UNITED STATES PATENT OFFICE.

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PROCESS OF REDUCING METALLIC SULFIDS.

No. 855,157. Specification of Letters Patent. Patented May 28, 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 Reducing Metallic Sulfids, of which the following is a specification.

This invention relates to the reduction of sulfids by means of silicon or silicon alloys.

The invention presents particular advantages as applied to the reduction of molybdenum and vanadium from their sulfid ores, and will be described by reference thereto. The process may, however, be applied generally to sulfid ores, concentrates, mattes or compounds, and the invention is not restricted to the specific instance described by way of illustration.

The usual commercial method of producing molybdenum comprises two steps, molybdenite, MoS_2, being first roasted in an oxidizing atmosphere to an oxid or mixture of oxids of molybdenum, which is then subjected to the reducing action of carbon. In order to produce a low-carbon metal by this method it is necessary to use an amount of reducing agent somewhat less than that theoretically requisite, and to maintain the temperature below the fusion point of the reduced molybdenum. The molybdenum thus obtained is in the undesirable form of powder, and contains several per cent of the oxids of molybdenum—chiefly the lower oxids such as Mo_3O_8. When the metal is produced in the fused condition the oxids are generally eliminated, but the molybdenum contains an objectionable proportion of carbon. The yield of molybdenum by this method is also low. Another commercial method consists in reducing molybdenum oxid by aluminium, thereby obtaining a fused metal of high purity, but at an excessive cost.

I have found that commercially pure molybdenum or vanadium may be produced by smelting in an electric furnace a mixture of molybdenum or vanadium sulfid, and silicon or a material containing silicon, the silicon being preferably employed in substantially the proportions indicated for molybdenite by the reaction—

$$MoS_2 + Si = Mo + SiS_2.$$

I have also found that a commercially pure ferro-molybdenum or ferro-vanadium or the corresponding nickel-molybdenum or nickel-vanadium alloys may be produced by smelting in an electric furnace a mixture of molybdenum or of vanadium sulfid, with a silicon alloy as ferrosilicon or nickel silicon, the alloy being preferably used in approximately the proportions required to supply sufficient silicon to unite with the sulfur of the sulfid.

In operation the sulfid, and a silicon-bearing reducing agent, comprising either silicon or a silicon alloy, both in a moderately fine state of subdivision, are smelted in any suitable electric furnace, which should preferably, in case a product low in carbon is required, be provided with a hearth or lining of material other than carbon.

It is not essential that the proportion of silicon to sulfur should be precisely that indicated by theory, for in case a product very low in silicon is required the sulfid should preferably be used in excess of such proportion; whereas if a certain proportion of silicon is permissible in the product an excess of the silicon or silicon-bearing reducing agent may be used. The operation is preferably rendered continuous in character by adding fresh portions of the charge from time to time and withdrawing the product as desired.

By smelting the charge in a close chamber and protecting the products from oxidizing influences the sulfid of silicon may be collected, but in open smelting furnaces both of the constituent elements of the sulfid unite with oxygen, yielding silica in a state of minute subdivision and sulfur dioxid; these products may be collected and utilized as desired.

In the production of the alloys of molybdenum or vanadium with iron, nickel and the like, I may incorporate iron, nickel, or other metal with the charge prepared for the reduction of molybdenum or vanadium, or I may introduce the desired proportions of these metals into the furnace at any time during the operation: or the metals, iron and nickel, for example, may be reduced from their compounds simultaneously with the reduction of the molybdenum or vanadium without interfering with the process.

I claim:

1. The process which consists in reacting upon a metallic sulfid with silicon.

2. The process which consists in reacting upon a metallic sulfid with a silicon alloy.

3. The process which consists in reacting upon a metallic sulfid with ferrosilicon.

4. The process which consists in commin-

gling a metallic sulfid and a silicon-bearing reducing agent, and electrically smelting the mixture.

5. The process which consists in commingling a metallic sulfid and ferrosilicon, and electrically smelting the mixture.

6. The process of producing metals of low silicon and carbon content which consists in reacting upon a metallic sulfid with silicon, the silicon being present in substantially the proportion required to unite with the sulfur of the sulfid.

7. The continuous process of reducing metallic sulfid which consists in smelting a mixture of said sulfid and a silicon-bearing reducing agent, adding fresh portions of the charge, and withdrawing the product as desired.

8. The process of reducing molybdenum sulfid which consists in reacting thereon with silicon.

9. The process of reducing molybdenum sulfid which consists in reacting thereon with a silicon alloy.

10. The process of reducing molybdenum sulfid which consists in reacting thereon with ferrosilicon.

11. The process of reducing molybdenum sulfid which consists in reacting thereon with silicon in substantially the proportion required to unite with the sulfur of the sulfid.

12. The process of reducing molybdenum sulfid which consists in reacting thereon with ferrosilicon in substantially the proportion required to supply silicon to unite with the sulfur of the sulfid.

13. The continuous process of reducing molybdenum sulfid which consists in smelting a mixture of molybdenite and silicon, adding fresh portions of the charge, and withdrawing the product as desired.

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

FREDERICK M. BECKET.

Witnesses:

C. P. TOWNSEND,

C. W. FOWLER.