FORM P 2

REPUBLIC OF SOUTH AFRICA

PATENTS ACT, 1978

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ASSIGNEE(S)	DATE REGISTERED
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TITLE OF INVENTION

54

"THE REFINING OF SILICON"

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REMARKS: (FOR OFFICE USE ONLY)

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FORM P 7

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978

Complete Specification

(Section 30(1) — Regulation 28)

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71 Full Name(s) of applicant(s)

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LAWRENCE BRUCE MCRAE

54 Title of invention

"THE REFINING OF SILICON"

THIS INVENTION relates to the refining of silicon and, more particularly, but not exclusively, to the refining of silicon metal fines produced when silicon metal is crushed after its production to a size suitable for further processing.

However, the scope of this invention is to be interpreted as extending to silicon metal whether in a lumpy or other form and wherein it needs refining. By refining, in this specification, is meant the reduction of at least one aluminium, calcium, and possibly boron and phosphorus levels in the silicon metal.

The conventional way of refining, and remelting silicon metal fines, is to do so under an acid slag in a submerged arc furnace. This process has certain economic disadvantages.

It has now, surprisingly, been found that a satisfactory degree of refining is achieved if the silicon metal material is simply heated and melted under certain conditions. It is, accordingly, an object of this invention to provide a method of refining silicon metal which avoids the use of the acid slag which has been employed heretofore.

It is another object of this invention to provide a method of refining silicon metal which is in the form of fines thereby rendering such fines useable whereas they may not, heretofore, have been favourably employed in further processes in the chemical or metallurgical industries.

In accordance with this invention there is provided a method of refining silicon metal comprising the simple remelting of the metal under a substantially inert gaseous atmosphere and separating any slag which is formed from the molten metal mass either before or after tapping of the metal from the furnace.

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Further features of the invention provide for the silicon metal to be in the form of metal fines; for the heating to be carried out under a thermal plasma in which the inert gas whereby the plasma is formed causes the atmosphere to become substantially inert; and for the silicon metal to be fed to the furnace at a rate calculated to ensure that the metal bath maintains a substantially constant preselected temperature and molten condition.

It will, accordingly, be understood that the temperature at which the silicon metal fines are melted is in excess of 1410°C which is the melting point of silicon.

In order to test the process of this invention various experiements were carried out, initially in a 100kVA transferred plasma arc furnace. Two types of materials were remelted, the one being a good quality metal fines whilst the other consisted of silicon recovered from launders, ladle sculls, and sweepings of the floor. The aluminium and calcium contents of each of these metals is set out below

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	Metal fines	Sweepings
Al%	0,59	3,37
Ca%	0,21	12,2

The feed materials were, in each case, fed at a controlled rate to the reaction zone of the thermal plasma furnace such that the temperature of the bath remained at a suitable temperature above the solidifying temperature of silicon. The argon gas used for generating the plasma was relied upon to maintain a substantially oxygen free atmosphere in the reaction zone.

After melting these two materials individually in the above mentioned furnace under the substantially inert atmosphere and at the rate controlled as indicated above a substantial degree of refining was achieved. The aluminium and calcium levels of the two materials were then as follows:-

	Metal fines	Sweeping
Al%	0,01	0,32
Ca%	0,01	0,01

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Thus a considerable degree of refining was obtained.

It must be mentioned that the boron levels were not checked in the initial tests.

In order to test the invention further, experiments were carried out on a larger scale in a 1500kVA transferred plasma arc furnace manufactured by Tetronics Research and Development Company Limited and substantially as described in their British Patent Nos. 1390351/2/3 and 1529526.

Silicon metal fines were fed to the furnace at a rate calculated to ensure that the metal bath was maintained at a constant selected temperature in excess of 1410°C, the melting point of silicon. It was possible, when operating under these conditions, to demonstrate that the process could be run continuously with molten metal issuing from the tap hole while silicon metal fines were being fed to the furnace.

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Still further tests were carried out using a 100kW 3-phase non-transferred arc plasma furnace using consumable graphite electrodes. Four different materials were remelted. Their analysis before melting is as follows:-

Sample	A	B	C	D
Al%	0,47	0,63	0,59	2,68
Ca%	0,24	0,30	0,40	2,93

After remelting a number of batches of each material their average composition was as follows:

Sample	A	B	C	D
Al%	0,25	0,22	0,20	0,44
Ca%	0,06	0,04	0,03	0,1

A considerable degree of refining was again achieved.

A further series of melting tests were undertaken. The object of these tests was to determine the improvement in quality that could be

obtained when high grade metal fines were remelted. The two samples had the following analyses prior to remelting:

Sample	A	B
Al%	0,45	0,39
Ca%	0,27	0,19

Batches of these materials were melted in a 100kVA transferred arc plasma furnace and the average analyses of the refined materials were as follows:

Refined Sample	A	B
Al%	0,29	0,23
Ca%	0,01	0,01

Thus the invention provides a highly useful but simple means of refining silicon metal fines by a simple remelting process in a thermal plasma arc using non-consumable, as well as consumable electrodes without the use of a refining acid slag.

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Whilst the results of the refining effect of boron were not analysed it is envisaged that boron will similarly be refined during the remelting process.

The invention therefore provides an extremely simple yet effective method of refining silicon metal which also enables silicon metal fines, which were formerly considered to be reject, to be usefully employed.

WHAT WE CLAIM IS:-

1. A method of refining silicon metal comprising the simple remelting of the metal under a substantially inert gaseous atmosphere and separating any slag which is formed from the molten metal mass either before or after tapping of the metal from the furnace.

2. A method as claimed in claim 1 in which the silicon metal starting material is in the form of fines.

3. A method as claimed in either of claims 1 or 2 in which the heating is carried out under a thermal plasma.

4. A method as claimed in claim 3 in which the inert gaseous atmosphere is generated by inert plasma forming gas employed in the generation of the thermal plasma.

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5. A method as claimed in any one of the preceding claims in which the silicon metal feed rate is controlled to ensure that the metal bath maintains a molten condition.

6. A method as claimed in claim 1 and substantially as herein described or exemplified.

7. Silicon metal whenever refined by a process as claimed in any one of the preceding claims.

DATED THIS 14th DAY OF SEPTEMBER, 1983

JOHN & KERNICK

for the Applicant