UNITED STATES PATENT OFFICE.

FREDERICK M. BECKET, OF NIAGARA FALLS, NEW YORK, ASSIGNOR TO ELECTRO METALLURGICAL COMPANY, A CORPORATION OF WEST VIRGINIA.

PROCESS OF PRODUCING ALLOYS.

No. 866,561. Specification of Letters Patent. Patented Sept. 17, 1907.

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To all whom it may concern:

Be it known that I, FREDERICK M. BECKET, a subject of the King of Great Britain, residing at Niagara Falls, in the county of Niagara and State of New York, have invented certain new and useful Improvements in Processes of Producing Alloys, of which the following is a specification.

This invention is a process for the production of alloys of low silicon and carbon content, and is particularly applicable to the production of ferro-alloys of chromium, tungsten, molybdenum and vanadium, these metals being hereinafter referred to as refractory metals.

The process presents particular advantages as applied to the production of ferro-vanadium, and will be described by reference thereto.

The invention consists in reducing a suitable oxid or oxygen containing compound or mixture of oxids by ferrosilicon, preferably containing not less than 50 per cent. silicon, the ferrosilicon being preferably used in proportions and under conditions to insure a low silicon content of the product. The conditions necessary for substantially complete reduction of the metallic oxids above referred to and the production of alloys of low silicon content are obtainable so far as known only in the electric furnace. Preferably a basic flux is used to combine with any excess of silica which may be present in the ore and with the silica derived from the oxidation of the silicon.

Metallurgists have long been familiar with the reducing action of ferrosilicon upon certain metallic oxids, such as oxid of iron, and advantage is taken of this chemical reaction in many industries,—for example the manufacture of steel. Ferrosilicon has also been employed for the production of double silicids of various metals and of alloys containing a considerable proportion of silicon. It has moreover been proposed to use ferrosilicon as a reducing agent for manganese dioxid in the manufacture of manganese steel. I have found that ferrosilicon may be advantageously employed in the electric furnace as a reducing agent for the oxids of the refractory metals above referred to. When a suitable mixture containing ferrosilicon, an oxid of one or more of the above metals, and a basic flux, is treated in an electric furnace the advantages of a continuous and very rapid process may be obtained, and by suitably proportioning the ingredients of the charge the silicon content of the product may be reduced to a fraction of one per cent.

As a specific example of the process I will describe its application to the manufacture of ferrovanadium of low silicon and carbon content, from an oxid ore of vanadium, or an ore which has been treated to convert the vanadium to the oxidized state, or concentrates from such ores. The material containing vanadium oxid is mixed with ferrosilicon, preferably in a moderately fine state of subdivision and preferably used in approximately the proportions indicated by theory, the silicon supplied being substantially equivalent to the oxygen of the vanadium oxid and of any oxid of iron which may be present. To this mixture is added a basic flux, such as lime, in proportion sufficient to yield with the silica a moderately fusible slag, and the charge is then fused in an electric furnace, the heating being continued until a product of the character desired is produced. It is not essential that the proportions used be precisely those indicated by theory, because in the case in which a very low silicon content is required in the alloy the ore or concentrate is used in excess of such proportion; whereas in cases in which a low silicon content is not essential, an excess of ferrosilicon is used. By proceeding in accordance with the latter method slightly higher yields are obtainable.

I prefer to employ a ferrosilicon containing not less than 50 per cent. of silicon, inasmuch as I find that by the use of such ferrosilicon alloys relatively rich in the refractory metals may be produced. It will be understood however that the grade of ferrosilicon is chosen in all cases with reference to the proportion of iron in the charge and the proportion of vanadium or other refractory metal desired in the product.

I do not limit myself to any particular type of electric furnace, but I have found it advantageous to carry on the reduction continuously in an electric furnace in which the current passes through a molten bath of a mixture of ore, ferrosilicon and basic flux, and from which part or all of the metal or slag may be withdrawn as desired, additional quantities of the mixture being added from time to time. To obtain a high yield of the desired alloy and to insure a low silicon content therein I have found it advantageous to feed the mixture to a bath which is maintained at a temperature higher than is necessary to cause some reaction. The electric furnace operation may be carried out by fusing the ore or concentrate and flux and then adding thereto the ferrosilicon, or by fusing a mixture of ore or concentrate and ferrosilicon and adding flux to the bath from time to time, but I have not found these methods to be as efficient as that above described.

The process presents important advantages for the treatment of highly silicious ores or concentrates containing vanadium, for the reason that it permits the direct production from such ores of low carbon and low silicon ferrovanadium.

I claim:

1. The process of producing alloys of refractory metals which consists in passing an electric current through a molten bath containing a refractory oxid reducible by silicon, and ferrosilicon.

2. The process of producing alloys of refractory metals which consists in passing an electric current through a molten bath containing a refractory oxid reducible by silicon, ferrosilicon and a basic flux.

3. The process of producing alloys of refractory metals which consists in passing an electric current through a molten bath containing a refractory oxid reducible by silicon, and ferrosilicon, silicon being present in substantially the proportion required to combine with the oxygen of the reducible oxids, whereby a substantially complete oxidation of the silicon is secured and a product low in silicon is obtained.

4. The process of producing alloys of refractory metals which consists in passing an electric current through a molten bath containing a refractory oxid reducible by silicon, ferrosilicon, and a basic flux, silicon being present in substantially the proportion required to combine with the oxygen of the reducible oxids, whereby substantially complete oxidation of the silicon is secured and a product low in silicon is obtained.

5. The process of producing alloys of refractory metals which consists in passing an electric current through a molten bath containing a refractory oxid reducible by silicon, and ferrosilicon, the ferrosilicon containing not less than fifty per cent. of silicon.

6. The process of producing alloys of refractory metals which consists in passing an electric current through a molten bath containing a refractory oxid reducible by silicon, ferrosilicon and a basic flux, the ferrosilicon containing not less than fifty per cent. of silicon.

7. The continuous process of producing alloys of refractory metals which consists in passing an electric current through a molten bath containing a refractory oxid reducible by silicon, and ferrosilicon, adding fresh portions of the charge and withdrawing the product as desired.

8. The process of producing ferrovanadium which consists in reacting in an electric furnace upon a vanadium compound reducible by silicon with ferrosilicon.

9. The process of producing ferrovanadium which consists in reacting in an electric furnace upon vanadium oxid with ferrosilicon.

10. The process of producing ferrovanadium which consists in reacting in an electric furnace upon vanadium oxid with ferrosilicon, the ferrosilicon containing not less than fifty per cent. of silicon.

11. The process of producing ferrovanadium which consists in reacting in an electric furnace upon vanadium oxid with ferrosilicon, silicon being present in substantially the proportion required to combine with the oxygen of the reducible oxids, whereby substantially complete oxidation of the silicon is secured and a product low in silicon is obtained.

12. The process of producing ferrovanadium which consists in passing an electric current through a molten bath containing vanadium oxid and ferrosilicon.

13. The process of producing ferrovanadium which consists in passing an electric current through a molten bath containing vanadium oxid, ferrosilicon and a basic flux.

14. The process of producing ferrovanadium which consists in reacting upon vanadium oxid with ferrosilicon in presence of a basic flux.

15. The continuous process of producing ferrovanadium which consists in passing an electric curren: molten bath containing vanadium oxid and ferr ilicon, adding fresh portions of the charge and withdrawing the product as desired.

16. The process of producing low-carbon ferro-alloys, which consists in smelting a charge containing ferrosilicon and a compound of a metal reducible by silicon and alloyable with iron, by means of an electrically-heated resistance-conductor, as set forth.

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

FREDERICK M. BECKET.

Witnesses:
CARLETON F. BROWN,
J. W. H. RANDALL.