducing aluminium ore in presence of a heavier metal to produce an alloy of said metal containing aluminium, and then extracting aluminium from the alloy by electrolyzing a fused aluminium-depositing electrolyte of greater specific gravity than pure aluminium, and of less specific gravity than the alloy, with the alloy as anode beneath the electrolyte, and a suitable cathode above the anode.

6. The process of producing substantially pure aluminium which consists in reducing aluminium ore in presence of an oxid of a heavier metal to produce an alloy of said metal containing aluminium, and then extracting aluminium from said alloy by electrolyzing a fused aluminium-depositing electrolyte of greater specific gravity than pure aluminium, and of less specific gravity than said alloy, with the alloy as anode beneath the electrolyte and a suitable cathode above the anode.

7. The process of producing substantially pure aluminium which consists in reducing aluminium ore in presence of iron oxid to produce an iron alloy containing aluminium, and then electrolytically extracting aluminium therefrom.

8. The process of producing substantially pure aluminium which consists in reducing clay in presence of iron ore to ferrosilicon containing aluminium, and then electrolytically extracting aluminium therefrom.

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

ANSON GARDNER BETTS.

Witnesses:

FREDERICK CLARK,
EDWARD F. KERN.