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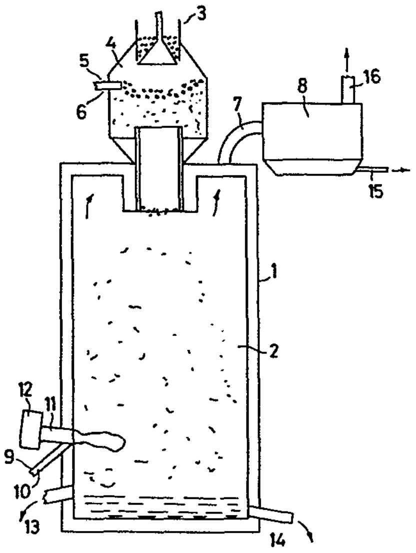
(54) Process for producing an aluminium-silicon alloy from concentrates containing corresponding oxides, even if chemically combined with each other and/or with other metal oxides.

(57) A process for producing an aluminium-silicon alloy from concentrate containing the corresponding oxides, even if chemically combined with each other and/or with other metal oxides, consisting of reducing said oxides with a carbon-based reducing agent in the presence of a plasma arc burner in a shaft reactor filled with reducing material of suitable size.



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This invention relates to a process for producing an Al-Si alloy from concentrates containing the corresponding oxides, even if chemically combined with each other in the form of alumino-silicates. For example, in the case of leucites, which is the most important case especially for Italy, a large number of processes have been developed during the last 50 years fro recovering alumina and alkalies, including experiments in pilot plants and sometimes on an industrial scale.

The results have always been negative for technical or economical reasons. The known processes of the art are as follows:

- attacking with HNO_3 + HCl (Italian patent 536,793), this being negative because of the high cost of the acid and because of material problems;
- attacking with CaO at 1000-1400°C (French patent 527,066);
- attacking with hot $NaNO_3$ in solution, under pressure;
- attacking with $Ca(OH)_2$ under pressure in order to recover KOH (French patent 556,994).

The most recent proposals relate to processes involving attack by H_2SO_4, HCl or alkali. However, at the same time the parametallurgical processes are making progress, these tending to recover the components of an alkaline (or alkaline earth) silico-aluminous concentrate in metal form as an Al-Si alloy, together with the alkaline oxide by virtue of its volatilisation. The use of conventional electric furnaces has not yet given promising technical and economical results because of the low metal recovery and high energy consumption.

It has surprisingly been found that the aforesaid difficulties and drawbacks can be obviated using the process according to the present invention, by which the metals Al and Si can be simultaneously reduced and alloyed into an alloy with high process yields, because of the high contact surface of the reaction phases.

With regard to the chemical reactions, the chemical-physical energy necessary to break the formation bond of leucite or Al and Si oxides is provided both by direct reduction with the carbon and by the energy associated with the Al-Si solution in liquid phase, which subtracts Si and Al as they become formed, thus lowering the activity of the reaction products.

The alkaline oxides contained in the silico-aluminous concentrates are recovered separately.

The present invention relates to a process for producing a metal alloy from the metal oxides either in individual form or chemically combined with each other, by reducing the oxides by means of a carbon-based reducing agent in the presence of a plasma arc burner in a shaft reactor filled with reducing material of suitable size, and is characterised in that the individual or chemically combined oxides are oxides essentially of aluminium and silicon, with oxides of alkaline and/or alkaline earth metals, the reduction reaction taking place at a temperature exceeding 2000°C, the product obtained being an alloy of aluminium and silicon.

According to the invention, the alkaline and/or alkaline earth metal oxides are separated at the top of the shaft reactor.

The invention is described in greater detail hereinafter with reference to the accompanying drawing, which represents a sectional view of a shaft or reactor which can be used in accordance with the present invention.

On the accompanying drawing, a shaft reactor 1 is filled with a reducing agent 2, preferably coke.

A blast furnace charger 3 is mounted at the top of the reactor 1, directly above the reactor itself, and is arranged to be continuously filled with coke to a predetermined level. In order to automatically obtain this predetermined level in the mouth 4 of the blast furnace charger 3, two level indicators 5, 6 are installed, to interact with filling members, not shown. A pipe 7, connected to a condenser 8, emerges from the top of the reactor 1.

The material to be treated, containing silicon and aluminium oxide, is fed through the inlet 9 either alone or in combination with the reducing material, which may also be fed through 10.

There is also a plasma arc burner 11 with a feed pipe 12, and on the base of the reactor 1 there are mounted tapping means 13 for the slag, and tapping means 14 for the liquid metal.

The following occurs during operation. The material to be treated is subjected to air blasting in the reaction zone of the reactor 1, where together with the reducing agent it becomes rapidly heated and reacts to form the liquid and gaseous reduction products. The liquid products consist of an Al + Si alloy, and slag deriving from slagging agents either added separately during the operation or mixed with the material containing the metal oxides, a certain quantity of ash originating from the reducing agent also being produced. The gaseous product consists of unreacted alkaline oxides and reduction gas, of which the composition depends on the reducing agent used.

The liquid reduction products are collected on the base of the shaft and can be discharged through the tapping holes 13, 14, whereas the gaseous products, essentially alkaline oxides, rise upwards through the shaft and are extracted through the pipe 7.

The coke in the shaft forms a permeable layer, through which the reaction products pass respectively towards the base and towards the top of the shaft, and in this respect the coke has the following purposes:

a) to form a large reaction surface for the contact of all the reaction phases;

b) to hold back all the fine grain material which passes through this layer;

c) if necessary, to act as a reducing agent and thus ensure that the reduction conditions exist from one end to the other of the shaft;

d) to prevent the evolved oxide vapours from becoming condensed, this being attained by virtue of the fact that the top of the shaft and the top of the blast furnace are protected by coke.

To ensure that the condition of point (d) is satisfied, coke is fed into the reactor by way of level regulators 5, 6. Furthermore, as stated heretofore, the entire coke layer is maintained at a temperature of about 1000°C or higher.

In addition, it is preferable to use a gaseous or liquid hydrocarbon or a solid coal as the reducing agent.

The reaction gas which leaves the shaft is made to pass through the condenser 8, in which it is separated, and the metal oxides contained in it are condensed and discharged from 15.

The remaining gas, consisting mainly of carbon monoxide and gaseous hydrogen, leaves the condenser at 16 and can be used for various purposes.

The process according to the invention is further illustrated with reference to the following example, which is given by way of non-limiting example only.

EXAMPLE

The material containing a leucite concentrate had the following composition: (in terms of its main elements)

20-23% Al_2O_3
50-53% SiO_2
20-21% K_2O
max. 0.80% as Fe
remainder: oxides of various metals

The following consumption of reducing agent, slagging agents and electricity was determined per ton of treated material:

- reducing agent 100 kg of dried coke
  300 kg of pit coal
- electricity 4 kWh

The following products were obtained per ton of starting material:

- 300 kg of alloy containing 30-35% Al and 65-70% Si
- 190 kg of potassium oxide.

CLAIMS:

1. A process for producing a metal alloy from the metal oxides either in individual form or chemically combined with each other, by reducing the oxides by means of a carbon-based reducing agent in the presence of a plasma arc burner in a shaft reactor filled with reducing material of suitable size, characterised in that the individual or chemically combined oxides are oxides essentially of aluminium and silicon with oxides of alkaline and/or alkaline earth metals, the reduction reaction taking place at a temperature exceeding 2000°C, the product obtained being an alloy of aluminium and silicon.

2. A process as claimed in claim 1, wherein the alkaline and/or alkaline earth metal oxides are separated at the top of the shaft reactor.

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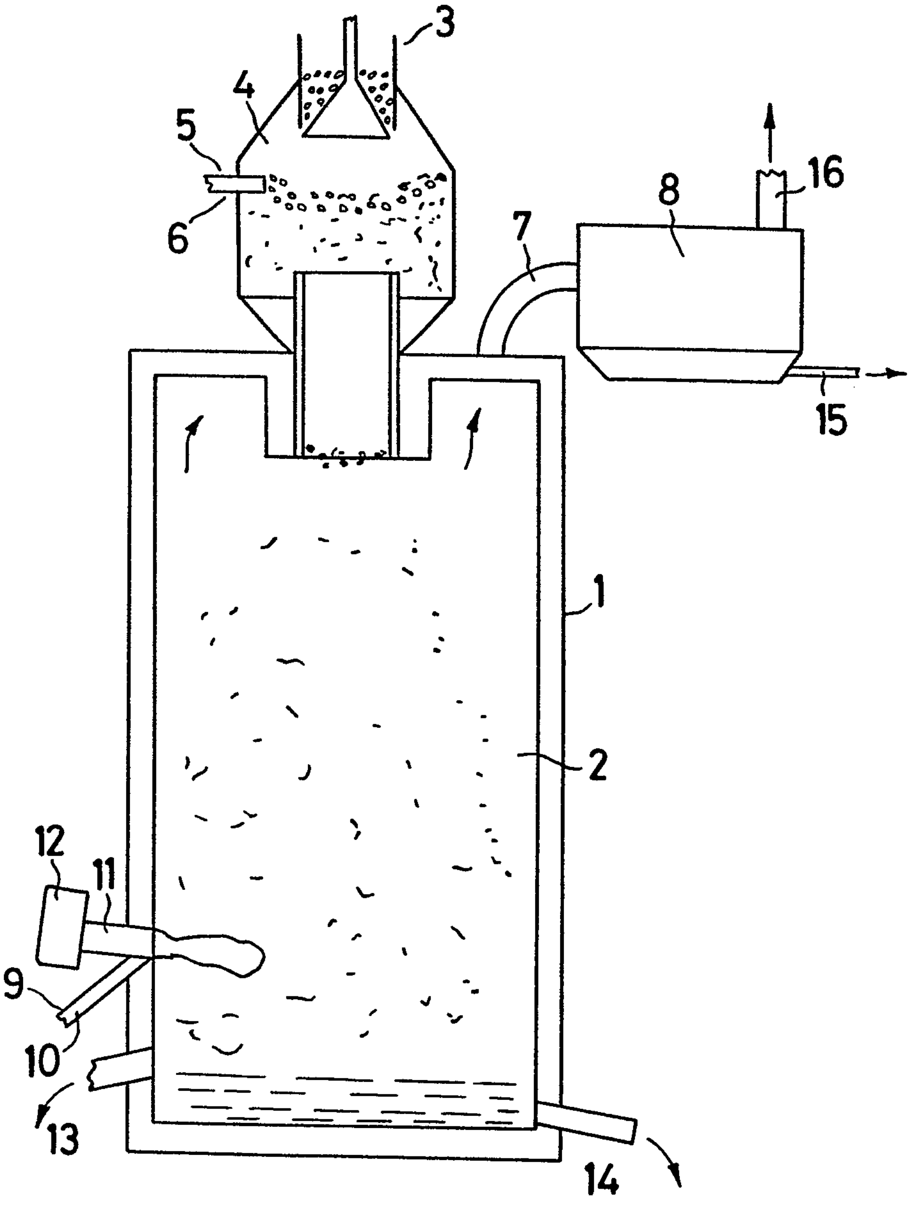

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EUROPEAN SEARCH REPORT

0097993

Application number

EP 83 20 0887

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
P,Y	EP-A-0 058 922 (ALLUMINIO ITALIA SpA) * Claims 1,5 * ---	1	C 22 C 1/02 C 22 B 21/02
Y	FR-A-2 372 900 (ALUMINUM COMPANY OF AMERICA) * Claims 1,12,14-19 *	1	
Y	* Page 10, line 26 - page 11, line 14 * ---	2	
Y	FR-A-2 330 772 (REYNOLDS METALS COMPANY) * Claims 1,3; figures 2-4 * ---	1	
Y	FR-A-2 396 253 (SOUTHWIRE COMPANY) * Claims 1,7 * ---	1	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	US-A-3 365 185 (ELVANDER et al.) * Claim 1; column 1, lines 12-16; column 2, lines 30-36 * ---	1	C 22 C C 22 B
A	FR-A-2 329 753 (BETHLEHEM STEEL CORP.) * Claims 1-3 * -----	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28-09-1983	LIPPENS M.H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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& : member of the same patent family, corresponding document