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METALLURGICAL PROCESS AND PRODUCTS

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16 Claims. (Cl. 75—122)

This invention relates to a process for the extraction of chromium and phosphorus from their compounds and the novel products resulting therefrom.

I have discovered that chromium and phosphorus may be extracted from native chromite and phosphatic materials by a simple reduction process which effects large economies in manufacture of steels and other products utilizing these elements.

Chromium has long been known as a difficult element to reduce and the usual reduction by carbon in the presence of ferrous materials results in a high carbon product that needs further refining. Non-carbonaceous reducing agents such as silicon and aluminum have been resorted to in order to avoid carbon contamination, but these are expensive and add materially to the cost.

I have found that carbon can be used as a reducing agent and still obtain a low-carbon product if smelting of chromite ore is done in the presence of phosphorus or phosphatic rock. The phosphorus combines with the iron-chromium base to exclude the carbon, thus forming a ferro-chromium-phosphorus alloy low in carbon.

This ferro-chromium-phosphorus may be used directly as an alloying addition in making chromium steel containing phosphorus or may be treated with fresh amounts of raw chromite to form low phosphorus-ferro-chromium alloy, together with other compounds of phosphorus.

I prefer to smelt in a suitable furnace a mixture of chromite ore, phosphatic rock, iron ore (or iron scrap), silicious material (such as quartz), lime and carbon. By suitably proportioning the acids and bases according to the practice usual in the manufacture of ferro-phosphorus from phosphatic rock, I obtain a product containing chromium, iron and phosphorus, the iron and chromium predominating. I may use this alloy in a number of ways, or I may treat it further to extract the phosphorus. For example, I may blow the molten ferro-chromium-phosphorus in a basic converter, recovering ferro-chromium alloy and phosphatic slag, the latter suitable for use in fertilizer production. Or I may treat the crude alloy of iron-chromium-phosphorus in a basic open hearth and after a preliminary low temperature oxidation for phosphorus removal, utilize the iron and chromium remaining as a charge for chromium steel, diluting the same with iron as desired, either before or after the phosphorus extraction.

By my process, I extract chromium and phosphorus from their native compounds by a single smelting and avoid the heretofore usual carbon contamination. All of this results in economies of production of iron-chromium alloys, chromium alloy steels, and phosphoric materials used in the industries. As will be understood, vaporized phosphorus and phosphorus compounds may be recovered as usual incidents of the process.

If desired, other low carbon ferro-alloys and corresponding steels may be prepared by my process. Examples of these are ferro-tungsten, ferro-molybdenum, ferro-vanadium, ferro-nickel, ferro-uranium, ferro-manganese, ferro-tantalum, ferro-zirconium, ferro-titanium, etc.

The various alloys disclosed herein made by the aforesaid process or by known conventional processes and particularly the iron-chromium-phosphorus alloy may be used as separate entities to make cast and wrought articles for corrosion-resistant and heat-resistant purposes. Such an alloy may contain iron and chromium totalling from 75 to 99% and phosphorus from .5% to 25%.

By the term "low-carbon", I mean less than 2½ percent when applied to ferro-alloys; and less than 1 percent when applied to alloy irons and steels, (preferably less than .50 percent).

I claim:

1. A process of making low-carbon iron-chromium-phosphorus alloys which comprises mixing reducible materials containing iron, chromium and phosphorus and reducing the same with a carbonaceous reducing agent, the phosphorus being present in sufficient amount to prevent a large accession of carbon in the alloy.

2. A product obtained according to claim 1 comprising a heat resistant and corrosion resistant iron base alloy containing as essential ingredients carbon from trace to 1%, iron and chromium totalling from 75 to 99%, and phosphorus from above .5% to 25%, the phosphorus repressing carbide formation in the alloy.

3. The process of making low carbon alloy iron and steel which comprises smelting an oxygen-containing compound of the group consisting of chromium, tungsten, molybdenum and vanadium, with an additional material containing a substantial amount of combined phosphorus under carbonaceous reducing conditions and refining the product.

4. The process of making an iron-chromium alloy low in carbon which comprises mixing chromite ore with phosphatic material and smelting the mass with a carbonaceous reducing agent.

5. The process of making low-carbon iron-chromium alloys which comprises reducing chromite ore with carbon in the presence of a sub-

stantial amount of an added phosphatic material and then treating the product with an oxidizing agent.

6. The process of making low carbon iron-chromium alloys which comprises treating chromite ore and ferruginous materials with a reducing agent in the presence of a large amount of phosphorus and then treating the product with an oxidizing agent.

7. The steps in the process of making low carbon iron-chromium alloys which comprise forming a charge containing chromite ore, phosphate rock, and siliceous material and reducing the same with carbon.

8. A low carbon alloy having high resistance to oxidation consisting of iron and chromium totalling from about 79 to about 95%, and phosphorus from about 5 to about 21%.

9. An iron-chromium-phosphorus alloy containing as essential ingredients iron and chromium totalling from 75 to 99% and phosphorus from above 0.5 to 25%, the carbon content of the alloy being from trace to 1%.

10. An alloy containing less than 1.0% carbon and containing iron, phosphorus, and at least one element of the group consisting of the metals chromium, tungsten, molybdenum and vanadium; the element of the group being present in essential amount totalling with the iron from 75% up to 99% of the alloy, and the phosphorus being present in an amount from over 0.5% to 25%.

11. The process which comprises smelting phosphatic material and a compound of the group consisting of chromium, tungsten, molybdenum and vanadium, the smelting being carried out under reducing conditions to produce a low carbon phosphorus alloy.

12. A low carbon alloy consisting of iron and chromium totalling about 80 to 97% and phosphorus from about 3 to 20%.

13. As a new article of manufacture, a ferro-alloy containing phosphorus from above .5% up to 25%, and an element of the group consisting of chromium, tungsten, molybdenum and vanadium, such element and iron being present in commercial ferro-alloy proportions and together with iron totalling from 75% up to 99% of the alloy, the carbon content being less than 2.5%.

14. The process of making an iron-chromium alloy low in carbon which comprises smelting chromite ore and a substantial amount of an added phosphatic material with a reducing agent.

15. The process of making an iron-chromium alloy which comprises reducing a charge containing a phosphorus compound and a chromium compound to produce a low carbon iron-phosphorus-chromium alloy and blowing the alloy in a basic converter.

16. The process of making an iron alloy which comprises smelting a charge containing ferruginous material and a compound of the group consisting of chromium, tungsten, molybdenum and vanadium with a carbonaceous reducing agent and sufficient phosphatic material to produce a low carbon alloy.

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