

UNITED STATES PATENT OFFICE.

FREDERICK M. BECKET, OF NIAGARA FALLS, NEW YORK.

METHOD OF REDUCING ORES.

No. 930,027.

Specification of Letters Patent.

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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 Methods of Reducing Ores, of which the following is a specification.

This invention contemplates the employment as a reducing agent for ores, and more particularly for the oxid ores of such refractory metals as chromium, tungsten, molybdenum and vanadium, of alloys consisting of or containing both silicon and boron. The use of such reducing agents presents particular advantages in the production of metals or alloys which are required to be low in carbon and silicon, and more particularly in such cases where the presence of a small proportion of boron in the final product is either advantageous or objectionable.

As a specific example of the process, I will describe its application to the manufacture of a low-carbon ferro-chromium from chromite. In this case the reducing agent may be a borid of silicon, which may contain an excess of or be alloyed with either silicon or boron, as well as iron, carbon, calcium, or other elements, the presence of which is incidental to the commercial preparation of the reducing agent. In case the borid contains also such reducing agents as carbon or calcium, or other impurities or constituents capable of exerting under the furnace conditions a reducing action upon the components of the ore, these impurities or constituents are taken into account in the preparation of the charge. The reducing agent may be used in substantially the proportion required to combine with the oxygen of the charge, or in somewhat smaller or greater proportion, depending upon the character of the product desired and whether boron is a desirable or non-injurious constituent thereof. In cases in which it is desired to produce a product low in boron or free from boron, the ore is preferably employed in excess; on the other hand, where boron is unobjectionable or is a desirable constituent of the product, a somewhat higher efficiency of operation may be secured by using a slight excess of the reducing agent, or such excess may correspond to the desired boron content of the product.

The operation is facilitated by the presence in the charge of a base capable of uniting

with the oxid of boron produced. Most commercial chromites contain from 8 to 15 per cent. of alumina and a similar proportion of magnesia, and to the extent of their presence these serve the purpose of a basic flux. In case of ores free from basic constituents, or in case of the deficiency of such constituents, a suitable basic flux as lime is added as required, the object being the formation of a slag having a suitable fusing point and a proper degree of fluidity at the working temperature of the furnace. Obviously, an acid flux may be added should the constitution of the charge require it for the production of a proper slag.

The reduction is preferably carried out in an electric furnace, and where a fused metallic product low in boron and silicon is required, the use of the electric furnace, or of a furnace capable of affording a like high temperature, is probably essential. The electrodes may be of carbon, or of a refractory metal or alloy suitably water-cooled, in accordance with the proportion of carbon permissible in the product. The lining of the furnace should be chosen with reference to the composition of the slag to resist so far as possible its corrosive effect. In case very low percentages of carbon are not required, the furnace may have a hearth or lining of carbon. The operation is preferably substantially continuous in character, the charge materials being supplied as required and the molten products tapped from the furnace. The slags are advantageously utilized for the production of borates, as for example the borates of the alkali metals, or they may be reduced by carbon in a separate operation. In the latter case the boron constituent is recovered, usually in the form of an alloy with the other reducible constituents of the slag, as for example, an alloy of boron with silicon, or with silicon and calcium, often in conjunction with a considerable proportion of the metal, as chromium, etc., originally reduced; in this form the boron may be repeatedly utilized for the reduction.

By the expression "refractory metals" occurring in certain claims, I mean such metals as require the application of heat to the charge to maintain the reacting temperature for their reduction by boron or alloys or compounds of boron with production of a reduced metal free or substantially free from the unoxidized reducing agent, the reaction not being self-propagating in character.

I claim:—

1. The method of reducing ores which consists in reacting thereon simultaneously with silicon and boron.
- 5 2. The method of reducing ores which consists in reacting thereon simultaneously with silicon and boron in the presence of a basic flux.
3. The method of reducing ores which consists in reacting thereon with a borid of silicon.
- 10 4. The method of reducing ores of refractory metals which consists in electrically smelting such ores with a reducing agent
- 15 containing silicon and boron.
5. The method of reducing oxid ores of refractory metals, which consists in electrically smelting a charge containing such ore, and a reducing agent containing silicon and
- 20 boron, the silicon and boron being present in substantially the proportion required to combine with the oxygen of the ores, where-

by a product low in silicon and boron is obtained.

6. The method of reducing oxid ores of refractory metals, which consists in electrically smelting a charge containing such ore, a reducing agent containing silicon, boron, and a basic flux, the silicon and boron being present in substantially the proportion required to combine with the oxygen of the ores, whereby a product low in silicon and boron is obtained.
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7. The method which consists in smelting an ore with silicon and boron, thereby producing a metal or alloy and a slag containing silicon and boron, and smelting said slag to recover silicon and boron therefrom.
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In testimony whereof, I affix my signature in presence of two witnesses.

FREDERICK M. BECKET.

Witnesses:

GEORGE C. FURNESS,
J. N. DEINHARDT.