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P. 3123.

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54	Title of invention
	"THE PRODUCTION OF MATTES CONTAINING PLATINUM GROUP METALS AND GOLD"

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THIS INVENTION relates to the production of
mattes containing platinum group metals and gold and,
in particular, to the production of such mattes from
concentrates having a relatively high chromite
5 concentration and also which can be somewhat richer
in platinum group metals when compared to the well
known Merensky Reef of Southern Africa.

Still more particularly, but not exclusively,
the present invention is concerned with the production
10 of platinum group metal containing mattes from a type
of ore commonly referred to, at least in Southern
Africa, as UG2. Such UG2 reefs have a lower matte-to-
slag ratio than in the case of the Merensky reef and the
slag has a higher liquidus temperature due to its
15 relatively high MgO content. The chromite content
of the UG2 concentrate is usually more than about ten
times that of the Merensky concentrate and the
platinum group metals (PGM) concentration is often of

the order of five times that of the Merensky concentrate.

As a result of these features of the UG2 concentrate there is produced a smaller amount of
5 matte which is to act as a collector for the relatively larger amount of PGM. This substantially increases the losses to the slag in most cases where a conventional process is employed. Also, there is the problem presented by the chromite present in that a conventional
10 smelting process will result in a build-up of chromite spinel which crystallises out in the bottom of the furnace and which leads to a decrease of the working volume of the furnace and also extremely difficult tapping. The removal of such a build-up is extremely
15 difficult and requires that the whole furnace be shut down as far as production is concerned for substantial lengths of time.

Such a build-up results, it is believed, from the fact that the usual 3 or 6 electrode in line type
20 of furnaces are operated substantially continuously and under relatively quiescent conditions which afford the chromite spinel the opportunity of crystallising out in the manner described. Such a furnace arrangement is

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therefore not practical for the treatment of the types of concentrate under consideration.

Apart from the above problems concerning the production of the matte, there are ancillary problems of obtaining a reasonably high quality flotation concentrate of the UG2 reef so that the relative quantity of slag is minimised to keep losses of the matte within acceptable limits.

It is the object of this invention to provide an improved process for the production of PGM containing mattes from UG2 reef or like material or, in fact, mixtures of such materials with Merensky type of reef material.

In accordance with this invention there is provided a method for the production of matte from a PGM and gold containing material which comprises the steps of:-

- (i) if the material is not already in the form of a concentrate, producing a concentrate therefrom in finely sub-divided form;
- (ii) agglomerating the concentrate to form a suitable feed material for a furnace;
- (iii) feeding the agglomerated material, together with any required additives or fluxes, to a circular

- 5 furnace and subjecting the material to smelting at a power density of at least 150kW/m² for a time period sufficient to remove a substantial proportion of matte from the slag and in a manner promoting movement in the slag and thus coalescence of matte particles and droplets;
- (iv) allowing the slag/matte mixture to settle for a suitable length of time and;
 - (v) separating the slag and matte from each other.

10 Further features of the invention provide for the concentrate to be agglomerated by being pelletised or, alternatively, spray-dried prior to being fed to the smelting furnace; for the smelting to be effected at a power density of greater than 250kW/m² and, preferably, at about 400kW/m² or more; for the slag and matte to be allowed to separate in the furnace after cutting off the power following on the smelting process in order to enable the slag and matte to separate properly under quiescent conditions; and for 20 the slag and matte to be tapped either separately or together from the furnace as may be required.

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The type of material to which this invention may be applied is, for example, a concentrate produced from so-called UG2 or like PGM and gold bearing material containing chromite in appreciable proportions by a
5 process of flotation concentration. Such flotation concentration process may include, for example, a rougher concentration step followed by one and preferably two cleaner stages. Coarse particles separated from the rougher concentrate in the cleaner
10 stages may be returned for regrinding and retreatment. Preferably, prior to concentration, the material is ground or milled to at least about 25% minus 75 micron or to a size suitable for flotation. Gangue depressants may be included in the flotation mixture in the usual way.

15 In order that the invention may be more fully understood, the process will be further discussed in more detail starting from a UG2 ore sample emanating from the Brits/Marikana area in the Republic of South Africa.

20 In this case, the ore, which contains some 33% chromite, was ground to 80% minus 75 microns prior to being subjected to flotation concentration.

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The flotation concentration was carried out in three stages namely, a rougher stage followed by two cleaner stages. During milling a sulphide activator was added to improve the sulphide flotation recovery and the sulphide collectors of any suitable type were added. Such collectors include the xanthates, dithiophosphate, mercaptans, and phosphine derivatives which could be used either individually or in combination. A frother also was added to enable the mineral froth to be collected more easily. Gangue depressants may also be employed during this process as required.

The chromite concentration was reduced to 7% in the rougher stage and to 2,9% after the two cleaner stages. The concentrate had a composition as follows:-

MgO	Cr ₂ O ₃	SiO ₂	FeO	Al ₂ O ₃	CaO	Ni	Cu	S	PGM+Au
%	%	%	%	%	%	%	%	%	ppm
20,1	2,9	42,5	12,7	3,6	2,3	2,1	2,1	3,0	430

It must be noted that in a production process coarse middling particles arising from the cleaner stages would be reground. In order to achieve such regrinding, it is considered that it may well be advantageous to separate from the coarse particles the fines which could probably be discarded in view of their low value.

The further treatment of the flotation concentrate thus obtained in a circular smelting furnace will now be described. As a preparatory step, the flotation concentrate was dried, mixed with 3% by weight bentonite, 5 moistened to about 6% by weight water and then pelletised on a rotating disc. After pelletising, the pellets were dried before being fed to the smelting furnace.

Briquetting could also be used as a means of agglomerating the feed and spray drying of the wet concentrate with 10 the use of a suitable binder to prevent dusting is also considered to be satisfactory.

Flux in the form of limestone was added to the smelting charge and, in various tests, these additions ranged between 8% and 30% by weight of the concentrate 15 charged. The higher levels were added when smelting in a furnace with a magnesite lining and it was also noted that because of the high temperatures obtainable in a circular furnace, successful smelting could be carried out without any flux additions whatsoever.

20 An arc was then struck and once this had stabilised feeding of the furnace commenced. The feed rate was regulated so that red top conditions were maintained. An alternative procedure would be to choke feed the furnace. In either case, super-heating was

continued for five minutes after all the feed had melted and after this time the power to the furnace was turned off and the molten contents allowed some fifteen minutes of quiescent conditions in which to settle. The furnace
5 was thereafter tapped using two tap holes in the particular embodiment of the invention being described and slag was tapped from the furnace after every smelt whereas matte was only tapped through the lower tap hole when sufficient quantity was present in the hearth.

10 The above described tests were conducted in a 200kW furnace and the results given below were obtained during a continuous run in which 5 550Kg of pelletised concentrate was smelted. The operating conditions were as follows:-

Charge:-	Pellets	5 550 kg
	Limestone	775 kg
Products:-	Slag	4 785 kg
	Matte	580 kg
	Power consumption	1 088 kWh/ton
	Electrode "	6,43 kg/ton concentrate
	Maximum amperes	1 550 A
	Maximum volts	130 V
	Power density	707 kW/m ²
	Average slag tapping temperature	= 1 475°C
	Average matte tapping temperature	= 1 301°C

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Analysis of a typical slag sample

MgO	Cr ₂ O ₃	SiO ₂	FeO	Al ₂ O ₃	CaO	Ni	Cu	S	PGM+Au
ξ	ξ	ξ	ξ	ξ	ξ	ξ	ξ	ξ	ppm
21,7	3,0	45,4	13,6	3,72	11,9	0,14	0,12	0,34	1,71

Analysis of a typical matte sample

Ni	Cu	Fe	Cr	S	PGM+Au
ξ	ξ	ξ	ξ	ξ	ppm
17,9	10,5	42,8	0,31	29,2	2 770

Absolutely no evidence was present of any build-up in the hearth of the furnace during the smelting campaign on the abovementioned concentrate which took place in 99 batch operations. This is attributed to the movement which is created in the charge in the circular furnace and under the high power densities used. This distinguishes the present invention clearly from the prior art where a charge of this nature would, in the normal "in-line" furnaces operating at normal current densities, result in a build-up of chromite spinel.

It will be quite clear from the results that the PGM plus gold reported effectively to the matte with only small quantities being entrained with the slag. This is attributed to the movement followed by the settling period during which most entrained matte can settle out of the slag.

It is envisaged that a highly effective commercial process will be based on the process provided by this invention and that such a process will most effectively take place at a power density of about 400kW/m². It must be mentioned that it is also envisaged that a charge consisting of a mixture of material high in chromite and PGMs with concentrates containing less of each can be effectively treated according to the invention. In particular, the invention may well be applied to a mixture of the so-called UG2 reef concentrates and those obtained from the Merensky type of reef. This mixture may be used purely for economies of operating on a desired scale.

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WHAT WE CLAIM IS:-

1. In accordance with this invention there is provided a method for the production of matte from a PGM and gold containing material which comprises the steps of:-
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 - (ii) agglomerating the concentrate to form
10 a suitable feed material for a furnace;
 - (iii) feeding the agglomerated material, together with any required additives or fluxes, to a circular furnace and
15 subjecting the material to smelting at a power density of at least 150kW/m^2 for a time period sufficient to remove a substantial proportion of matte from the slag and in a manner promoting movement
20 in the slag and this coalescence of matte particles and droplets,
 - (iv) allowing the slag/matte mixtures to settle for a suitable length of time and;
 - Iv) separating the slag and matte from each other.

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