P. 1466

John&Kernick
Patents Trade Marks and Designs

REPUBLIC OF SOUTH AFRICA

Patents Form No. 1.

THE PATENTS ACT, 1952, AS AMENDED.

APPLICATION FOR A PATENT.

(WITH AUTHORISATION OF AGENT)

FOR OFFICIAL USE ONLY

Filing date and Application No. 75/7930

Full Name(s) of Applicant(s): NATIONAL INSTITUTE FOR METALLURGY

Address(es) of applicant(s): 1 Yale Road, Milner Park, Johannesburg, Transvaal Province, Republic of South Africa

Full name(s) of inventor(s): DAVID IAN OSSIN

I/We do hereby declare that I am/we are in possession of an invention the title of which is

"STAINLESS STEEL PRODUCTION"

I am/We are the assignee(s)/legal representative(s) of the inventor(s). To the best of my/our knowledge and belief there is no lawful ground of objection to the grant of a patent to me/us on this application and I/we pray that a patent may be granted to me/us for the invention.

I/We enclose the provisional/complete specification.

I/We hereby appoint the partners and qualified staff of the firm of John&Kernick jointly and severally, to act for me/us in all matters relating to this application and any letters patent granted thereon.

Dated this 21st day of November 1975

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Table of Classification	
Class	Sub-class

Signature of Applicant(s) and Capacity

PATENTS
Form No. 3

JOHN & KERNICK
Patents, Trade Marks and Designs
9 Sturdee Avenue
Rosebank
Johannesburg
and at
Van der Stel Buildings
Pretorius Street
Pretoria

Application No. 75/7930

P.7152

REPUBLIC OF SOUTH AFRICA

The Patents Act, 1952

COMPLETE SPECIFICATION

(a) Here insert title verbally agreeing with that in the application form.

(a) "STAINLESS STEEL PRODUCTION"

(b) Here insert (in full) name, address, and calling of applicant(s) as in application form.

(b) We, NATIONAL INSTITUTE FOR METALLURGY, of:
1 Yale Road, Milner Park, Johannesburg, Transvaal Province, Republic of South Africa,

do hereby declare this invention, the manner in which and the method by which it is to be performed, to be particularly described and ascertained in and by the following statement :—

THE PRESENT INVENTION relates to the production of stainless steel, and more particularly to the chromium additions required therefor.

High-carbon ferrochromium alloys produced from Transvaal chromites can be more easily and more economically produced when the alloy made contains more than 7 per cent carbon. Due to the low process temperatures and friable nature of the ore, alloys containing lower carbon contents are more difficult to produce and result in increased production costs and lower chromium recoveries. Since high-carbon ferrochromium is a major source of chromium in the new pneumatic processes for stainless steel production these economics and the high-carbon contents are reflected in the production of stainless steel when these new processes are used.

The production of stainless steel alloys by the new pneumatic processes consists primarily of melting together mild steel scrap, stainless steel scrap, high-carbon ferrochromium and ferromanganese, nickel, molybdenum and any other alloying conditions that may be required. The stainless steel scrap provides a low-carbon source of chromium units that aids in the dilution of the high-carbon content arising from the use of high-carbon ferrochromium.

amount of high-carbon ferrochromium used is thus limited by the final carbon requirement (e.g. less than 2% in argon-oxygen decarburization process and less than 0,7% in the vacuum oxygen decarburization), and the limit on the carbon content in the stainless steel melt at the start of decarburization is based on economic grounds. Although pneumatic processes can accommodate virtually any carbon content, high-carbon contents become uneconomic as they result in excessive refractory wear, long refining periods and higher gas consumption. It follows that the higher the proportion of high-carbon ferrochromium used in the melting stage the greater is the proportion of stainless steel scrap required to dilute the carbon content of the final alloy. Because stainless steel scrap is in short supply it has become desireable to provide a method for minimising its use, particularly when using high-carbon ferrochromium produced from Transvaal chromites as the source of chromium.

In our South African Patent Number 72/6389 we describe a method for producing a ferrochromium alloy containing less then 5% carbon by a solid state reaction. Use of this alloy in the production of stainless steel does not require dilution by stainless steel scrap to obtain the required carbon levels for treatment, for example, by duplex pneumatic process such as the Argon Oxygen Decarburization (AOD) technique.

An object of this invention is therefore to provide a single melt process for producing stainless steel in which the carbon

An object of this invention is therefore to provide a single melt process for producing stainless steel in which the carbon content is minimized without the necessity of chromium additions in the form of stainless steel scrap.

According to the invention a process of stainless steel manufacture comprises:

pre-reducing, predominantly in the solid state and to a metallisation of at least 45% of the chromium a mixture of finely divided chromite ore and carbonaceous reductant; the reductant being limited to an excess of 20% unless excess carbon is required to maintain a neutral or reducing atmosphere in the reaction vessel;

adding a predetermined amount of the pre-reduced mixture to a steel melt together with fluxes and non carbonaceous reductants and other alloying additions if required; and

removing the formed slag and decarburizing the final melt in a known manner.

The invention further provides that the mixture be agglomerated; that there be no excess of carbonaceous reductant; that the pre-reduction be effected in an otherwise known manner at temperatures in excess of 1300°C;

The invention still further provides that the mixture of finely dividied chromite ore and reductant be agglomerated in known manner; that the carbonaceous reductant is not in excess of the stoichiometric amount required; that the metallisation be in the region of 80%; that the non-carbonaceous reductant be ferrosilicon or ferrochromium silicide or ferromanganese silicide or any combination of these; that a duplex pneumatic process such as the argon-oxygen process, for example, be used in decarburizing the final melt; and that the steel melt be derived from mild steel scrap, sponge iron or any other source of low carbon iron.

The preferred form of the invention provides that there be approximately 80% of the stoichiometric carbonaceous reductant requirements to obtain a reasonably high degree of metallisation in the mixture.

In the preferred form of the invention, described by way of example only, a process for producing stainless steel comprises the following basic stages:

1. Chromite ore and carbonaceous reductant are individually milled and agglomerated into pellets of the required composition utilizing a suitable binder. Preferably the pellets contain about 80% of the stoichiometric amount of reductant required to completely reduce the chromite.

2. The dried and cured pellets are then heated to a temperature in excess of 1300°C and preferably in excess of 1350°C for a length

of time sufficient to effect 55% to 60% (or higher) metallisation of the chromium in the chromite. However, the temperature should be sufficiently low to ensure that the solid state of the pellet constituents predominates.

3. A predetermined amount of the pre-reduced pellets if then added continuously over a period of time to a bath of molten mild steel scrap together with other alloy additions, fluxes and non-carbonaceous reductants as required. These reductants, in the form of ferrosilicon, ferrochromium silicide, ferromanganese silicide or a combination of these are necessary in amounts inversely proportional to the degree of metallisation of the pellets and proportional to the amount of agglomerated material added to the melt. The agglomerated, pre-reduced ore may alternatively be added in the form of one or more batches.

4. The melt is then tapped and after separation of the slag and metal is decarburized to the required carbon content using a duplex pneumatic process such as the argon-oxygen process. Other decarburization processes may however be used.

Results of the experimental tests conducted to date are summarized in the following tables:

RAW MATERIAL DATA

Experiment NO.	PELLET ANALYSIS C	Cr	Fe	MgO	Al_2O_3	SiO_2	metallization %	Fluxes % by mass of pellets CaO	SiO_2	% by mass of pellets FeCrSi
1.	1,33	33,6	21,5	13,5	17,5	5,1	77,3	22,0	22,0	6,6
2.	2,53	32,9	21,1	13,5	17,5	5,1	71,1	27,4	27,4	4,9
3.	1,81	33,1	20,8	13,5	17,5	5,1	73,5	27,0	27,0	15,7
4.	2,91	33,3	21,3	13,5	17,5	5,1	80,9	27,7	27,7	11,1
5.	1,66	33,3	21,7	13,5	17,5	5,1	76,8	27,3	22,3	9,9

PRODUCT DATA

EXPERIMENT NO.	ALLOY ANALYSIS							SLAG ANALYSIS					
	C	Cr.	Fe	Si	Ni	S	Cr Recovery %	SiO_2	Al_2O_3	Cr_2O_3	MgO	CaO	Fe_2O_3
1.	1,06	16,4	73,7	0,19	8,11	0,060	85,0	30,3	14,5	13,9	13,5	22,7	3,0
2.	1,44	16,3	69,2	0,16	7,36	0,056	86,4	30,8	14,8	14,3	14,3	21,9	3,1
3.	0,86	15,4	74,6	0,73	8,29	0,036	82,6	32,6	14,9	10,5	18,5	18,0	2,1
4.	1,37	16,5	72,4	0,44	7,88	0,037	87,3	32,0	16,9	5,4	22,8	21,8	1,4
5.	1,08	16,2	70,9	0,46	8,11	0,041	85,9	33,9	15,6	8,7	14,5	22,6	1,5

As may be noted from the above data the invention provides a method of stainless steel manufacture wherein the alloy, after the addition of chromium in the form of pre-reduced chromite ore and prior to decarburization, has a sufficiently low carbon content to make decarburization, for example, by the argon oxygen decarburization process, economically viable without the use of stainless scrap in the bath as a diluent for carbon.

The process may be varied in many ways without departing from the scope of the invention. Thus, for example, the ratio of chromite to reductant may be varied, the temperature may be varied, the time may be varied and the proportion of mild steel scrap and/or sponge iron may be varied according to the grade of stainless steel being produced.

Having now particularly described and ascertained our said invention and in what manner the same is to be performed, we declare that what we claim is:-

1. A process for producing stainless steel comprising:

pre-reducing a chromite ore to metallization of at least 45% of the chromium using a predetermined amount of carbonaceous reductant;

adding the resulting pre-reduced mixture to a steel melt in a predetermined ratio and together with any fluxes, non-carbonaceous reductants and alloying additions required; and

removing the slag formed and decarburising the final melt in known manner.

2. A process as claimed in claim 1 in which the amount of carbonaceous reductant is limited to a maximum of 20% in excess of the reductant required for stoichiometric reduction of the chromite ore unless further carbon is required for maintaining a neutral or reducing atmosphere in the reaction vessel used in the pre-reduction.

3. A process as claimed in either of claims 1 or 2 in which the chromite ore and the carbonaceous reductant are in a finely divided state and mixed together.

4. A process as claimed in claim 3 in which the mixture of finely divided chromite ore and reductant are agglomerated in known manner.

5. A process as claimed in any of the preceding claims in which the carbonaceous reductant is not in excess of the stoichiometric amount required.

6. A process as claimed in any of the preceding claims in which the metallization is in the region of 80%.

7. A process as claimed in any of the preceding claims in which the pre-reduction is effected at temperatures in excess of 1300°C.

8. A process as claimed in any of the preceding claims in which the non-carbonaceous reductant is ferrosilicon or ferrochromium silicide, or ferromanganese silicide or a combination of any of these.

9. A process as claimed in any of the preceding claims in which a duplex pneumatic process is used in decarburizing the final melt.

10. A process as claimed in claim 9 in which the duplex pneumatic process is the argon oxygen process.

11. A process as claimed in any of the preceding claims in which the steel melt is mild steel scrap, sponge iron or any other source of low carbon iron.

12. A process substantially as herein described.

DATED this 18th Day of November, 1976.

JOHN & KERNICK
FOR THE APPLICANTS